

REGULATION AND SYLLABUS
FOR
POST GRADUATE DEGREE PROGRAMME
CHOICE BASED CREDIT SYSTEM (CBCS)
2014-15



Faculty of Life Science
JSS UNIVERSITY

(Established under section 3 of UGC Act 1956)
Accredited by NAAC with 'A' Grade
Mysore - 570 015 Karnataka, India

REGULATIONS

I. Definition

1. Program and Course:

a. **Program:** Post-graduate Degree Program

b. **Course:** A theory or a practical or a project work or a combination of all as said above, studied in a semester.

2. **Dean:** The head of the Faculty nominated by the University among the Senior Faculty

3. **Chairman:** A recognised faculty of the respective department nominated by the HOD/ Dean in consultation with the Vice Chancellor.

4. **Faculty:** A teaching member as per UGC.

5. **Semesters:** There are two semesters in a year. The semester that begins in July (July to December) is known as Odd semester and the semester that begins in January (January to June) is known as Even Semester. This includes examination and vacation for both the semesters.

II. Program Study:

1. **Curriculum:** Every department has a prescribed course structure, which in general terms is known as Curriculum/Course of Study/Program. It prescribes courses to be studied in each semester. This includes all the curricula and course contents. The medium of the instruction, examination, seminar and project work should be in English.

2. **Credit System:** In general a certain quantum of work measured in terms of credit is laid down as the requirement for a particular degree. The student acquires credits by passing courses every semester. There are mainly two types of courses: i) Laboratory courses consisting of theory and practical and ii) Non-laboratory courses consisting of only theory papers. The credit (C) for a course/paper is dependent on the number of hours of instruction per week in that program. Credits are assigned to practical training, seminar, **workshop** and projects also. The quantum of credits for such activities are stipulated by respective program committee of the department. It is mandatory that the HOD must seek the prior approval for the number of credits by the Board of Studies prior to the CBCS meeting.

3. Duration and Structure of the Program:

The minimum and maximum semesters for completion of a program are given below:

Structure and Duration of the PG Courses

Sl. No	Programs	No. of Semester	Maximum No. of Semester (to complete the Program)	Remarks
1.	Full Time			Minimum two semester/year with 90 working days in each semester
1.a	M.Sc	4	6	
2.	Part - Time			
2.a	M.Sc	8	11	

The minimum number of credits required for the successful completion of the 2 years PG programs is 92.

4. Credit Assessment:

One credit is assigned for each lecture of one-hour duration per week (A 4 credit course will need 4 one hour lecture in one week). Two hours of practical session in a week is equal to one credit (i.e. 1 credit practical course will need 2 hours of practical). The minimum and maximum numbers of credits, a candidate has to be registered in a semester are given below.

Credits

Sl. No.	Semester	Minimum Credits	Max Credits
1	First	20	26
2	Second	20	26
3	Third	20	26
4	Fourth	16	14
	Total	76	92

III. Registration:

1. Registration Procedure:

The student is requested to register for opted courses/papers with the respective faculty, after due announcement of the prescribed dates and at the beginning/commencement of each semester.

The HOD/concerned faculty member will inform the students the list of Core, Allied and Electives courses available for the students for registration. The procedure is as follows:

- i. The registration of courses for the semester(s) other than the first semester shall be made at least one week prior to the end-semester examination of the previous semester.
- ii. The details of the core, Allied and elective and the project shall be intimated to the students, two weeks prior to the date of registration.
- iii. The registration form shall be filled in and signed by the student and the concerned teacher.
- iv. A student may be granted permission to withdraw from a course earlier registered by him/her within two weeks (or in the event of absenting himself/herself for more than two weeks) from the date of commencement of the semester.
- v. A student who has withdrawn his/her registration for a specific course may register for that course again when the same course is offered by the concerned department, in subsequent semester.

2. Temporary withdrawal of registration:

A student may be permitted by the Dean of the faculty on the recommendation of the chairperson of the Program Committee and the concerned Head of the Department to temporarily withdraw from the program up to a maximum of two semesters for valid grounds.

IV. Program Committee:

1. Every post graduate program shall have a Program Committee constituted by the HOD in consultation with all the Course Teachers of the corresponding program.
2. The composition of the Program Committee shall be as follows:

Among the faculty member one will be the Chairperson; Teacher of all courses of the corresponding program; Student Adviser and two student representative of the program (one in I year and other in II year), nominated by the Head of the Department.

3. Duties of the Program Committee:

- i. Reviewing periodically the progress of the classes.
- ii. Discussing the problems concerning curricula, syllabi and the conduct of classes.

- iii. Providing consultation of the Course Teachers on the nature and scope of assessment for the course, this shall be announced, to the students at the beginning of respective semesters.
- iv. Communicating its recommendation to the Head of the Department on academic matters.
- v. The Program Committee shall meet at least thrice in a semester preferably at the end of each internal continuous assessment tests and before the final end semester exam.

V. Attendance:

- i. No candidate who has put in less than 75% of the full attendance for the course shall be permitted to take the semester examination of the concerned course.
- ii. On the day on which a course is concluded, the Course Teacher of the course shall intimate the Head of the Department, the particulars of total class hours, hours attended and percentage of attendance of all students, who have shortage of attendance in the course offered by him/her.
- iii. The Head of the Department shall announce the names of all students who will not be eligible to take the end – semester examination in the various courses due to shortage of attendance.
- iv. Condonation of shortage of attendance will be permitted up to 10% after paying the prescribed fee as per the University norms.
- v. Students having less than 65% of the attendance are directed to re-register for the respective course again to compensate for the short-fall in attendance.

VI. Examination:

A. Continuous Internal Assessment (CIA)

- 1. The Continuous Internal Assessments may be in the form of a combination of periodical tests, assignments seminar and % of attendance.
- 2. The assessment procedure to be followed for each course shall be approved by the Program Committee and announced to the students at the commencement of each semester by the Course Teacher.
- 3. Such schedule for continuous assessment procedure will be displayed on the notice board in the beginning of the semester.
- 4. The course teacher shall intimate the internal marks of the candidates and their attendance detail to the student through notice board.
- 5. The HOD will send the internal assessment marks together with attendance secured by each candidate and forward to Controller of Examinations office. Based on this detail and CBCS regulations, the Controller of Examinations will issue hall ticket (admit cards) for end semester examination, through HOD.

DETAILS OF SESSIONAL ASSESSMENT/INTERNAL ASSESSMENT (25 MARKS)

Examination	Assessment	%Marks
Test	Average of best two test performance	40
Assignment	Average of the two submitted	20
Seminar	Presentation on a given topic	20
Attendance		20 (delete)

The question paper for the test, topic of the assignments and seminar will be assigned by the respective course teacher. All tests will be conducted only on prior notice in the respective departments. The exact date and timing will be announced by the HOD at the start of the semester. The internals for attendance is as follows:

75-85% of attendance	2 marks
85-90% of attendance	3 marks
90-95% of attendance	4 marks
95-100% of attendance	5 marks

B. End Semester Examination (ESE):

1. There shall be one end semester examination (ESE) of three hours duration on each lecture based course.
2. For practical examination, the duration shall be fixed minimum 3 hours and may be extended depends on the course.
3. The end semester examination is compulsory for all students and evaluated by the office of the Controller of Examinations following double evaluation system.

VII. Weightages:

1. For lecture based courses (Non-laboratory)

Continuous internal assessment	- 25 %
End – semester examination	- 75%
2. For laboratory based courses / Practical

sessional assessment	- 25%
End – semester examination	- 75%

VIII. Supplementary Examination:

1. Students who have missed CIA on valid reason(s) may apply for retests to the concerned Course Teacher specifying the reason for the absence and the Course Teacher shall conduct a retest when satisfied with the validity of the reasons given for the absence with the approval of the HOD.
2. Students who have missed the end-semester written examinations on valid reason like hospitalization or accidents may make an application for supplement

examination duly recommended by the HOD within five days from the date of examination missed. The same may be communicated to the Controller of Examinations within 7 working days and the Controller of Examinations may conduct the supplementary examination within a month after paying the prescribed fee (need more discussion on this).

3. A candidate who has failed in one or more subjects in the previous semesters should be cleared six month before i.e. on or before the 5th Semester.

IX. Course wise Grading of Students Letter Grades:

1. Based on the performance, each student shall be awarded a Final Letter Grade at the end of the semester in each course.
2. The letter grades and their corresponding grade points are as follows:

Grade Points	Lower Limit	Upper Limit	Range for P	Grade
5	40	49	$40 \geq P < 50$	E
6	50	59	$50 \geq P < 60$	D
7	60	69	$60 \geq P < 70$	C
8	70	79	$70 \geq P < 80$	B
9	80	89	$80 \geq P < 90$	A
10	90	99	$90 \geq P < 100$	O

The Semester-end Grade Point Average (SGPA) and the Course-end Cumulative Grade Point Average (CGPA) are computed as follows:

The Grade Point in a said course may be calculated by using the formula

$GP = CV \times G$, where CV is the Credit Value of the said course and G is Grade obtained

Better to provide one example

The SGPA may be calculated as follows:

$SGPA = \frac{\text{Sum of all GPs in the said semester}}{\text{Sum of Credits in the said semester}}$

The CGPA may be calculated as follows:

$CGPA = \frac{\text{Sum of GPs in all the semesters}}{\text{credits for the said program}}$

The CGPA may be expressed to an accuracy of three decimal digits

The percentage equivalence may be obtained by multiplying CGPA by 10.

3. The above grading is done by Controller of Examinations office after taking into account both CIA marks together with end semester marks.
4. No student is considered to have completed a course successfully and earned the credits when he / she secure a Letter Grade of "NA" or "I".
5. A Letter Grade of "NA" in any course implies the incompleteness of that course.

6. A course successfully completed can be repeated for the purpose of improving Cumulative Grade Point Average by re – registration with prescribed fee.

X. Method of awarding letter grades:

1. In a reasonable time frame, the Controller of Examinations office will scrutinize the answer books by following “double valuation”. Then the finalized marks(CIA+) is converted to the Letter Grades to be awarded to the students for different courses.
2. Three copies of the Grade Sheets containing the marks awarded with Letter Grades and the results in terms of pass or incompleteness for each course, shall be forwarded to the concerned department.

XI. Grade Card:

The grade card issued at the end of each semester to each student by the Controller of Examinations Office shall contain the following:

1. The credits for each course registered for that semester.
2. The performance in each course shown by the letter grade obtained.
3. The Grade Point Average (GPA) of all the courses registered for the semester.
4. The Cumulative Grade Point Average (CGPA) of all the courses studied from the first to final semesters.
5. The maximum marks that can be obtained will be in direct proportion to the credit in the ratio of 25:1.
6. The total marks secured by the candidate for each of the courses in which the candidate appeared for the end semester examinations.
7. For the computation of cumulative grade point average (CGPA) a similar formula is used in which the sum is obtained by adding over all the courses taken in all the semesters completed up to the point in time and substituted in the formula used in the case of CGPA.
8. For both GPA and CGPA calculation, NA-Grade is also included but not I-Grade.

XII. Eligibility for the award of the Postgraduate Degree:

A student shall be declared to be eligible for the award of the Postgraduate Degree, when he/she has fulfilled the following conditions.

1. Registered for and undergone all the core, elective courses and completed the Project Work or Field Trip, etc if any as prescribed by the Scheme of Examinations. (Total No. of credits 76)
2. Successfully acquired the required credits under elective and supportive courses as specified in the curriculum of the Program within the stipulated time.
3. Has a CGPA of 5.0 or higher.
4. Has no dues to the University, Hostel and Library.
5. Has no disciplinary action pending against him/her.
6. Classification of the student for awarding the degree will be as follows.

Sl. No.	CGPA	Grade Point	Classification
a	$8 \leq \text{CGPA} \leq 10$	10	First class with distinction
b	$6 \leq \text{CGPA} < 8$	8	First class
c	$5 \leq \text{CGPA} < 6$	6	Second class

XIII. A. Procedure for award of mark:

The Controller of Examinations office is involved in valuation of answer scripts of various courses conducted as the end semester examination (75 marks). The answer scripts of different courses are subjected to double valuations. They are called as first and second valuation. Whenever the difference in marks between first and second valuation is within 20% marks, the average of the two marks will be taken as the mark secured and the results are **declared by the COE**. If the difference in mark is 20% and above, it will be referred to a third examiner and the third valuation will be compared with the nearest two other marks in arriving at the average mark.

B. Redressal on the award of the mark

1. When a student is aggrieved with regard to the award of mark to course(s), he/she shall make a formal representation on the matter to the Controller of Examinations through the HOD in the prescribed form and fees within the stipulated time (7 working days after receiving the Marks Card).
2. The marks awarded for each answer will be re-totaled by a competent authority by the Controller of Examination office. The result of the re-totaled will be intimated to the candidate and HOD within 15 days.

XIV. Details of Sessional Assessment / Internal Assessment for Core, Allied, and Elective papers (For 25 Marks)

Examinations	Assessment		Marks
Test	Average of best two test performance		10
Assignment	Average of the two submitted		05
Seminar	Average of best two presentation of a given topic		05
Attendance	65-75% of attendance / semester	1 mark	05
	75-85% of attendance	2 marks	
	85-90% of attendance	3 marks	
	90-95% of attendance	4 marks	
	95-100% of attendance	5 marks	

The question paper for the test, topic of the assignments and seminar will be assigned by the respective course teacher. All tests will be conducted only on prior notice in the respective departments. The exact date and timing will be announced by the HOD at the start of the semester.

XV. Question Paper Pattern (Core, Allied and Elective)

Time: 3 Hours	Maximum Marks: 75
PART A: (5 X 2 =10 marks) Answer ALL questions All questions carry equal marks	Brief note 1. Unit I 2. Unit II 3. Unit III 4. Unit IV 5. Unit V
PART B: (5 X 4 = 20 marks) Answer ALL questions choosing either a or b All questions carry equal mark	Short answers 6. a or b Unit I 7. a or b Unit II 8. a or b Unit III 9. a or b Unit IV 10. a or b Unit V
PART C: (3 X 15 = 45 Marks) Answer any THREE questions All questions carry equal marks	Long Answer 11. Unit I 12. Unit II 13. Unit III 14. Unit IV 15. Unit V

M.Sc. BIOCHEMISTRY

Course overview

Postgraduate degree in Biochemistry, offered by JSS University, is a well-designed program, which provides in depth knowledge in basic biochemistry while covering the fundamentals of molecular biology, nano-technology and tissue culture.

The course begins with fundamentals of biochemistry, which introduces various physico chemical properties of biomolecules, their organization and function. Next, the student is exposed to various theoretical and practical aspects of biochemical techniques, which will help in any area of life science research. The course continues with the basic aspects of molecular biology that encompassing the structural organization of DNA, RNA and protein, central dogma of life, transcription and translation mechanisms. In addition, in the first semester the student will also study fundamentals of nanotechnology as one of the subjects and statistical models of biology as an elective, which are very much essential in the modern science.

Keeping in mind the demands of modern research in life science, in the second semester, the student is exposed to the basics of cell and tissue culture, genetics, immunology and nanobiology and nanosystems. Knowledge in the gene regulation and expression is very much essential for advancing the career in biochemical research. In addition, the student studies cancer biology as elective and performs experiments covering all the above subjects.

In the Semester-3, the student studies both clinical and plant biochemistry subjects to acquire the knowledge beginning from the synthesis of food all the way to its metabolism in human systems and its impact on human health and disease management. Additionally, the student also studies the fundamentals of enzymes, enzyme inhibitors their role in disease management. Along with these, the student also studies the basics of proteomics, one of the most important areas of research in modern life science. The student is also exposed to various biochemical techniques used in clinical biochemistry laboratory.

The fourth semester provides an opportunity to student to get exposed to modern research labs. The student performs experiments under the supervision of a expert research guide and submits his report as dissertation thesis. In addition, the student can also present his/her research findings in national/international seminars, publish work in high impact peer-reviewed journals. In total, the student gets a chance to shape his/her career in modern life science research.

In conclusion, the M.Sc. in Biochemistry course offered under Faculty of Life Sciences, JSS University is a well-designed masters program for shaping a students career in modern research and teaching.

Eligibility:

A graduate in Science (B.Sc.) from an UGC recognized University with biology as a major subject.

Career opportunities:

Opportunities in Academia: A candidate with M.Sc. in Biochemistry can continue the studies for higher degrees such as M.Phil and Ph.D. In addition, the candidate can also join a teaching institution as lecturer.

Opportunities in Industry: M.Sc. Biochemistry students are highly rated as skilled individuals, therefore, they are more preferred when they appear for interviews in industries for research staff positions.

Opportunities abroad: Students with M.Sc. in Biochemistry can also join various academic and research institutes abroad

M. Sc. BIOCHEMISTRY

	Semester I	Credits
Paper 1	Fundamentals of Molecular Biology	4
Paper 2	Fundamentals of Nanotechnology	4
Paper 3	Fundamentals of Biochemistry and Biomolecules	4
Paper 4	Biochemical Techniques	4
Elective 1	Statistical Methods for Biology	4
Practical 1	Biochemical Techniques (Practical 1)	6
		26
	Semester II	
Paper 5	Cell and tissue culture technology	4
Paper 6	Genetics	4
Paper 7	Nanobiology and Nanosystems	4
Paper 8	Immunology	4
Elective 2	Cancer Biology	4
Practical 2	Combination of all the above (Practical 2)	6
		26
	Semester III	
Paper 9	Plant Biochemistry and Genetic Engineering	4
Paper 10	Enzymology	4
Paper 11	Metabolism	4
Paper 12	Clinical Biochemistry	4
Elective 3	Proteomics	4
Practical 3	Combination of all the above (Practical 3)	6
		26
	Semester IV	
	Summer Project	2
	Thesis and viva voce examination	12
		14
	Total Credits	92

SEMESTER I

PAPER 1: FUNDAMENTALS OF MOLECULAR BIOLOGY

4 CREDITS

Unit I:

Bio-molecules and Cells- Introduction, The Molecules of Life, Genomes, Cell Architecture, and Cell Function, Cells into Tissues: Unicellular and Metazoan Organisms Used for Molecular Cell Biology Investigations.

Unit II:

DNA as Chemical and Genetic Material- Covalent Bonds and Non-covalent Interactions, Chemical Building Blocks of Cells, Chemical Reactions and Chemical Equilibrium, instances of Binding Reactions Reflect the Affinity of Interacting Molecules.

Unit III:

RNA Synthesis and Properties- Structure of Nucleic Acids, Transcription of Protein-Coding Genes and Formation of Functional mRNA, The Decoding of mRNA by tRNAs.

Unit IV:

Protein Synthesis and Properties- Chemical Building Blocks of Cells

Basic Molecular Genetic Mechanisms: Introduction, Structure of Nucleic Acids, The Decoding of mRNA by tRNAs, Stepwise Synthesis of Proteins on Ribosomes. Overview of prokaryotic and eukaryotic gene regulations.

Unit V:

Bio-molecule Structure and Function: Protein Structure and Function, Introduction, Hierarchical Structure of Proteins, Protein Folding, Chemical Reactions and Chemical Equilibrium, Membrane Proteins: Structure and Basic Functions. **Protein Binding and Enzyme Catalysis-** Purifying, Detecting, and Characterizing Proteins.

Reference:

1. Bray A. D., Lewis J., Raff M., Roberts K. and Watson J.D. Molecular Biology of the Cell. B. Garland Publishing, New York and London.
2. De Robertis E.D.P., De Robertis E.M.F. 2001. Cell and Molecular biology. Lippincott Williams & Wilkins. Bombay.
3. Freifelder D. 1990. Molecular biology. Narosa Publishing House, New Delhi

4. Gardner E J & D P Snustad 1996. Principles of genetics. John Willey, New York.
 5. Alberts, B., Bray, D., Lewis, J., Raff, M, Roberts, K, and Watson, J. D. 5th Edition. 2007 Molecular biology of cell. Garland Publishing Inc., New York.
 6. Lodish, H., Berk A., Zipursky, S.L. Matsudaria, P. Baltimore, D. and Darnell, J. 2003. Molecular Cell Biology, Media connected, W.H. Freeman and Company.
 7. Celis J E (Ed). Cell biology. 1998. A laboratory handbook. Academic Press.
 8. Darnell J, Lodish H, Baltimore D 1990 Molecular Cell Biology. 2nd ed. New York, Scientific American Books.
 9. Cooper G M. The Cell: A Molecular Approach 2000 Sinauer Associates, Inc. Sunderland, Massachusetts.
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PAPER 2: FUNDAMENTALS OF NANOTECHNOLOGY

4 CREDITS

Unit I:

Fundamentals and overview of Nanoscience and Technology, History of Nanoscience, properties at nanoscale – theory and definition, electronics, optical and magnetic properties at the nanoscale.

Unit II:

Types of nanomaterials, inorganic - metal and metal oxides, organic – self assembly structures, liposomes, micelles, nanoemulsions and polymeric nanoparticles, carbon based systems –carbon nanotubes (CNTs), bucky balls and graphene.

Unit III:

Synthesis of nanomaterials. Top-down method – lithography, ball milling and etching, Bottom-up method – colloidal method of synthesis, wet-chemistry synthesis and self-assembly.

Unit IV:

Materials used in the synthesis of nanoparticles, organic-based synthetic polymers, phospholipids, surfactants, inorganic salts, natural biopolymers.

Unit V:

Characterization of nanomaterials, electronic microscopy techniques, SEM and TEM, optical spectroscopy techniques, UV-vis absorption and fluorescence spectroscopy, dynamic light scattering, Scanning Probe Microscopy, Atomic force microscopy and scanning tunneling microscopy.

Reference:

1. *Nanoscale Science and Technology*, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005, ISSN: 978-0-470-85086-2.
 2. *Introduction to Nanotechnology*, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, New Jersey, 2003, ISSN: 978-0-471-07935-9.
 3. *Bio-Inspired Nanomaterials and Nanotechnology*, Edited by Yong Zhou, Nova Science, 2005, ISSN: 978-1608761050.
 4. *Nano: The Essentials: Understanding Nanoscience and Nanotechnology*, T. Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008, ISSN: 978-0071548298.
 5. *Nanocrystals: Synthesis, Properties and Applications*, C. N. R. Rao, P. J. Thomas and G. U. Kulkarni, Springer, New York, 2007, ISSN: 978-3-54068751-1.
 6. *Nanochemistry: A Chemical Approach to Nanomaterials*, Geoffrey A. Ozin, Royal Society of Chemistry, Cambridge, UK, 2005, ISSN: 978-1847558954.
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PAPER 3: FUNDAMENTALS OF BIOCHEMISTRY AND BIOMOLECULES

4 CREDITS

Unit I:

Carbohydrates- Structure and classification of carbohydrates. **Chemistry of monosaccharides-** Pentoses, hexoses, deoxyglucose, amino sugars, muramic acid, neuraminic acid. Linkages in sucrose, lactose and maltose, trehalose and glycosides. **Isolation of polysaccharides-** Homopolysaccharides and heteropolysaccharides, starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell wall polysaccharides, blood group polysaccharides, pectin and pectic polysaccharides. **Structural elucidation of carbohydrates-** graded acid hydrolysis, periodate oxidation, methylation, acetylation, GC-MS, IR and NMR. **Glycobiology-** Glycoproteins; N- and O-glycosylation, lectins, carbohydrates in tissue engineering. Proteoglycans; aggrecan, syndecan, and decorin.

Unit II:

Aminoacids- Nomenclature, classification and buffering properties of amino acids, zwitterionic structure, reaction of amino acids, unusual amino acids, non protein amino acids. **Peptide bond-** Features of the peptide bond, naturally occurring peptides; glutathione, enkephalins and endorphins. Chemical synthesis of peptides; Khorana's solution phase synthesis, Merrifield's solid phase synthesis. **Determination of amino acid compositions-** Acid and base catalyzed hydrolysis, separation, quantification, determination of N and C terminal residues, determination of site of glycosylation and type of linkage (o-glycosyl and n-glycosyl). **Elucidation of structure of proteins-** Isolation of proteins; overview of purification and criteria of purity.

Determination of primary structure- Sequencing strategies; N-terminal and C-terminal, sequencing methods. Automated sequencers. Determination of disulfide bond position. Secondary structure of protein; α , β sheet, β -bend, β -turn and super secondary structures. Secondary structure prediction methods; Ramachandran plot, Chou and Fasman algorithm. Tertiary and quaternary structures. **Factors responsible for protein folding and confirmation-** Anfinsen's experiment. Weak forces of interaction; hydrogen bonding, Vander Waal's forces, London force, ionic interactions, hydrophobic interactions, S-S bridges, peptide bond, glycosidic bond, phosphodiester bond, and allolysine. Denaturation and renaturation of proteins, molten globule. 3D Structure of myoglobin, hemoglobin, immunoglobulin, collagen, chymotrypsin and keratin. Chaperons and Levinthal paradox.

Unit III:

Lipids- Classification of lipids; oils, fats, and waxes. Occurrence and physico-chemical properties of fatty acids, esters of fatty acids, cholesterol, phospholipids, glycolipids, sphingolipids, cerebroside and gangliosides.

Lipid mediators- Eicosanoids, prostaglandins, leukotrienes, prostacyclins, thromboxanes, DAG and ceramide.

Unit IV:

Nucleic Acids- Nitrogenous bases, nucleosides, nucleotides, physicochemical properties. Isolation of DNA and RNA from biological sources (microbes, plants and animals). Purification of nucleic acids, physicochemical properties of nucleic acids, melting of DNA, T_m ; factors affecting T_m , Cot curve, classification of DNA based on cot curve. Chemical reactions of DNA and RNA; Nucleotides as regulatory molecules, enzyme cofactors and mediators of chemical energy in cells. **Sequencing of DNA-** Maxam Gilbert method, dideoxy method. Chargaff's rule, secondary structure of DNA. Watson and Crick model; B and Z DNA, other models of DNA structure. Types of RNA, secondary structure of tRNA and cloverleaf model; Other secondary structural features in DNA, stem loop structure, palindromic sequences, cruciforms. DNA protein interaction; zinc finger leucine zipper, helix-turn-helix, other motifs, DNA bending and kinks.

Unit V:

Porphyrins- Structure and properties of porphyrins – Heme, chlorophyll and cytochromes. Reactive oxygen species and detoxification mechanisms.

Vitamins- Water soluble and insoluble vitamins, structure and function, deficiency symptoms.

Reference:

- 1) Lehninger PRINCIPLES OF BIOCHEMISTRY - 5th Edition David L Nelson and Michael M. Cox
- 2) BIOCHEMISTRY – 5th Edition Jeremy M. Berg; John L. Tymoczko and Lubert Stryer
- 3) BIOCHEMISTRY – 4th Edition Donald Voet and Judith G. Voet
- 4) OUTLINES OF BIOCHEMISTRY – 5th Edition Erice Conn and Paul Stumpf
- 5) TEXT BOOK OF BIOCHEMISTRY – 4th Edition Edward Staunton West; Wilbert R. Todd; Howard S. Mason and John T. Van Bruggen

PAPER 4: BIOCHEMICAL TECHNIQUES

4 CREDITS

Unit I:

Separation techniques- Principles, methods and applications of chromatography – Paper, thin layer, ion exchange, gel filtration and affinity chromatography, GLC, HPLC, UPLC and chromatofocussing. **Spectroscopic techniques-** Principles of colorimeter, spectrophotometer, fluorimeter. Beer-Lambert's Law and its limitations. Extinction coefficient, fluorescent probes and their applications

Unit II:

Cell fractionation techniques- Cell lysis, preparation of lysis buffers, pH, ionic strength, ionic and non-ionic detergents, composition of general lysis buffers such as RIPA, homogenization, extraction, salting in, salting out, dialysis and ultrafiltration. **Centrifugation-** Svedberg's constant, sedimentation velocity and sedimentation equilibrium. **Ultra centrifugation-** Differential and density gradient centrifugation, centrifugal elutriation, construction of preparative and analytical ultracentrifuge, Schlieren optics.

Unit III:

Electrophoretic techniques- Polyacrylamide gel electrophoresis, SDS-PAGE, 2D-electrophoresis, agarose gel electrophoresis, isoelectric focusing, pulsed field electrophoresis, high voltage electrophoresis, capillary electrophoresis, isotachopheresis. Separation of proteins, lipoproteins and nucleic acids. Visualizing separated components; staining, fluorescence, PAS staining, zymogram and reverse zymogram.

Unit IV:

Isotopic tracers- Heavy isotopes and radio-isotopes, theory and construction of mass spectrometer. Ionization, fragmentation, m/e, time of flight, MALDI and ESI. **Radioisotopes in Biology-** ^3H , ^{14}C , ^{32}P , ^{131}I , ^{35}S , concept of half-life, decay constant, detection and quantitation - GM counter and solid and liquid scintillation counter. Specific activity, autoradiography and their applications. **Labeling-** Using plant system (monosaccharides and polysaccharides), animal system, chemical (Glucose- ^{14}C) and enzymatic methods (disaccharides). Labeling of acetate ($1\text{-}^{14}\text{C}$ and $2\text{-}^{14}\text{C}$), ATP ($\alpha\text{-}^{32}\text{P}$ and $\gamma\text{-}^{32}\text{P}$), proteins and nucleic acids. **Applications of radioactivity-** Dilution techniques, pulse chase method, carbon dating, substrate product relationship (cholesterol biosynthesis) and bond cleavage specificity.

Unit V:

Animal models, choice of animals, types of studies, xenografts, allografts, mutant organisms (auxotroph), cultured animal and plant cells as representative models.

Reference:

- 1) PRINCIPLES AND TECHNIQUEST OF BIOCHEMISTRY AND MOLECULAR BIOLOGY – 7th Edition Keith Wilson and John Walker
 - 2) BIOCHEMICAL TECHNIQUES THEORY AND PRACTICE
John F. Robyt and Bernard J. White
 - 3) BIOCHEMICAL METHODS – A CONCISE GUIDE FOR STUDENTS AND RESEARCHERS Pingoud; C. Urbanke; J. Hoggett and A. Jeltsch
 - 4) BASIC METHODS FOR THE BIOCHEMICAL LAB
Holtzhauer Martin
-

ELECTIVE 1: STATISTICAL METHODS FOR BIOLOGY

4 CREDITS

Unit 1:

Numerical Methods to Represent Variation-Importance and Scope of Statistics, Data Types, frequency distribution, Graphical Representation Methods (Histogram, Bar Charts, Pie Charts), Measures of Center Tendency (Mean, Median, Mode,) and Dispersion (Standard Deviation, Variance) Advantages and Disadvantages, Co-Efficient of Variance.

Unit 2:

Probability- Basic Terminology, Definition of Probability, Basic Laws of Probability, Types of Probability, Additional Rule of Probability and Multiplication Rule of Probability, Probability Distribution-Bernoulli Distribution, Binomial Distribution, Poisson distribution and Normal Distribution-Simple Problems.

Unit 3:

Sampling Methods- Collection of Data, Census Method, Concept of Population, Sample, Sampling, Sample Size, Sampling Error, Advantages and Disadvantages of Sampling Method, Necessity of Sampling, Types of Sampling Methods, Types of Random Sampling Methods – SRS, Stratified Random Sampling, Systematic Random Sampling And Cluster Sampling.

Unit 4:

Testing of Hypotheses- Statistical Hypotheses-Null and Alternative, Level of Significance, Type I and Type II Error, Critical Region, Power of the Test, P Value, Degrees Of Freedom, Chi-Square Test for Independence of Attributes and Goodness of Fit, Student's t Test: One Sample t Test and Paired t Test, F Test.

Unit 5:

Regression and Analysis Of Variance- Simple Linear Regression, Multiple Linear Regression (Definition, Assumptions, Applications, and Examples), Analysis of Variance –Introduction ,Definition of ANOVA, Assumption , Test Of ANOVA, Types Of ANOVA, Construction of One Way Analysis of Variance.

References:

1. Fundamentals of Biostatistics: Veer Bala Rastogi
 2. Fundamentals of Mathematical Statistics: S.C. Gupta and V. K. Kapoor
 3. Fundamentals of Statistics: S.C. Gupta
 4. Biostatistics, Snedger and Gohrran.
 5. Introductory Statistics for Biology 2nd Edition, R. E. Parker
-

PRACTICAL 1: BIOCHEMICAL TECHNIQUES**6 CREDITS**

1. Paper chromatography – ascending and descending – separation of amino acids and sugars.
2. Qualitative tests for the identification of amino acids and carbohydrates.
3. Thin – layer chromatography of amino acids and lipids.
4. Column (GPC) chromatographic separation of proteins (albumin and trypsin).
5. Polyacrylamide Gel Electrophoresis and agarose gel electrophoresis of serum proteins.
6. Ion exchange chromatography of amino acids.
7. Absorption spectrum of chlorophyll extracted from green leaves.

8. Absorption spectrum of aromatic amino acids, purines and pyrimidines. Determination of Molar absorption coefficient of tyrosine.
9. Optical rotation of sugars using polarimeter.
10. Molecular weight determination of proteins by SDS-PAGE
11. Western blotting
12. Quantitative estimation of proteins by spectrophotometric method.

Reference:

- 1) PRINCIPLES AND TECHNIQUES OF BIOCHEMISTRY AND MOLECULAR BIOLOGY – 7th Edition Keith Wilson and John Walker
- 2) BIOCHEMICAL TECHNIQUES THEORY AND PRACTICE. John F. Robyt and Bernard J. White
- 3) BIOCHEMICAL METHODS – A CONCISE GUIDE FOR STUDENTS AND RESEARCHERS. A. Pingoud; C. Urbanke; J. Hoggett and A. Jeltsch
- 4) BASIC METHODS FOR THE BIOCHEMICAL LAB Holtzhauer Martin.

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SEMESTER II

PAPER 5: CELL AND TISSUE CULTURE TECHNOLOGY

4 CREDITS

Unit I:

Tissue culture media- (composition and preparations), genetic methods and application of superior culture, protoplast, anther, pollen, ovary and embryo culture; organogenesis, somatic embryogenesis: hardening and green house technology, synthetic seeds, germ plasm conservation, somoclonal variations, protoplast fusion and somatic hybridization.

Unit II:

Gene transfer in plants- gene transfer through vectors- biology of vectors used Ti and Ri plasmids, binary vectors, viral vectors cloning strategy and method of gene transfer, vector less gene transfer- electrophoresis and gene gun method.

Unit III:

Transgenic animal- methods used in gene identification, localization and sequencing of genes.

Unit IV:

Types of cell culture- primary and established culture, organ culture, tissue culture, three dimensional culture and tissue engineering, feeder layers, disaggregation of tissue and primary cell culture, Cell separation, cell synchronization, cryopreservation, Culture media, cell culture in continuous, hollow fiber reactor, mass transfer in mammalian cell culture.

Unit V:

Isolation of cells from various sources- maintenance of the cell- conclusion of stem cell research. Introduction to Bio artificial organs- Historical background- Liver, Kidney- skin, pancreas- Urinary Bladder- bone- challenging and advantages

Reference:

1. Plant cell and tissue c culture by Jeffrey W. Pollard and John M Walker.
2. Plant tissue culture by Dixon, Oxford Washington DC, 1985.
3. Plant tissue c culture by Street.
4. Medical Molecular Biology – P.C. Trivedi (2008).
5. Principles of cell and Tissue engineering- Robert Lanza (2005).
6. Microbial genetics- Friedfelder.
7. Animal tissue culture by Ian Freshney.

PAPER 6: GENETICS

4 CREDITS

Unit I:

Introduction to Genetics- Introduction, Scope and significance of genetics. Principle of Genetic Transmission: Mendel's' Experiments, Symbols and terminology, Principle of dominance and segregation, Principle of independent assortment, Mendelian inheritance and probability (Multiplication and Addition rules).

Unit II:

Extension of Mendelism- Allelic variation and gene function, Incomplete dominance, co (dominance, multiple allele, Gene action (from genotype to phenotype), Gene interaction, penetrance, expressivity, epistasis, pleiotropy, interaction with environment. **The chromosomal basis of Mendelism-** Chromosomes – chromosome number, Chromosome theory of inheritance, Experimental evidence, non disjunction as proof of chromosome theory, chromosomal basis of Mendel's principles of segregation and independent assortment, Sex linked genes in humans. **Genetic disorder-** Color blindness, Cystic fibrosis, Down syndrome, Duchenne muscular dystrophy, Hemophilia, Klinefelter syndrome, Sickle-cell disease, Turner syndrome

Unit III:

Mutations- Spontaneous, Induced mutation, Conditional lethal mutations –Base substitution mutation, Missense, Nonsense and Silent mutations; Chemical, Physical and Biological mutagenesis and Detection of mutations.

Concept of gene- Fine structure of gene, Split gene, Jumping gene, Overlapping gene & multiple genes.

Unit IV:

Sex Determination- Sex chromosomes, Chromosomal basis of sex determination in *C.elegans*, *Drosophila*, Man and Plant Example: Lichnis (Melandrium). Molecular basis of sex determination in *C.elegans*, *Drosophila* and Man. **Dosage compensation-** Genic balance, Gene dose, Molecular basis of dosage compensation in *Drosophila* and man.

Unit V:

Molecular anatomy of eukaryotic chromosome – Centromere, Telomere, Nucleosome, Nucleomere, Kinetochore, Chromosome banding.

References:

1. Genetics – Principle and Analysis – Hart and Jones.
 2. Principles of Genetics – Snustad and Simmons.
 3. Genetics – A Continuity of Life– Daniel J. Fairbanks, W. Ralph Anderson.
 4. Atherly A G, Girton, J R and Mc Donald J F, 1999. The Science of Genetics, Saunders College Publishing, Harcourt Brace College Publishers.
 5. Brooker R.J. 1999. Genetics. Analysis and Principles. Ed. Benjamin Cummings. California, Gardner E J, Simmons M J, Snustad D P 1991. Principles of Genetics. John Wiley & Sons, Inc.
 6. Griffith A J F, Miller J H, Suzuki D T, Lewontin R C, Gelbert W M.1996. An introduction to Genetic Analysis. W.H. Freeman and Co. New York
 7. Strickberger, M. W. 1976. Genetics. Macmillan New York
 8. Watson, J. D., Baker T. A., Bell S. P., Gann A., Levine M., Losick R. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Delhi, India.
 9. Klug, W S, and Cummings M. R. 1998. Essentials of Genetics, 3rd Ed. Prentice Hall, Upper Saddle River, NJ.
 10. Hartl, D L & Jones E W 2006. Essential genetics: a genomics perspective (4th Ed), Jones and Bartlett Publishers, Boston.
 11. Tamarin R. H. 2002. Principles of Genetics. Tata-McGraw Hill, Seventh Edition.
 12. Lewin B., Gene IV, V, VI. Oxford University press, Oxford.
-

PAPER 7: NANOBIOLOGY AND NANOSYSTEMS

4 CREDITS

Unit I:

Introduction to Nanobiology - Bio-inspired nanomaterials, interaction between biomolecules and nanoparticle surfaces, synthesis of hybrid Nano-bio assemblies.

Unit II:

Biological Membranes: Lipid membranes, structure and properties, Protein–lipid assembly, applications of biomimetic membranes, interaction of nanoparticles with membranes.

Unit III:

Protein and DNA based nanostructures: Protein based nanostructures building blocks and templates, nanobioelectronic devices and polymer nanocontainers, topographic and electrostatic properties of DNA and proteins, Nanoparticle-based carrier for genetic material. Nanofabrication via DNA origami. Protein therapeutics and protein based nanoparticles. Smart hydrogels and cell penetrating peptides.

Unit IV:

Stem cell nanotechnology: Basics, properties, classification and types of stem cells, three-dimensional scaffolds, stem cell differentiation and proliferation, nanochemistry, nanoshapes and nanomechanics. Nanotechnology for regenerative medicine.

Unit V:

Microbial Nanotechnology: Interaction of microbes with nanoparticles, surface properties, antimicrobial properties of metallic nanoparticles, mechanism of action.

Reference:

1. *Nanoscience : Nanobiotechnology and Nanobiology*, P. Boisseau, P. Houdy and M. Lahmani, Springer, New York, 2010, ISSN: 978-3-540-88632-7.
 2. *Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology*, Hari Singh Nalwa, American Scientific Publishers, USA, 2005, ISSN: 1588830349.
 3. *Nanobiotechnology*, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, 2004, ISSN: 3-527-30658-7.
 4. *Nanocomposite Science & Technology*, Ajayan, Schadler & Braun, Wiley VCH, 2006, ISSN: 3527605177.
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PAPER 8: IMMUNOLOGY

4 CREDITS

Unit I:

Introduction: Historical development and milestones in immunology – Contributions of Edward Jenner, Louis Pasteur, Emil von Behring & Kitasato, Metchnikoff, Primary and secondary lymphoid organs – Lymphatic system, Reticulo-endothelial system, Types of immunity, Innate & Acquired.

Unit II:

Non-specific defenses: Barriers to infection – skin, mucous membrane, inflammation, phagocytosis. Complement system: Classical, alternate and lectin binding pathway, Generation of membrane attack complex. Anaphylotoxins & Opsonins. Antigens: Chemical nature & properties, Epitopes, Antigenicity, Immunogenicity, Valency of antigens, Haptens. Antibodies: Structure, Classes and subclasses, Paratopes, Immunoglobulin variants – Isotypes, Allotypes & Idiotypes, Valency of antibody, antibody diversity.

Unit III:

Immune responses: Primary and secondary, class switching. Structure & functions-MHC antigens in man, Vaccines: Vaccines and their preparations (traditional and recombinant vaccines) BCG, Polio, DPT, HBV, Adjuvants.

Unit IV:

Cellular basis of immunity: Hematopoiesis, Biology of T-cells and B-Cells. T-cell subsets. T-cell and B-Cell receptors. Antigen presenting cells and accessory cells (macrophages & dendritic cells), T-cell and B-Cell co-operation, Antigen processing & presentation, Clonal selection, Cytokines – role in immunity. Transplantation: Tissue typing-Autograft, Isograft, Allograft & Xenograft. Graft versus host reactions (GVHD). Immunosuppression. Hypersensitivity: Types of Hypersensitivity reactions. Types I, II, III & IV Anaphylaxis.

Unit V:

Monoclonal antibodies – preparations & applications, Immunological techniques: Preparations, agglutinations, Complement fixation, Immunodiffusion, Immunoelectrophoresis, Immunofluorescence, RIA & ELISA, Western blotting. Disorders of immunity: Immunological tolerance, Autoimmunity. Immunodeficiency disorders, SCID, AIDS, Tumor immunology: Tumor associated antigens & Tumor specific antigens. Immune surveillance, TNF & α , β , immunotherapy.

References:

1. Roitt I M, Brostoff J and Male D K. Immunology.3rd edn. 1993. Mosby – Yearbook Europe Ltd., London.
 2. Roitt I M Delves P J. Essential Immunology 10th ed 2001 Blackwell Scientific Publications.
 3. Boyd W C Fundamentals of Immunology 1964 Toppan Co. Ltd., Tokyo.
 4. Kimball J W Introduction to Immunology. 1983. Macmillan Publishing Co., Inc.New. York.
 5. Otto S. View and others. Fundamentals of Immunology.
 6. Wier D M. Experimental Immunology 1978 Blackwell Scientific Publications Oxford.
 7. Kubay J. Immunology. 2001. Second Edition. W H Frecman & Company NewYork.
 8. Abbas A K Lichtman A H Cellular and molecular immunology 3rd edition 2007. Oxford University Press, Oxford.
-

ELECTIVE 2: CANCER BIOLOGY

4 CREDITS

Unit I:

Cell organelles and molecular organization of cell- Structural and functional organization of eukaryotic cells -cytoskeleton, plasma membrane, ribosome, endoplasmic reticulum, golgi complex, lysosome, mitochondria, peroxisome, nucleus elements of cells, biomolecules - nucleic acids, carbohydrates, lipids, proteins (structural and functional proteins), assembly of macromolecules.

Unit II:

Cellular reproduction and differentiation- The cell cycle, interphase, M-phase - mitosis and cytokinesis, meiosis; methods to study cell cycle changes, cell differentiation – general characteristics, nucleocytoplasmic interactions, molecular mechanisms of cell differentiation.

Unit III:

Cancer- Definition, benign tumors vs. malignant tumors, types of cancer, common symptoms, hallmarks of cancer – growth signal autonomy, evasion of growth inhibitory signals, evasion of apoptosis, unlimited replicative potential, angiogenesis, invasion and metastasis, molecular basis of cancer - cancer genes - oncogenes and tumor suppressor genes, carcinogenesis – a multistep process, evidences for multistage models of carcinogenesis, animal models of cancer – carcinogen induced models, xenografts, genetically modified models.

Unit IV:

Genetic instability and epigenetics- Basic defense, barriers to genomic instability, genetic variations in cancer, mechanisms of genome destabilization in tumors, chromosome instability, whole chromosome aneuploidy and cancer, perspectives and implication for cancer therapeutics, genetic mutations and drug resistance mechanisms, epigenetic process, epigenomic changes in cancer (DNA methylation, histone acetylation), epigenetic biomarkers and therapies

Unit V:

Signal transduction system- Sensory machinery, ligands and receptors, regulation of protein kinases, small-molecular second messengers, efficiency and specificity, formation of multiprotein signaling complexes, signaling networks influencing cell proliferation, survival and metastasis.

Reference:

- 1) MOLECULAR BIOLOGY OF THE CELL – 5th Edition By Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter
 - 2) TEXT BOOK OF BIOCHEMISTRY FOR MEDICAL STUDENTS – 7th Edition D.M. Vasudevan, S. Sreekumari, Kannan Vaidyanathan
 - 3) GENES IX. By Benjamin Lewin.
-

PRACTICAL 2: QUANTITATIVE ANALYSIS AND MOLECULAR BIOLOGY

6 CREDITS

1. Determination of pKa and PI values of an amino acid by titrimetric method
2. Estimation of proteins by Lowry, Bradford methods
3. Determination of total carbohydrates by Phenol-Sulfuric Acid method
4. Determination of reducing sugars by DNS method
5. Estimation of $\text{Ca}^{++}/\text{Zn}^{++}$ by EDTA titrimetric method
6. Determination of melting temperature (T_m) of DNA
7. Isolation of DNA from bacterial, plant and animal cells.
8. Estimation of DNA by Diphenylamine method
9. Agarose gel electrophoresis for separating DNA and PCR products
10. Estimation of RNA by Orcinol method.
11. Estimation of DNA and RNA by UV absorption method and determination of purity of nucleic acids.
12. PCR

Reference:

1. PRINCIPLES AND TECHNIQUEST OF BIOCHEMISTRY AND MOLECULAR BIOLOGY – 7th Edition Keith Wilson and John Walker.
2. BIOCHEMICAL TECHNIQUES THEORY AND PRACTICE
John F. Robyt and Bernard J. White.
3. BIOCHEMICAL METHODS – A CONCISE GUIDE FOR STUDENTS AND RESEARCHERS A. Pingoud; C. Urbanke; J. Hoggett and A. Jeltsch.
4. BASIC METHODS FOR THE BIOCHEMICAL LAB Holtzhauer Martin.
5. PRACTICAL CLINICAL BIOCHEMISTRY. Harold Varley.
6. HAWK'S PHYSIOLOGICAL CHEMISTRY – 14th Edition. By Philip Bovier Hawk, Edited by Bernard L. Oser.

SEMESTER III

PAPER 9: PLANT BIOCHEMISTRY

4 CREDITS

Unit I:

Thermodynamics- I, II and III laws of thermodynamics. Enthalpy, entropy, free energy and chemical equilibrium. **Respiration-** Plant mitochondrial electron transport and ATP synthesis. Energy currency, ATP, ADP, creatine phosphate, phosphoenol pyruvate as energy rich compound. ATP synthesis, ATP synthase complex, binding change mechanism, proton motive force, Mitchell's hypothesis. Substrate level phosphorylation, futile cycles and their application. **Mitochondrial electron transport-** Entry of reducing equivalents for oxidation; malate-aspartate shuttle, glycerol phosphate shuttle. Organization of respiratory chain complexes, structure and function of the components; Fe-S proteins, cytochromes, Q cycle, proton transfer, P/O ratio, respiratory control, oxidative phosphorylation, uncouplers and inhibitors, sequence of electron carriers based on red-ox potentials. **High energy compounds, Biosynthesis of cofactors-** NAD⁺, FAD and coenzyme A, polyamine biosynthesis and their metabolic role.

Unit II:

Plant hormones- Biosynthesis, storage, breakdown and transport. Physiological effects and mechanisms of action of auxines, gibberellins, cytokinins, ethylene, abscisic acid. **Photosynthesis-** Photosynthetic apparatus in plants, photosystems I and II, light harvesting antenna complex. Electron flow and phosphorylation; cyclic and noncyclic, oxygen evolution, Calvin cycle. C₃, C₄ and CAM cycle. Photorespiration, bacterial photosynthesis. Regulation of photosynthesis. RUBISCO.

Unit III:

Nitrogen metabolism- Importance of nitrogen in biological systems, nitrogen cycle. Nitrogen fixation; symbiotic and non-symbiotic, nitrogenase complex, energetics and regulation. Formation of root nodules in legumes. Assimilation of nitrate and ammonium ion. **Host parasite interaction-** Recognition and entry processes of different pathogens like bacteria, viruses, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in plants, cell-cell fusion in both normal and abnormal cells.

Unit IV:

Sensory photobiology- Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, stomatal movement,

photoperiodism and biological clocks. Seed dormancy, inception of germination. Germination and growth regulators, juvenility, vernalization. **Solute transport and photo assimilate translocation-** Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem. Transpiration, mechanisms of loading and unloading of photo-assimilates.

Unit V:

Stress physiology- Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress. **Secondary metabolites-** Terpenes, phenols, flavonoids and nitrogenous compounds and their roles in plant physiology and as alternative medicine. Methods in phytochemicals: Extraction, fractionation and characterization.

Reference:

1. FUNDAMENTALS OF BIOCHEMISTRY. A.C. Deb
 2. PLANT BIOCHEMISTRY P.M. Dey and J.B. Harborne
 3. PLANT BIOCHEMISTRY, Hans-Walter Heldt and Birgit Piechulla
 4. MOLECULAR BIOLOGY OF THE CELL – 5th Edition. By Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter
-

PAPER 10: ENZYMOLOGY

4 CREDITS

Unit I:

General aspects- Classification of enzymes, nature of enzymes, localization, isolation, purification and characterization of enzymes. Criteria of purity of enzymes, fold purity. Nomenclature and IUB classification of enzymes. Enzyme specificity, specific activity, assay methods; coupled enzyme assays, continuous, end point and kinetic assay. Units of enzyme activity, IU and Katal

Unit II:

Enzyme kinetics- Michaelis-Menten equation, initial velocity approach, steady state approach. V_{max} , K_m and their significance. Linear transformation of Michaelis-Menten equation; Lineweaver-Burk plot, Eadie-Hofstee, Wolf and

Cornish-Bowden. Scatchard plot. Rate of a reaction, order and molecularity. First order reaction kinetics. Rectangular hyperbola, Michaelis- Menten equation as rectangular hyperbola, asymptote, linear transformation, calculation of slope, intercept. **Inhibition-** Reversible and irreversible inhibition; competitive, non-competitive, uncompetitive product inhibition and suicide inhibition. Determination of K_i and K_d . **Bisubstrate reaction-** Cleland's notation with examples of ordered, ping-pong, and random reactions. General rate equation. Primary and secondary plots.

Unit III:

Mechanisms of enzyme catalysis- Active site structure; methods of determining active site structure, isolation of ES complex, affinity labeling, chemical modification studies and active site structure investigation. **Nature of enzyme catalysis-** Transition state theory, proximity and orientation, orbital steering, acid base catalysis, covalent catalysis, metal ion catalysis, nucleophilic and electrophilic catalysis, intramolecular catalyses, entropy effects. Effect of temperature and pH on enzyme catalyzed reaction. **Cooperativity-** Binding of ligands to macromolecules; Scatchard plot, cooperativity, positive and negative cooperativity. Oxygen binding to hemoglobin. Hill equation, homotropic and heterotropic effectors, aspartyltranscarbamylase as an allosteric enzyme.

Unit IV:

Mechanisms of action of specific enzyme- Chymotrypsin; zymogen activation, acid-base catalysis, charge relay net-work. Lysozyme, alcohol dehydrogenase, ribonuclease, carboxypeptidase A, RNA as an enzyme, abzymes, coenzymic action of NAD^+ , FAD, TPP, PLP, Biotin, CoA, folic acid and lipoic acid. Isoenzymes; LDH, multifunctional enzymes (DNA polymerase) and multi enzyme complex (PDC).

Unit V:

Metabolic regulation of enzyme activity: Feedback and feed forward regulation mechanisms with examples, allosteric regulation, fine control of enzyme activity, multi-enzyme complexes with examples – PDH, fatty acid synthesis.

Reference:

1. Lehninger - PRINCIPLES OF BIOCHEMISTRY - 5th Edition. David L Nelson and Michael M. Cox
2. BIOCHEMISTRY – 5th Edition. Jeremy M. Berg; John L. Tymoczko and Lubert Stryer

3. BIOCHEMISTRY – 4th Edition. Donald Voet and Judith G. Voet
 4. OUTLINES OF BIOCHEMISTRY – 5th Edition. Erice Conn and Paul Stumpf.
 5. TEXT BOOK OF BIOCHEMISTRY – 4th Edition. Edward Staunton West; Wilbert R. Todd; Howard S. Mason and John T. Van Bruggen
 6. FUNDAMENTALS OF BIOCHEMISTRY. A.C. Deb
-

PAPER 11: INTERMEDIARY METABOLISM

4 CREDITS

Unit I:

Introduction- Catabolism, anabolism, catabolic, anabolic and amphibolic pathways. **Integration of metabolic pathways-** Integration of carbohydrate and lipid metabolism, and their regulation and manipulation. **Hormonal regulation of metabolism-** Effect of insulin and glucagon, catecholamines, growth hormones and corticosteroids on carbohydrate and lipid metabolism in different tissues. Action of thyroid hormones and their mechanisms.

Unit II:

Metabolism of Carbohydrates- Digestion and absorption of carbohydrates, cellular ingestion of glucose, glycolysis, energetics regulation. Pathways of utilization of pyruvate-lactate, ethanol, gluconeogenesis, regulation, Cori cycle, glucose paradox, citric acid cycle its regulation, energetics, anaplerosis, glyoxylate cycle. HMP shunt pathway inter-conversion of hexoses. Uronic acid pathway, Utilization of non-glucose sugars, Biosynthesis of sucrose, starch and glycogen. **Metabolic disorders-** Disorders of carbohydrate metabolism; diabetes mellitus, classification, metabolic disturbances in diabetes

Unit III:

Metabolism of Lipids- Degradation of triacylglycerols, phospholipids and sphingolipids and regulations; lipase, hormone sensitive lipase, phospholipases and sphingomyelinase. Fatty acid degradation; β -oxidation Knoop's experiment, saturated and unsaturated fatty acids. Regulation, α and ω oxidation. Energetics and biosynthesis of fatty acids; fatty acid synthetase complex, chain elongation and desaturation. Pathways in plants and animals, conversion of linoleate to

arachidonic acid (scheme only). **Cholesterol synthesis, degradation and regulation-** Metabolism of circulating lipids; chylomicrons, HDL, LDL and VLDL. Reverse cholesterol transport by HDL. Oxidized lipids and their metabolism, Foam cell formation. Regulation of blood cholesterol, triglycerides, LDL and HDL. Obesity, and mechanisms, exercise and regulation of energy metabolism. **Phospholipid biosynthesis and regulations-** De novo pathway and inter conversion, biosynthesis of phospholipids, sphingolipids, ether lipids and glycolipids. Degradation and biosynthesis of gangliosides and cerebroside. Biosynthesis of prostaglandins, thromboxanes leukotrienes.

Unit IV:

General mechanisms of amino acid metabolism and regulations- Deamination, transamination, decarboxylation desulphuration, degradation and biosynthesis of individual amino acids. Differences in the pathways in microorganisms, plants and animals. Ketogenic and glucogenic amino acids. Regulation of amino acid biosynthesis; transglutaminase cycle, urea cycle. Inborn errors of amino acid degradation; Phenyl Ketonuria, alcaptonuria, maple syrup urine. **Proteins-** General mechanisms of degradation in cells; ubiquitin-proteasome pathway, lysosomal pathway. Degradation and biosynthesis of glycoproteins and proteoglycans. Biosynthesis and degradation of heme and porphyrins. Non ribosomal peptide synthesis: glutathione, gramicidin. Biosynthesis of creatine, polyamines.

Unit V:

Purines and pyrimidines- Pathways of degradation of nucleic acids, purines and pyrimidines, uric acid formation. Salvage pathways, de novo biosynthetic pathways and regulations. Gout and Lesch-Nyhan syndrome. Conversion of nucleotides to deoxynucleotides. Mechanisms of action of methotrexate, 5-fluorouridine, azathioprine.

Reference:

1. Lehninger - PRINCIPLES OF BIOCHEMISTRY - 5th Edition. David L Nelson and Michael M. Cox.
2. BIOCHEMISTRY – 5th Edition. Jeremy M. Berg; John L. Tymoczko and Lubert Stryer.
3. BIOCHEMISTRY – 4th Edition. Donald Voet and Judith G. Voet.
4. OUTLINES OF BIOCHEMISTRY – 5th Edition. Erice Conn and Paul Stumpf.

5. TEXT BOOK OF BIOCHEMISTRY – 4th Edition. Edward Staunton West; Wilbert R. Todd; Howard S. Mason and John T. Van Bruggen.
 6. FUNDAMENTALS OF BIOCHEMISTRY. A.C. Deb.
 7. TEXT BOOK OF BIOCHEMISTRY FOR MEDICAL STUDENTS – 7th Edition.
 8. D.M. Vasudevan, S. Sreekumari, Kannan Vaidyanathan.
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PAPER 12: CLINICAL BIOCHEMISTRY

4 CREDITS

Unit I:

Basic concepts- Health and disease. Normal and pathological changes affecting cells in the body. Cell death and the physiological causes; physical, chemical, biological agents and nutritional deficiency.

Unit II:

Blood- Composition, cells, functions of plasma proteins and lipo-proteins in diseases. Disorders of hemoglobin; thalassemia, sickle cell anemia. Anemias; microcytic, normocytic and macrocytic. **Diagnostic enzymology-** Mechanisms of elevated enzyme activities. Clinically important enzymes; alkaline phosphatase, creatine kinase, LDH, AST, ALT and isoenzyme changes.

Unit III:

Endocrine disorders- Laboratory diagnosis to assess the function of pituitary, thyroid, adrenals and gonads. Disorders - Graves disease, Hashimoto disease, Addison's disease, Hypo- and Hyper secretion of hormones, Acromegaly, Gigantism.

Unit IV:

Liver- Biochemical indices of hepatobiliary diseases. Bile pigments; formation of bilirubin, urobilinogen, bile acids. Jaundice; prehepatic, hepatic and post hepatic. Diagnosis of liver function tests, diseases of the liver - hepatitis, cholestasis, cirrhosis, fatty liver and gallstones. **Kidney-** Assessment of renal function; creatine clearance, renal calculi, uremia, laboratory investigation of kidney disorders. **Gastrointestinal disorders-** Fractional gastric analysis, hypo and hyper acidity, gastric ulcers, malabsorption syndrome, steatorrhea, diarrhea.

Cardiovascular disorders- Major Cardio vascular system, atherosclerosis, risk factors and pathogenesis. Diagnosis and prognosis.

Unit V:

Metabolic disorders- of amino acid, lipid, nucleic acid and carbohydrates: Phenylketone urea, alkapton urea. Lesch-Nyhan, Gout. Diagnosis of metabolic disorders, Amniocentesis. Disorders of carbohydrate metabolism; diabetes mellitus, classification, etiology, management. Laboratory investigations; GTT, HbA1c, diabetic complications and advanced glycation end products. In born errors of carbohydrate metabolism; glycogen storage diseases, galactosemia, lactose intolerance, pentosuria. Determination of lipids and lipoproteins. Hyper lipoproteinemia and types of modification of lipoproteins. Tay Sachs, Nieman-Pick disease, Fabry's disease. **Cancer-** Etiology, diagnosis, treatment and prognosis. Carcinogens, oncogenes, mechanism. Biochemistry of ageing: Cellular senescence, cystic fibrosis, Mechanism of detoxification of xenobiotics.

Reference:

1. PRACTICAL CLINICAL BIOCHEMISTRY. Harold Varley
 2. HAWK'S PHYSIOLOGICAL CHEMISTRY – 14th Edition. By Philip Bovier Hawk, Edited by Bernard L. Oser
 3. TEXT BOOK OF BIOCHEMISTRY FOR MEDICAL STUDENTS – 7th Edition. D.M. Vasudevan, S. Sreekumari, Kannan Vaidyanathan.
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ELECTIVE 3: PROTEOMICS

4 CREDITS

Unit I:

Introduction to proteomics, Analytical methods of protein and peptide separations, protein digestion techniques, Mass Spectrometers for protein and peptide analysis. Protein identification by peptide mass fingerprints, peptide sequence analysis by tandem mass spectrometry.

Unit II:

Protein sequence analysis using software:- Emboss, Data mining proteomes, Motif mapping using Prosite, Prodom, protein expression profiling, protein -

protein interactions, protein complexes. Mapping protein modifications. Protein secondary structure analysis, Molecular visualization protein 3D structure using Rasmol, pdb file format.

Unit III:

Molecular modeling, Concepts of Molecular Modeling, Molecular structure and internal energy, Energy minimization of small molecules, Ab initio, DFT and semi-empirical methods, Construction of initial model, Refining the Model, Manipulating the model, Rotamer libraries, Three- Dimensional structure prediction, comparative modeling, Homology modeling, Threading, Energy based prediction of protein structures, Modeling software SPDBV. SWISS - Model.

Unit IV:

Introduction to basic concepts, Molecular recognition by receptor and ligand design, Generation of Rational Approaches in Drug design, Introduction to drug designing, Discovering a drug, Target identification and validation, Identifying the lead compound, Optimization of lead compound.

Unit V:

Docking methods introduction, three dimensional descriptions of binding site environment and Energy calculation, Automatic Docking Method, Three Dimensional database search Approaches, Design of ligands, Drug-receptor interactions automated structure Construction methods, AUTODOCK.

References:

1. Cohen N. C. 1996. Guidebook on Molecular Modeling in Drug. Design. Academic Press.
 2. Brandon C., Tooze J. 1998. Introduction to Protein Structure. Garland Science Publishing.
 3. Creighton T E. Proteins. 1983 Structures and Molecular Properties. Freeman, New York
-

PRACTICAL 3: CLINICAL BIOCHEMISTRY

6 CREDITS

1. Analysis of Blood for:

- Glucose by chemical (O-toluedene, Folin-Wu methods)
- Enzymatic methods (GOPO)

2. Analysis of serum for:

- Creatine and creatinine
- Uric acid by chemical and enzymatic methods
- Urea
- Inorganic phosphorus
- Bilirubin
- Vitamin-E and Vitamin-C
- Total Cholesterol, HDL and LDL cholesterol
- Total proteins, albumins and globulins by dye binding method
- SGOT and SGPT
- LDH
- Acid and Alkaline Phosphatase
- Amylase

3. Analysis of Plasma for Fibrinogen

4. Analysis of Urine for:

- Qualitative tests and microscopic examination
- Urea by DAM method

Reference:

1. Practical clinical Biochemistry, Harold Varley.
 2. Hawk's Physiological Chemistry -14th Edition By Philip Bovier Hawk, Edited by Bernard L. Oser.
-

SEMESTER IV

Summer project work – 2 credits

Thesis and Viva-voce examination – 12 credits

#

M.Sc. BIOINFORMATICS

Course Overview

Objective

To have better understanding to correlate the fundamentals and advance concepts in biology, mathematics, pharmaceuticals, medicine computationally.

Curriculum

The study of PG course of bioinformatics includes the areas of development of new computational methods for studying Organization and Evolution of Genes and Genomes, computational approaches to Macromolecular structure, dynamics and simulation, Comparative Evolutionary Genomics, Drug design and Discovery, Pharmacogenomics, Algorithm Development, Data base Development, Sequence Analysis, Data Mining, Prediction and Analysis of structure etc.

Course Description

The Course extends for a period of two years under Semester Pattern (Four semesters).The Program has been designed in a way to make the students understand the basic and fundamental concepts in bioinformatics and their kind of application in biological issues. Pharmaceutical and medical bioinformatics is a new discipline in the area of the genomics revolution. It is central to biomedicine with application in areas like pharmacy, medicine, biology and medicinal chemistry.

Outcome

The distinctiveness of the program is that every student can face the biological issues systematically.

Eligibility

A graduate in Science (B.Sc.) from an UGC recognized University with biology as a major subject.

Career opportunities

Graduates acquire a wide range of subject specific and transferable skills and gain extensive research experience. Around half of each class find PhD positions straight after the M.Sc., whilst others build upon their training to enter careers in biology and IT. The combination of Systems Biology and Bioinformatics addressed in this course reflects the current skills sought in academic and industrial (e.g. pharmaceutical) settings.

M.Sc. BIOINFORMATICS

	Semester I	Credits
Paper 1	Fundamentals of Statistics	4
Paper 2	Fundamentals of Computer Science	4
Paper 3	Fundamentals of Molecular Biology	4
Paper 4	Recombinant DNA technology	4
Elective 1	Statistical computing using Excel and SPSS	4
Practical 1	(Practical 1)	6
		26
	Semester II	
Paper 5	Visual basics with RDBMS	4
Paper 6	Multivariate analysis	4
Paper 7	PERL for Bioinformatics	4
Paper 8	System Biology	4
Elective 2	Molecular statistical model using 'R'	4
Practical 2	Combination of all the above (Practical 2)	6
		26
	Semester III	
	General Bioinformatics	
Paper 9	Protein structure and function	4
Paper 10	Advances in structural Bioinformatics	4
Paper 11	CADD (Drug Designing)	4
Paper 12	Molecular Interactions	4
Elective 3	Bioinformatics tools in MatLab	4
Practical 3	Combination of all the above (Practical 3)	6
		26
	Pharmaceutical Informatics	
Paper 9	Database Management, Sources and Scripting Languages	4
Paper 10	Pharmaceutical Design, Development And Computer Application	4
Paper 11	Chemistry of Pharmacology	4
Paper 12	Anatomy and Physiology	4
Elective 3	Bioinformatics tools in MatLab	4
Practical 3	Combination of all the above (Practical 3)	6
		26
	Medical Informatics	
Paper 9	Principles of Epidemiology	4
Paper 10	Clinical Decision Support Systems	4
Paper 11	Health/Clinical Informatics	4
Paper 12	Advance Health Informatics Education	4
Elective 3	Bioinformatics tools in MatLab	4

Practical 3	Combination of all the above (Practical 3)	6
		26
	Semester IV	
	Summer Project	2
	Thesis and viva voce examination	12
		14
	Total Credits	92

SEMESTER I

PAPER 1: FUNDAMENTALS OF BIOSTATISTICS

4 CREDITS

Unit I:

Introduction to Biostatistics- Definition of Biostatistics, Aims of Bio-Statistics, Role of Biostatistics in Modern research, Brief History, Limitations of Statistical Methods, Application and Uses of Biostatistics, Descriptive and Inferential Biostatistics .

Unit-II:

Representation of Bio- Metric Data- Types of Variables – Continuous, Discrete, Dependent and Independent Variables, Scales Of Measurements - Nominal, Ordinal, Interval And Ratio Scales, Frequency Distributions, Class Intervals, Working Rule To Prepare a Frequency Table, Pie Chart ,Bar Chart, Stem And Leaf ,Dot Diagram, and Histogram, Measures of Central Tendency – Mean, Median and Mode, Measures of Variability – Standard Deviation and Variance, Coefficient of Variance.

Unit-III:

Probability- Trial, Event, Sample Space, Definition Of Probability, Mutually Exclusive Events, Independent Event, Laws Of Probability-Simple Problems, Binomial Distribution ,Poisson Distribution and Normal Distribution: Properties-Problems

Unit-IV:

Fundamentals of Testing Of Hypotheses - Null and Alternate Hypotheses, Type I and Type II Errors, Tests Of Significance, Parametric And Non-Parametric Tests, Level Of Significance and Power Of The Test, 'P' Value And Its Interpretation, Statistical Significance And Clinical Significance, 'Z' Test, Student's 't' Test: Paired and unpaired, 'F' Test

Unit-V:

Analysis of Categorical Data- Analysis Of Variance-Introduction, Definition Of ANOVA, Assumption, Types Of ANOVA, Construction Of One Way And Two Way ANOVA ,Correlation , Types Of Correlation, Karl Pearson's Correlation Coefficient, Regression , The Method Of Least Squares, The Regression Of X On Y, Wilcoxon Test, Mann-Whitney U Test,

Reference:

1. An Introduction to Biostatistics: Gurumani N.
 2. Fundamentals of Biostatistics: Veer Bala Rastogi
 3. Biostatistics: Vinod kumar Bais
 4. Fundamental of Mathematical Statistics: S C Gupta and V K Kapoor
 5. Medical Biostatistics: Abhaya Indrayan Sanjeev B.Sarmukaddam
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PAPER 2: FUNDAMENTALS OF COMPUTER SCIENCES**4 CREDITS****Unit I:**

Computer Fundamentals: Operating systems, Data base Management System, Concepts of Hardware & Software, and Basics of Internet & HTML.

Unit II:

Data Communication, Computer Graphics, Object Oriented programming with C++, Introduction to C language, Web programming and Java Script

Unit III:

Networking, Software Engineering, Advance Java programming, RDBMS

Unit IV:

Visual Basics, Data Structure using C++, Java Programming, Computer Architecture

Unit V:

Asp.net programming using C++, VB.net and XML, Software quality and Testing, (Project)

References:

1. Computer programming with C by E, Balaguruswamy.
 2. Elements of Statistics by Gupta.
-

PAPER 3: FUNDAMENTALS OF MOLECULAR BIOLOGY

4 CREDITS

Unit I:

Bio-molecules and Cells- Introduction, The Molecules of Life, Genomes, Cell Architecture, and Cell Function, Cells into Tissues: Unicellular and Metazoan Organisms Used for Molecular Cell Biology Investigations.

Unit II:

DNA as Chemical and Genetic Material- Covalent Bonds and Non-covalent Interactions, Chemical Building Blocks of Cells, Chemical Reactions and Chemical Equilibrium, instances of Binding Reactions Reflect the Affinity of Interacting Molecules.

Unit III:

RNA Synthesis and Properties- Structure of Nucleic Acids, Transcription of Protein-Coding Genes and Formation of Functional mRNA, The Decoding of mRNA by tRNAs.

Unit IV:

Protein Synthesis and Properties- Chemical Building Blocks of Cells.

Basic Molecular Genetic Mechanisms- Introduction, Structure of Nucleic Acids, The Decoding of mRNA by tRNAs, Stepwise Synthesis of Proteins on Ribosomes. Overview of prokaryotic and eukaryotic gene regulations.

Unit-V:

Bio-molecule Structure and Function, Protein Structure and Function, Introduction, Hierarchical Structure of Proteins, Protein Folding, Chemical Reactions and Chemical Equilibrium, Membrane Proteins: Structure and Basic Functions.

Protein Binding and Enzyme Catalysis, Purifying, Detecting, and Characterizing Proteins.

Reference:

1. Bray A. D., Lewis J., Raff M., Roberts K. and Watson J.D. Molecular Biology of the Cell. B. Garland Publishing, New York and London.
2. De Robertis E.D.P., De Robertis E.M.F. 2001. Cell and Molecular biology. Lippincott Williams & Wilkins. Bombay.
3. Freifelder D. 1990. Molecular biology. Narosa Publishing House, New Delhi
4. Gardner E J & D P Snustad 1996. Principles of genetics. John Wiley, New York.

5. Alberts, B., Bray, D., Lewis, J., Raff, M, Roberts, K, and Watson, J. D. 5th Edition. 2007 Molecular biology of cell. Garland Publishing Inc., New York.
 6. Lodish, H., Berk A., Zipursky, S.L. Matsudaria, P. Baltimore, D. and Darnell, J. 2003. Molecular Cell Biology, Media connected, W.H. Freeman and Company.
 7. Celis J E (Ed). Cell biology. 1998. A laboratory handbook. Academic Press.
 8. Darnell J, Lodish H, Baltimore D 1990 Molecular Cell Biology. 2nd ed. New York, Scientific American Books.
 9. Cooper G M. The Cell: A Molecular Approach 2000 Sinauer Associates, Inc. Sunderland, Massachusetts.
-

PAPER 4: RECOMBINANT DNA TECHNOLOGY

4 CREDITS

Unit I:

Introductory Bioinformatics and overview of biological research with bioinformatics. Molecular evolution and phylogeny, Publicly available Biological databases (NCBI, EBI and UniProt, HPRD *etc.*,)

Unit II:

Molecular biology concepts, Fundamentals of genetic Engineering, historical perspectives, tools of genetic engineering – modifying enzymes, cloning vectors – naturally occurring plasmids, cloning plasmids, virus as cloning vehicles, hybrid vectors, cloning host. Techniques in genetic engineering - Gene cloning, DNA libraries, Microarray techniques, DNA sequencing, Massively parallel sequencing (Next Generation sequencing), Data repositories.

Unit III:

Biological databases, Plants database, Fly database, Genomics (TCGA, PSRA), Proteomics, Human Proteomic Atlas and Metabolomics (HMDB), Pathway database (KEGG, Netpath), dbSNP.

Unit IV:

Pairwise and multiple sequence analysis (BLAST, Fasta, BLAT and Clustal). Motif and domain assignments.

Unit V:

DNA and RNA sequence analysis, Protein sequence analysis- Sequence alignment homology, Structure and function prediction, Motif analysis, Domain and motifs, Localization of signal sequences for targeting proteins, Nuclear localization signal, DNA-RNA binding motifs, Gene expression analysis, Protein expression profiling, Protein modification.

Reference:

1. Principles of Gene Manipulation and Genomics(link is external) – 7th Edition – Sandy B. Primrose, Richard Twyman – Blackwell Publishing
 2. Gene Cloning and DNA Analysis: An Introduction(link is external) - 6th Edition - T. A. Brown - John Wiley & Sons
 3. An Introduction to Genetic Engineering(link is external) - 3rd Edition - Desmond S. T. Nicholl - Cambridge University Press
 4. Molecular Biotechnology: Principles and Applications of Recombinant DNA (link is external)- 4th Edition - Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten - ASM Press.
-

ELECTIVE 1: STATISTICAL COMPUTING USING EXCEL AND SPSS

4 CREDITS

Unit I:

Introduction to Excel- Workbooks and Worksheets, Cell Addresses, Entering And Editing Data, Savings Files, Importing/Accessing Data, Mathematical Operators In Excel, Creating Formulas And Functions, Data Analysis Toolpak: Installing The Analysis Toolpak, Using The Analysis Toolpak, Practice Problems.

Unit II:

Creating Tables, Charts and Descriptive Statistics Using Excel Functions- Creating And Formatting Tables, Frequency Distribution Tables, Histograms And Bar Charts, Pie Chart, Scatter Diagram, Descriptive Statistics Using Excel Functions, Practice Problems.

Unit III:

Statistical Functions in the Analysis Toolpak- Creating an XY Plot of Data, Using The Regression Function to Fit A Straight Line, Correlation, ANOVA, t-Test And F Test.

Unit IV:

SPSS For Windows: An Introduction- Overview And Scope Of SPSS, Starting SPSS, Typing in Data, Loading Data, Starting SPSS For Windows, Entering Data, Importing a File ,Defining The Variables, Missing Values, Saving Your Data, Help, Exiting SPSS.

Unit-V:

Writing / Performing Programs Using SPSS on Problems from The Following Topics: Frequencies, Bar Chart, Pie chart, Box plot, Descriptive Statistics, One and two Sample Parametric and Nonparametric Tests, Chi-Square Tests, Regression and Correlation Analysis, Analysis of Variance and Kruskal-Wallis Test.

References:

1. Essentials Of Biostatistics Workbook Statistical Computing Using Excel: By Lisa M.Sullivan(Second Edition)
 2. An Introduction To Statistics Using Microsoft Excel: By Dan Remenyi George Onofrei Joe English
 3. Practical Statistics Using SPSS Authors Nicola Spiers, Brad Manktelow, Michael J. Hewitt.
-

PRACTICAL 1: BIOCHEMICAL TECHNIQUES

6 CREDITS

1. Paper chromatography – ascending and descending – separation of amino acids and sugars.
2. Qualitative tests for the identification of amino acids and carbohydrates.
3. Thin – layer chromatography of amino acids and lipids.
4. Column (GPC) chromatographic separation of proteins (albumin and trypsin).
5. Polyacrylamide Gel Electrophoresis and agarose gel electrophoresis of serum proteins.

6. Ion exchange chromatography of amino acids.
7. Absorption spectrum of chlorophyll extracted from green leaves.
8. Absorption spectrum of aromatic amino acids, purines and pyrimidines.
Determination of Molar absorption coefficient of tyrosine.
9. Optical rotation of sugars using polarimeter
10. Molecular weight determination of proteins by SDS-PAGE
11. Western blotting
12. Quantitative estimation of proteins by spectrophotometric method.
13. Demonstration of Polymerase Chain Reaction

SEMESTER II

PAPER 5: VISUAL BASICS WITH RDBMS

4 CREDITS

Unit I:

JAVA: An introduction to JAVA programming, Object-oriented programming and Java, Java Basics, Working with objects, Arrays, Conditionals and loops, Biological applications, Examples of biological database and their architecture, Querying a database to retrieve data.

Unit II:

Creating Classes and Applications in Java, More about methods, Java Applets Basics, Graphics, Fonts and Color, Simple Animation and Threads, Advanced Animation, Images and Sound.

Unit III:

Managing Simple Events and Interactivity, Creating User Interfaces with AWT, Windows, Networking and other Tidbits, Modifiers, Access Control and Class Design Packages and Interfaces, Exception.

Unit IV:

Multithreading, Streams and I/O, Using Native Methods and Libraries, Under the Hood Java Programming Tools, Working with Data Structures and Java, Image Filters.

Unit V:

Programming in Visual Basic: Introduction to Application Development using Visual Basic, Working with Code and Forms, Variables, Procedures and Controlling Program Executor, Standard Controls. Data Access Using Data Control, Connecting to Oracle Database using Visual Basic.

References:

1. Java In a Nutshell by David Flanagan, Oreilly Publications.
2. Java Examples in a Nutshell by David Flanagan, Oreilly Publications.
3. Java 2: The Complete Reference by Patrick Naughton and Herbert Schildt, McGraw Hill.

4. Schaum's Outline of Theory and Problems of Programming with Visual Basic
(2001) By yron S. Gottfried, Published by McGraw-Hill Professional.

PAPER 6: MULTIVARIATE ANALYSIS

4 CREDITS

Unit I:

Multivariate Data In Biological Sciences, Examples, Multivariate Normal Distribution, Maximum Likelihood Estimators of Parameters, Multivariate Linear Regression Model, Estimation of Parameters, Testing Linear Hypothesis About Regression Co-efficients.

Unit II:

Principal Component Analysis, Factor Analysis –Orthogonal Factor Model, Factor Loadings, Estimation Factor Loadings, Factor Scores, Applications, Canonical Correlations and Canonical Variable - Definition, Use, Estimation And Computation.

Unit III:

Classification and Clustering, Linear Discrimination, Classification Trees, Hierarchical Clustering, K-Means Clustering, Multidimensional Scaling.

Unit IV:

Application in Test on Mean Vectors For Single and Several Multivariate Normal Populations, Hotelling's T^2 -Statistic and its Distribution, Relationship with Mahalanobis D^2 Statistic, Applications of Hotelling's T^2 -Statistic.

Unit V:

Methods and Applications of MANOVA, Structural Equation Modelling and Path Analysis.

Reference:

1. Anderson, T. W.(1984) Introduction to Multivariate Analysis (John Wiley)
2. Kshirsagar, A. M. (1983) Multivariate Analysis (Marcel Dekker)
3. Morrison, D.F.(1990) Multivariate Statistical Methods (McGraw Hill Co.)(3rd ed.)
4. Rao, C. R.(1995) Linear Statistical Inference and its Applications. (Wiley Eastern Ltd.)
5. Johnson R.A. & Wichern, D.W. (1988) Applied Multivariate Statistical Analysis
6. Hardle, W. and Simar, L. (2003). Applied Multivariate Statistical Analysis. Springer.

7.Mardia, K.V., Kent, J.T. and Bibby, J.M. (1979). Multivariate Analysis. Academic Press.

PAPER 7: PERL FOR PROGRAMMING

4 CREDITS

Unit I:

Introduction to Perl Scripting language. Interpreted Language. About Perl. Why Perl for Bioinformatics?, CPAN. Basic structure of Perl language – print command – First Perl program – Executing your code. Variables in Perl: Scalars, Arrays and Hashes. Package and Lexical Variables. Reading from the Keyboard – using chomp. Introduction to Python, Working with Data, Program Organization and Functions.

Unit II:

Data Structures in Perl Literals: Numbers and Strings, Operators, Scalar data, Array data, Hash data. Manipulation of Data Structures: Scalar Variable: (Function list - chomp, chop, length, chr, oct, hex, ord, index, rindex, substr, uc, ucfirst, lc, lcfirst). Array Variable: Creating an array, Use of range operator in an array, Adding and removing elements, getting the number of elements in an array, Accessing elements in an array. (Function list - reverse, sort, join, split, pop, push, shift, unshift, grep, map). Hash Variable: Printing hash data, accessing and removing elements (Function list - keys, values, delete, each, exists)

Unit III:

Control Structures and Regular Expressions Control Structures: if, else, elsif, switch, unless, while, until, do...while, for and for...each. (Statements associated with loops – next, last, redo, goto, continue) Regular expressions: Simple string comparisons, Matching, Substitutions, and Translations. Special characters in patterns. Storing and reusing portions of patterns. Escape characters.

Unit IV:

File and Directory Manipulations. File opening modes (read, write, append), File variable, Die – terminating a program, Reading a file line by line, Closing a file. File test operators (d, e, l, r, s, w, x, B, T). File Manipulation Functions – select, eof, seek, tell, read, sysread, syswrite, link, unlink, rename, truncate. Directory Manipulation functions – mkdir, chdir, opendir, readdir, closedir, telldir, seekdir, rewinddir, rmdir. System variables.

Unit V:

Object Oriented Programming Sub routines, references, OOPs in Perl – Introduction to modules, Classes in Perl, Methods, Constructors, Destructors, Inheritance, Polymorphism, Operator overloading. BioPerl – basics. CGI, DBI, LWP.

Reference:

1. Beginning Perl for Bioinformatics by James Tisdall, O-Reilly.
 2. Developing Bioinformatics Computer Skills by Cynthia Gibas, Per Jambeck, OReilly
 3. Learning Perl by Randal L. Schwartz, Tom Phoenix, O-Reilly.
 4. Programming Perl by Larry Wall, Tom Christiansen, Jon Orwant, O-Reilly.
 5. Programming the Perl DBI by Alligator Descartes, Tim Bunce, O-Reilly.
 6. Advanced Perl Programming by Sriram Srinivasan, O-Reilly.
-

PAPER 8: SYSTEMS BIOLOGY

4 CREDITS

Unit I:

General introduction to systems biology– overview of molecular mechanism and molecular functions, Molecular networks. Mathematical models vs. computational analysis vs. statistics.

Unit II:

Integrating multi-omics datasets and understanding biological systems – Genomics, proteomics, transcriptomics, metabolomics and phenomics. Understanding genomics and proteomics into biology *in-silico*. Omics analysis tools.

Unit III:

Concept of gene expression, Comparative Genomics and chromatin. Genome sequencing, genome assembly and finishing, genomic annotation, comparative genomics, and chromatin.

Unit IV:

Computational systems biology - Computational modeling to understand a) the fundamental properties of biochemical networks, and b) the properties of specific biochemical systems. Use of systems biology software to construct and analyses biochemical network models.

Unit V:

Human Molecular genetics: Genetic mapping of human chromosomes, detection of mutations in human genes, determining gene function, human gene therapy, pro-drug activation therapy, Predicting the effect of mutations on protein function-SIFT Polyphen.

Reference:

1. Hiroaki Kitano (editor). Foundations of Systems Biology. MIT Press: 2001. ISBN 0-262-11266-3.
 2. CP Fall, E Marland, J Wagner and JJ Tyson (Editors). "Computational Cell Biology." Springer Verlag: 2002 ISBN 0-387-95369-8.
 3. G Bock and JA Goode (eds).In Silico" Simulation of Biological Processes, Novartis Foundation Symposium 247. John Wiley & Sons: 2002. ISBN 0-47084480-9.
 4. E Klipp, R Herwig, A Kowald, C Wierling, and H Lehrach. Systems Biology in Practice. Wiley-VCH: 2005. ISBN 3-527-31078-9 .
 5. L. Alberghina and H. Westerhoff (Editors) – Systems Biology: Definitions and Perspectives, Topics in Current Genetics 13, Springer Verlag (2005), ISBN 9783540229681.
 6. Z. Szallasi, J. Stelling, and V.Periwal (eds.) System Modeling in Cellular Biology: From Concepts to Nuts and Bolts (Hardcover), MIT Press: 2006, ISBN 0-262-19548-8.
-

ELECTIVE 2

MOLECULAR STATISTICAL MODEL USING `R`

4 CREDITS

Unit I:

Introduction to statistical software R Downloading and Installing R, Essentials, Advantages and objects, Functions and arguments, Manipulating vectors, Factors, Matrix operations: addition, subtraction, multiplication, Lists, Importing of files, Data frame, Getting Help: The functions help(), help.search() and example().

Unit II:

gene expression studies and data visualization, Functional Genomics 2: SNP arrays, cDNA, EST, SAGE, MPSS, RNA expression and DNA microarray (Gene Expression Omnibus (GEO), ArrayExpress): database and basic tools, DNA microarray: design of microarray chip, understanding of microarray data, visualization of data, normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools (especially clustering approaches - Kmeans technique), algorithmic approaches to clustering gene expression

data and applications, Methods and tools for identification of disease associated genes in molecular diagnostics (molecular markers).

Unit III:

Descriptive statistics and Graphics in R Measure of central tendency and measure of dispersion (Mean, median, standard deviation, variance, quartiles, five number summary), R-Graphics- Bar Graph, Pie chart, Box-plot, Dot diagram, Stem and leaf plot and Histogram,

Unit IV:

Introduction to Probability and Probability Distribution using R functions Sample spaces, Events, Set Union, Intersection, and Difference, Basic probability problems in R, Probability Mass Functions with Mean, Variance, and Standard Deviation in R, Fitting of distributions to given data with R –Binomial distribution, Poisson distribution and Normal distribution.

Unit V:

R functions in Linear modelling and standard statistical tests Correlation, correlation coefficient, Simple linear regression, one way ANOVA and two way ANOVA, One and two sample t-tests, Chi-squared tests, F- test for equality of variance and non parametric tests: Kruskal-Wallis Test.

Reference:

- 1) Purohit S.G., Gore,S.D. and Deshmukh,S.R.(2008) Statistics Using R, Alpha Science.
 - 2) Peter Dalgaard: Introductory statistics for R ,Springer.
 - 3) Statistical Methods Using R Software :V. R. Pawagi and Saroj A. Ranade
 - 4) Verzani, J. (2005). Using R for Introductory Statistics, Chapman and Hall, London.
 - 5) Introduction to Probability, and Statistics Using R, G. Jay Kerns, First Edition
 - 6) Andrew R. Leach (2001) "Molecular Modeling – Principles and Applications"; Second Edition, Prentice Hall, USA
 - 7) Gasteiger Johann (2003) Chemoinformatics: A Textbook, Wiley, John & Son, ISBN13
 - 8) 3. Schaum's Outline of Computer Graphics by Zhigang Xiang and Roy A. Plastock Second Edition, Mc Graw Hill, USA
-

PRACTICAL 2: INFORMATICS LABORATORY

6 CREDITS

1. Building databases
2. Data retrieval from data bases.
3. Real life data from biomedical sciences-Finding significant observation using statistics.
4. Perturbation to biosystem and its implication on cell and organ function.
5. RNA and DNA sequence alignment, Exome and whole genome alignment.
6. Building gene and protein networks.
7. Characterize Putative protein sequences.
8. Identification of the pathogens.
9. Motif identification.
10. Usage of Bioinformatics tools.

SEMESTER III
GENERAL BIOINFORMATICS
PAPER 9: PROTEIN STRUCTURE AND FUNCTION
4 CREDITS

Unit I:

Protein synthesis: Biological and recombinant protein synthesis. Peptide synthesis. Post-translational modifications. Protein chemistry: inclusive peptide sequencing and chemical modification of proteins.

Unit II:

Biological protein degradation. Protein informatics: Databases for protein sequences, structure and function. Methods for protein informatics.

Unit III:

Protein structure: Protein folding. Determination of the three-dimensional structure of proteins: X-ray crystallography, NMR spectroscopy, microscopy. Protein structure modeling and analysis using molecular graphics Protein structure-function relationships.

Unit IV:

Functional genomics and proteomics: Directed evolution of proteins
- Protein interactions: Protein ligand, protein-DNA and protein-protein interactions.

Unit V:

Kinetic and thermodynamic characterization of interactions, methods and interpretations. Examples of protein function and applications: a. Enzymes. b. Membrane proteins, receptors, c. Protein-protein interactions, signal transduction, d. Multiprotein complexes, viruses.

Reference:

PAPER 10: ADVANCES IN STRUCTURAL BIOINFORMATICS

4 CREDITS

Unit I:

Structural biology and structural databases. Nucleic acid structures, RNA folding, RNA loops, conformational study. various ribose ring conformations, ribose-ring puckering. protein-protein interactions, protein ligand interactions. DNA-binding proteins, RNA-binding proteins. Ramachandran plot, 3-dimensional structures of membrane proteins, importance of 310 helix and loops, biophysical aspects of proteins and nucleic acids. Structural databases:- Protein Data bank (PDB), Nucleic Acid Data Bank (NDB), Molecular modeling Data Bank (MMDB). Secondary structure, three-dimensional structure prediction, protein folding and functional sites, protein folding classes.

Unit II:

Protein structure prediction, Protein Structure Prediction:- Homology modeling, prediction of protein structure from sequences, functional sites. Protein folding problem, protein folding classes, protein identification and characterization:- AAComplident, TagIdent, PepIdent and Multident, PROSEARCH, PepSea, PepMAPPER, FindPept, Predicting transmembrane helices, Primary structure analysis and prediction, Secondary structure analysis and prediction, motifs, profiles, patterns and fingerprints search. Methods of sequence based protein prediction.

Unit III:

Molecular Modeling and Molecular Mechanics, Molecular modeling:-Introduction, force field, quantum chemistry, Schrödinger equation, potential energy functions. Energy minimization, local and global minima, saddle point, grid search.

Various approximations; LCAO, HF, semi-empirical calculations; single point calculations, full-geometry optimization methods, ZDO, MNDO, CNDO, NDDO, AM1, PM3, RM1. Conformational search, Z-matrix, docking, molecular modeling packages.

Unit IV:

Molecular mechanics, Definition, balls and springs, force fields, bond-stretching, bond-bending, dihedral motions, out of plane angle potential, non-bonded interaction, coulomb interactions, conformational search, united atoms and cut-offs.

Derivative methods:- First-order methods; Steepest descent, conjugate gradient, Second order methods; Newton-Raphson method.

Unit V:

Molecular dynamics:-Introduction, Newton's equation of motion, equilibrium point, radial distribution function, pair correlation functions, MD methodology, periodic box, algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzman velocity, time steps, duration of the MD run. Starting structure, analysis of MD job, uses in drug designing, ligand protein interactions.

Reference:

PAPER 11: CADD (DRUG DESIGNING)

4 CREDITS

Unit I:

Concepts in Molecular Modeling: Introduction; Coordinate System; potential energy surfaces molecular graphics; Molecular Mechanics: Features of molecular mechanics, force fields; Bond structure and bending angles – electrostatic, van der Waals and nonbonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Calculating thermodynamic properties using force field; Transferability of force field parameters, treatment of delocalised pi system; Force field for metals and inorganic systems – Application of energy minimization.

Unit II:

Molecular Dynamics Simulation Methods: Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time-dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation.

Unit III:

Drug Designing Related Applications: Drug discovery process, Role of Bioinformatics in drug design, Target identification and validation, lead optimization and validation, Structure-based drug design and ligand based drug design, Modeling of target-small molecule interactions, Finding new drug targets to treat diseases, , Molecular Simulations.

Unit IV:

Molecular Modeling in Drug Discovery: Pharmacophore identification, Deriving 3D pharmacophore, Molecular Docking, methods to identify lead compounds, de novo ligand design, Applications of 3D Database Searching and Molecular docking.

Unit V:

Structure Activity Relationship: QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Analysis in the QSAR equations. Drug designing softwares: Free and commercial Tools available for various stages in drug discovery and refinement processes.

References:

1. Andrew R. Leach (2001) "Molecular Modeling – Principles and Applications"; Second Edition, Prentice Hall, USA
 2. Gasteiger Johann (2003) Chemoinformatics: A Textbook, Wiley, John & Son, ISBN13: 9783527306817
 3. Schaum's Outline of Computer Graphics by Zhigang Xiang and Roy A. Plastock Second Edition, Mc Graw Hill, USA
 4. Fenniri, H. (2000) "Combinatorial Chemistry – A practical approach", Oxford University Press, UK.
 5. Lednicer, D. (1998) "Strategies for Organic Drug Discovery Synthesis and Design"; Wiley International Publishers.
-

PAPER 12: MOLECULAR INTERACTION**4 CREDITS****Unit I:**

Structure of atoms, molecules and chemical bonds. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

Unit II:

Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).

Unit III:

Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties). Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

Unit IV:

Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).

Unit V:

Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Stability of proteins and nucleic acids. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

Reference:

ELECTIVE 3: BIOINFORMATICS TOOLS ON MATLAB

4 CREDITS

Unit I:

Introduction To Matlab, Matlab key features, basic functionalities-tool box , data types,variables, operators, vectors, matrix operations, trigonometric functions, 2D,3D-graphics , Limits. Control structures, function handling, class file handling, mat file creation, symbolic mathematics. Numerical Methods- solving linear equations, solving differential equations-ODE suite, integration, interpolation, regression. Statistical analysis- probability, hypothesis testing, ANOVA and cluster analysis.

Unit II:

Bioinformatics Tool Box, Sequence Analysis, NGS,Graph Theory, Gene Ontology, Importing Data and Deploying.

Unit III:

Biological Data Analysis, Microarray Data Analysis, Mass Spectrometry Data Analysis, statistical classification of biological data

Unit IV:

Image Processing, Key Features,Importing and Exporting Images, image file formats and format conversion, Pre- and Post-Processing Images, Spatial Transformations and Image Registration. Microarray image analysis.

Unit V:

Systems Biology, Basics of enzyme kinetics, Kinetic Laws.Modeling Biological System, Simulation, sensitivity analysis, parameter estimation using simbiology.Pharmacokinetic

modeling- simulation, population study. Model of the Yeast Heterotrimeric G Protein Cycle and glycolysis.

Reference:

Practical III:

1. Assigning protein function using protein networks
2. Cytoscape, GeneMania
3. Kyoto Encyclopedia of Genes and Genomes (KEGG), NetPath, Wetslim.
4. Genome Browse- NCBI, ENSEMBLE, UCSC Genome Browser, Integrative Genome Viewer.
5. Y2H ([yeast two-hybrid](#))
6. Map viewer- Search or Browse the Genome, BLAST, Clone Finder, Use of Genome Resources.
7. Sequence to determine genetic cause of the disease, NGS- BOWTIE, TOPHAT, VARSCAN, TOPHAT FUSION.

SEMESTER III

PHARMACEUTICAL INFORMATICS 4 CREDITS

PAPER 9: DATABASE MANAGEMENT, SOURCES AND SCRIPTING LANGUAGES

Unit I:

Database Design and Management- Data Processing, Information Systems and Computers – Data Presentation for Computing – Classification and Generation of Computers – Components of Computer Based System – The CPU – Input Devices – Storage Devices – Output Devices Development of Computer Programming Languages – The Operating System (Windows & Linux) – Introduction to DBMS – The Network – Distributed Processing.

Unit II:

The Internet - Database concepts- Database models and ER diagrams – Normalization – Introduction to SQL-DDL and SQL-DML- Creation of databases – Searching database using SQL – Joins-Built-in-functions – String manipulation – Improving query Performance - 'Group By' Clause-stored Procedures – Backup of the database – MS-ACCESS – MS-SQL – ORACLE databases – Introduction to MySQL – Configuring and Running MySQL on Linux.

Unit III:

Chemical Information Sources and Searches- Advantage/Limitation of computer searching strategies and tactics for searches -Types of Publications (Journals, technical reports, Patents, Conference Papers, Dissertations, Electronic Publications) – Types of databases – Public databases (NCBI, RCSB, CSD, SWISS-PROT) and paid databases (CAT'STN and SciFinder) - Computer searching of chemical abstracts – Webbased cross platform solutions for Cheminformatics and chemical communications – JChemBase – Keyword-based general bibliographic searches – Chemical connectivity and structure searches(2D) – Chemical structure, property and shape based searches(3D) – Searching for the synthesis (or) reactions of specific compounds or classes of compounds.

Unit IV:

Data Sequencing and Mining- An introduction to Data Mining – What is Data Mining? – How Data Mining works – An Architecture from data Mining – Difference between Data Mining and Machine learning techniques– Data Visualization – Visualizing Data mining models – Decision Tree – Data warehousing – Data mining and analytic technology – Comparing different Models using visualization – Software- past and present developments.

Unit V:

Scripting Languages- Introduction to Shell scripting – Common Linux commands (Bash) – Basic shell Programming – Linux text editors (Vi) – Introduction to Perl –

Language basics – Using 4 sequences and strings – Subroutines – BioPerl for Cheminformatics/Bioinformatics Accessing MySQL database using Perl.

References:

1. MS-DOS User's Guide by Paul Hoffman and Tamara Nicoloff, Osborne McGrawHill
 2. Systems programming by John J. Donovan, McGrawHill
 3. MySQL (TM): The Complete Reference by Jeremy D. Zawodny and Derek J. Balling. O'Reilly & Associates, April 2004.
 4. Oracle Volume I & II Version 7.1, Software Solution Integrated.
 5. MySQL (TM): The Complete Reference by Vikram Vasvan, McGrawHill
 6. Mastering UNIX Shell Scripting by Randal K. Mitchenall Wiley Publisher, Inc, Indianapolis, Indiana.
 7. Quick, Painless Introduction to the Perl Scripting Language. Norman Matloff. University of California, Davis c 2002-2007.
-

PAPER 10: PHARMACEUTICAL DESIGN, DEVELOPMENT AND COMPUTER APPLICATION 4 CREDITS

Unit I:

Principles of Drug Discovery- Drug discovery without lead – Pencillins and Librium. Lead discovery- random screening nonrandom screening.(screening of natural products, medical folklore, screening synthetic banks, existing drugs from natural ligand or modulator, combinatorial synthesis, computer aided designing & serendipity – in brief). Drug metabolism studies – phase I, Phase II metabolism. Clinical observations: phase I, phase-II, phase-III, phase -IV trials.(introductory treatment). Principles of drug design; agonist, antagonist drugs, structure pruning technique in drug design(eg. morphine pharmacophore). Development of cimetidine, captopril from lead molecules.

Unit II:

SAR Studies- Binding role of hydroxy group, Amino group, aromatic ring, double bond, ketones and amides. Variation of substituents- alkyl substituents, aromatic substituents, extension of structure, chain extension/contraction, ring expansion/contraction, ring variation, ring fusion. Isosteres.iii. Simplification of the structure, rigidification, conformational blockers, X-ray crystallographic studies. Ex: A case study of Oxamiquine (schistosomiasis), Sulpha drugs(antibacterial), Benzodiazepines(Hypnotics) and Taxol analogues (anticancer drugs).

Unit III:

QSAR Studies and Structure Based Drug Design- QSAR parameters – Physiochemical parameters- Lipophilicity - Electronic parameters, Steric parameters,

effect of electronic and steric parameters on lipophilicity. Methods used in QSAR studies- Linear free energy relationship (LFER) – Partial Least Squares Method – Multivariate Statistics – Correlation – Regression – Principal Component Analysis - Cluster significant analysis - Application of Hammett equation, Hansch analysis, significance of slopes and intercepts in Hansch analysis. QSAR- 2D, 3D: CoMFA, CoMSIA Case study – on Pyranenamine. Achievements of QSAR – Forecasting biological activity, selection of proper substituents, bioisosterism, drug receptor interactions and pharmacokinetic information - Database similarity searches – Pair-wise alignment – Dot matrix comparison – Needleman -Wunsch Global sequence analysis – Smith waterman Local Sequence Alignment – Multiple Sequence Alignment – Homology Modeling – Energy minimization methods – Active site Identification – Virtual Screening – Small molecule Building – Docking Algorithms – Docking Analysis.

Unit IV:

Computational Chemistry and Molecular Modeling- Quantum mechanical and classical mechanical approaches - Empirical force field (Molecular mechanics) methods. Potential for bond stretching, bending, torsional, columbic and non bonded interactions. Coordinate systems – Z- matrix- Potential Energy Surface Contour Diagram- Minima, Maxima and Global Minimum, Local Minimum – Introduction to Molecular Mechanics - Features of Molecular Mechanics – Bond energy, bond angle energy, torsion angle energy, Charge-charge interaction-Bond Stretching – Angle Bending Torsional Terms – Improper Torsions and out of Plane Bending Motions – Cross Terms and Non Bonded Interactions – Electrostatic Interactions - Van-der Waals interactions - Hydrogen Bonding in Molecular Mechanics- Force Field Equation in Energy minimization (Energy as function of r , θ , ω) and variation w.r.t ω only .

Unit V:

Introduction to Derivative Minimization Methods- First Order Minimization – The steepest Descent Method – Conjugate Gradients Minimization – Conformation Search - Conformational Analysis of Ethane - Geometry optimization procedures - Introduction to molecular dynamics–description of molecular dynamics- basic elements of monte carlo method-differences between molecular dynamics and monte carlo method. Qualitative (brief) exposure to molecular dynamics simulations, conformational analysis.

Reference:

1. Drug design By E.J. Arienes
 2. Jenkin's quantitative pharmaceutical chemistry By Knevel and Dryden
 3. Recent advances in Bioinformatics By I. A. Khan and A Khanum
 4. Computational chemistry By GH. Grant and WG. Richards
 5. Molecular modelling By Hans Dieter Holtje and Gerd Folkers
 6. Molecular modelling By Leach
 7. Computational Chemistry by Jensen
 8. Bio Informatics by Rastogi
 9. The Science and practice of Pharmacy – Vol I and Vol II by Remington.
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PAPER 11: CHEMISTRY OF PHARMACOLOGY

4 CREDITS

Unit I:

General Principles of Pharmacology Introduction - Nature and sources of drugs - Routes of administration of drugs - Concept of absorption – bioavailability - Drug distribution - Biotransformation and excretion drugs - Biological half-life and its significance - Mechanism of action including drug receptor - Interactions and factors influencing them - Dose response relationship.

Unit II:

Theories of drug activity occupancy theory, rate theory. Induced fit theory. Receptor concept of drug activity. Introduction to molecular targets- lipids, carbohydrates, proteins and nucleosides. A brief introduction to the architecture of the cell- Human Cell structure, Cell wall, cell membrane - membrane lipids, membrane proteins, membrane carbohydrates.

Unit III:

Pharmacology Of Drugs Acting on ANS Introduction - Transmission - Distribution and Functions of Drugs acting on Autonomic Nervous System: Cholinergic agonists – Acetylcholine, Anticholinergic agents - Atropine, Anti Cholinesterase drugs – Physostigmine, Local anaesthetics- Procaine, Adrenergic stimulants - Epinephrine, Dopamine, Adrenoceptor – Antagonist drugs - Doxazosin. Anti-Histamine agents: Cimetidine.

Unit IV:

Pharmacology Of Drugs Acting on CNS Introduction - Transmission - Distribution and Functions of Drugs acting on Central Nervous System: CNS Neuro transmitters; CNS Stimulants-Analeptics: Nikethamide, Psychomotor stimulants-Amphetamine, Antidepressants - Imipramine, Hypnotics and Anxiolytics – Antipsychotic Agents – Chlorpromazine, Anti-epileptic Agents-Phenytoin, General Anesthetics - Haloethanes (inhalation anesthetic), Thiopentone (intravenous anesthetic). Neurodegenerative 7 disorders: Alzheimers disease: Donepezil, Parkinson disease: Levodopa, Huntington's disease: Haloperidol. Drug dependence and drug abuse. Pharmacological management of Parkinsonism and other movement disorders.

Unit V:

Drugs Acting on Cardio Vascular & Respiratory System and Gastro Intestinal System- General considerations - Pharmacology of drugs used in the treatment of congestive heart failure - Anti-arrythmics – Classification with examples, Anti-hypertensives ACE inhibitors- captopril, blockers - Propranolol, Ca²⁺channel blockers- Nifedipine. α - Adrenoreceptor stimulant: Clonidine, α - Adrenoreceptor blocking agent- Prazocin, Anti-hyperlipedemic - Clofibrate, Antianginal drugs – Amoldepine. Drugs used in the therapy of shock. Pharmacology of Drugs affecting Respiratory System: Drugs used in the treatment of disorders of Respiratory Function and Bronchial Asthma – Broncho dilators- i) β – adrenergic agents – Albuterol ii) Phosphodiesterase inhibitors – Aminophylline, Anticholinergic agents – Atropine, Corticosteroids – Beclomethasone, Inhibitors of mediator release – Cromolyn Sodium, Antitussives- Codeine and

Expectorants – Guaifenesin Pharmacology of Drugs affecting Gastro intestinal System
Pharmacology of purgatives/laxatives, Anti-diarrhoeals–Lopramide.

Reference:

1. Pharmacology and Pharmacotherapeutics, R.S. Satoskar and S.D. Bhandarker, Popular Prakashan, Mumbai.
 2. Pharmacology, H.P. Rang, M.M. Dale & J. M. Ritter : Churchill Livingstone, 4th edition.
 3. Basic and Clinical Pharmacology, 9th edition – Bertram. G. Katzung.
 1. Essentials of Medical Pharmacology, K.D. Tripathi, J. P. Brothers Medical Publishers.
 2. Lewis's Pharmacology, by J. Crossland, Churchill Livingstone.
 3. Pharmacological Principles of Medical Practice, by Krantz and Care, Williams and Wilkins co.
 4. Goodman and Gilman's, The Pharmacological Basis of Therapeutics. J. G. Hardman and Lee E. Limbard, Mc. Graw Hill, Health professions Division.
 5. Text book of Organic, Medicinal and Pharmaceutical Chemistry by Delgrado and William.
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**PAPER 12: ANATOMY AND PHYSIOLOGY
4 CREDITS**

Unit I:

Introduction- Anatomy and Physiology – definitions: Levels of structural organization of the body (Chemical, cellular, tissue, organ, system and organism). Anatomical terms in relation to parts of the body, system and organs. Inorganic compounds: Acids, Bases, Salts and Buffers; Organic Compounds: Carbohydrates, fats, Proteins, Nucleic acids (DNA and RNA) and ATP; Parts of the Cell. Tissues of the body – properties and functions of epithelial, connective, muscular, nervous and osteous (bone) tissues. General principles of membrane permeability, diffusion, transport, membrane potentials and action potentials. Elementary knowledge of the human skeleton and functions. Control of Homeo stasis, Imbalances in Homeostasis as cause of disorders.

Unit II:

Nervous Systems – Neuron, synapses, ganglion, plexus, physiology of nerve impulse, neurotransmission, reflex arc, central nervous system (parts and functions) and autonomic nervous system.

Unit III:

Cardiovascular System and Blood Heart: Pericardium and Heart wall, anatomy of the chambers of the heart, Heart valves Blood vessels: arteries and veins; Cardiac cycle, circulation, blood pressure and its regulations. Types of Shock, signs and symptoms of

shock. **Blood:** Function of blood, Physical characteristics and principal components of blood, ABO and Rh blood group, blood clotting. Homeostatic control Mechanisms.

Unit IV:

Respiratory System – Gross anatomy of respiratory passages, physiology of respiration, nervous control of respiration, vital capacity, respiratory volume, introduction to terms such as anoxia, hypoxia & dyspnoea.

Digestive System – Gross anatomy of alimentary canal, movements of alimentary canal, gastric secretions and the enzymes involved in digestion.

Endocrine System – General mechanisms of hormonal secretion, Physiological considerations of thyroid, pancreas, pituitary, parathyroid, adrenal glands and gonads. Disorders as a consequence of Homeostatic imbalances.(Pituitary, Thyroid, Adrenal, and Pancreatic imbalances)

Unit V:

Renal System – Various parts, structure and functions of the kidney and urinary tract. Physiology of urine formation, output and factors controlling it. 9

Physiology of Special Senses – Basic anatomy and physiology of the eye (vision), ear (hearing), taste buds (Tongue), nose (smell) and skin (touch and pain). Integumentary System: Structure and development of Integumentary system, Functions of Skin: Thermoregulation, Protection, Excretion and absorption. Maintaining Homeostasis - Wound Healing

Reference:

1. Principles of anatomy and physiology by Tortora G.J., and N.P. Anagnokokos,
2. Principles of Anatomy and Physiology by Ross & Wilson.
3. Human Physiology by C.C. Chatterjee, Medical Allied Agency, India.
4. Text Book of Medicinal Physiology by A.C. Guyton, W.B. Prism Books Pvt.Ltd.,

MEDICAL INFORMATICS

III SEMESTER

PAPER 9: PRINCIPLES OF EPIDEMIOLOGY

4 CREDITS

Unit I:

The historical context- Origins, Recent developments in epidemiology Definition, scope, and uses of epidemiology, Epidemiology and public health-Causation of disease Natural history of disease Health status of populations Evaluating interventions, Achievements in epidemiology Smallpox Methyl mercury poisoning Rheumatic fever and rheumatic heart disease Iodine deficiency diseases Tobacco use, asbestos and lung cancer Hip fractures HIV/AIDS SARS.

Unit II:

Measuring health and disease- Defining health and disease Definitions Diagnostic criteria, Measuring disease frequency Population at risk Incidence and prevalence Case

fatality Interrelationships of the different measures, Using available information to measure health and disease Mortality Limitations of death certificates Limitations of vital registration systems Towards comparable estimates, Death rates Infant mortality Child mortality rate, Maternal mortality rate Adult mortality rate Life expectancy Age-standardized rates.

Unit III:

Types of studies-Observations and experiments Observational studies Experimental studies, Observational epidemiology, Experimental epidemiology Randomized controlled trials Field trials Community trials. Potential errors in epidemiological studies Random error Sample size Systematic error Selection bias Measurement bias, Confounding

Unit IV:

Causation in epidemiology- The concept of cause Sufficient or necessary Sufficient and necessary A causal pathway Single and multiple causes Factors in causation Interaction A hierarchy of causes, Establishing the cause of a disease Considering causation Temporal relationship Plausibility Consistency Strength Dose-response relationship Reversibility Study design Judging the evidence.

Unit V:

Clinical epidemiology- Definitions of normality and abnormality, Normal as common Abnormality associated with disease Abnormal as treatable, Diagnostic tests Value of a test, Natural history and prognosis Prognosis Quality of life Quantity of life, Effectiveness of treatment Use of evidence-based guidelines Prevention in clinical practice.

Reference:

PAPER 10: CLINICAL DECISION SUPPORT SYSTEMS

4 CREDITS

Unit I:

Clinical Decision Support Systems- Reasoning with clinical knowledge, clinical task- Alerts and reminders, Diagnostic assistance, Therapy critiquing and planning,

Prescribing decision support systems, Information retrieval, Image recognition and interpretation.

Unit II:

Diagnostic and educational systems- Acute Care Systems, Post-operative care decision support, Parenteral nutrition planning for neonatal ICU (VIE-PNN), ICU ventilator management, Clinical toxicology advisor, Interpretation of acid-base disorders, Chemical pathology expert system.

Unit III:

Expert laboratory information systems, Machine learning systems, Evaluation of Clinical Decision Support Systems, Improved patient safety, Improved quality of care, Improved efficiency in health care delivery.

Unit IV:

Improvement in Patient Safety, Reduction in Medication Errors and Adverse Drug Events, Enhancing Prescribing Behaviour, Improved Quality of Care, Improved Compliance with Clinical Pathways and Guidelines, Time Released for Patient Care, Improved Efficiency of Health Care Delivery Processes.

Unit V:

Development of Computer Based Monitoring- Data Acquisition and Signal Processing, Advantages of Built-In Microcomputers, Arrhythmia Monitoring—Signal Acquisition and Processing, Bedside Point of Care Laboratory Testing, Commercial Development of Computer-Based Monitoring and Intensive-Care-Unit Information Systems, Information Management in the Intensive-care Unit, Computer-Based Charting.

Reference:

PAPER 11: HELATH/CLINICAL INFORMATICS
4 CREDITS

Unit I:

Combined Health Information Database, Health Information Sites, Securing Health Care Data, Integrated Data Depository, Translation of Bioinformatics, Clinical Research Informatics, Developing Data Integrity Policies.

Unit II:

Online Learning Experiences, Barriers, Challenges, and Concerns for eHealth, Organizational Differences of Health Care Organizations, Professional Code of Conduct, Availability of Health Care Information, Educational Opportunities in Health Care Informatics.

Unit III:

Medical record keeping- Capturing and using information, Representing, interpreting and displaying information, Sources of clinical information, The costs of information, Assessing the quality of information, Patient orientated health portals.

Unit IV:

Direct access to medical literature, Mediated access to medical literature, Teleconsultation, Diagnostic process- Diagnostic process- Medical history, Family history, Drug history, Laboratory results, Preconsultation screening, Coding of clinical data.

Unit V:

Protocol and Report Writing- Data collection and acquisition, Protocol design and efficient management, Recruitment and management, Adverse event management, Regulatory compliance, Data transfer, Processing and storage, Management of continuing problems, Multimedia information retrieval, Risk prediction tools.

Reference:

PAPER 12: ADVANCE HEALTH INFORMATICS EDUCATION

4 CREDITS

Unit I:

Overview and History of Health Informatics, History of Computing, Data Information and Knowledge Management, Data and Information Quality, Evidence-based Practice, Information for Patient-centred Care, Secondary Uses of Information.

Unit II:

Healthcare Data Analytics- Terminology of Analytics, Challenges to Data Analytics, Research and Application of Analytics- Centers for Medicare and Medicaid Services (CMS), Role of Informaticians in Analytics.

Unit III:

Overview of Mobile Health Technology, mHealth Technology: Use Cases for Wellness & Prevention, Use Cases for Chronic Disease and Remote Patient Monitoring, Use Cases for Acute and Sub-Acute Care Delivery, Health Data, Information and Knowledge, Health Data Standards, Big Data and Cloud Computing, Mobile Health App Use Cases.

Unit IV:

Public Health Informatics: Improving and Transforming Public Health in the Information Age, Principles of Public Health Informatics, Major Challenges, Recognition of the need for public health informatics, Training, Physical infrastructure/architecture, Profile Project Charter Scope Statement, Conceptual Framework Diagram, Assessment Tool, Report and Stakeholder Analysis and Communication Strategies.

Unit V:

E-Research Concepts for e-Health, Large collections of complex data sets, Advanced and intensive computational technique, Tools for advancing human understanding and interaction, A major impediment to large scale linking of health databases, e-Health Opportunities for e-Research, High Volume Patient Data Logging, e-Research paradigm.

Reference:

ELECTIVE 3: BIOINFORMATICS TOOLS ON MATLAB

4 CREDITS

Unit I:

Introduction To Matlab, Matlab key features, basic functionalities-tool box , data types, variables, operators, vectors, matrix operations, trigonometric functions, 2D, 3D-graphics , Limits. Control structures, function handling, class file handling, mat file creation, symbolic mathematics. Numerical Methods- solving linear equations, solving differential equations-ODE suite, integration, interpolation, regression. Statistical analysis- probability, hypothesis testing, ANOVA and cluster analysis.

Unit II:

Bioinformatics Tool Box, Sequence Analysis, NGS, Graph Theory, Gene Ontology, Importing Data and Deploying.

Unit III:

Biological Data Analysis, Microarray Data Analysis, Mass Spectrometry Data Analysis, statistical classification of biological data

Unit IV:

Image Processing, Key Features, Importing and Exporting Images, image file formats and format conversion, Pre- and Post-Processing Images, Spatial Transformations and Image Registration. Microarray image analysis.

Unit V:

Systems Biology, Basics of enzyme kinetics, Kinetic Laws. Modeling Biological System, Simulation, sensitivity analysis, parameter estimation using simbiology. Pharmacokinetic modeling- simulation, population study. Model of the Yeast Heterotrimeric G Protein Cycle and glycolysis.

Reference:

Practical:

SEMESTER IV

Summer project work – 2 Credits

Thesis and viva-voce examination – 12 Credits

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M.Sc. Cognitive Neuroscience Overview of the Program

This course will be a broad overview of current research and methods in the field of developmental cognitive neuroscience. The course will start with a basic overview of organization of the nervous system and functional organization of brain from cognitive perspective. Also the neural mechanisms involved in the development of memory, language, spatial cognition, object perception, executive functions, and attention would be studied. The method researchers use to study developmental cognitive science, including metabolic measures, electrophysiological techniques (including biofeedback, neurofeedback, EEG and ERPS) would be discussed in detail. An emphasis is also laid on the computational intelligence and its relation to cognitive science. The course work also focuses on the socio-cognitive components of decision-making etc. A separate paper is dedicated to consciousness studies involving the like spirituality in relation to cognition. The students are required to submit a dissertation thesis in the last semester on any of the topics related to cognitive science. The aim is to provide students experience in research design, data analysis and interpretation. Cognition is the process by which one acquires processes, stores and acts on information from the environment.

Cognitive Science: It is the study of relationships among the integration of cognitive psychology, biology, anthropology, computer science, linguistics, philosophy, and mathematics. The subject matter has its roots in different basic disciplines like:

- * Philosophy of Mind: The subject matter that deals with the structure of mind and relationship of mind and body.
- * Neuroscience: A science that establishes link between brain functions and behavior.
- * Computational Intelligence: The subject matter that aims to understanding intelligent agent in computational terms.
- * Language: It is the main tool through which our thoughts get expressed and modes of reasoning become manifest.
- * Culture: A cognitive account assumes that some trends in culture results from universal properties of human mind

Eligibility: A graduate in Medicine/Ayurveda/Homeopathy/Nursing/BPT/B.Sc. Speech and Hearing Science/BCA/B.Tech/BA Psychology, from a recognized University. Students who have not studied biological sciences may take an add on course in biological science/physiological psychology/mathematics to facilitate the learning for the courses related to Neuro Sciences and students from the science stream may take an add on consciousness studies/psychology.

M.Sc. Cognitive Neuroscience

	Semester I	Remarks
Paper 1	Developmental Cognitive Science	4
Paper 2	Principles of Neuro Science	4
Paper 3	Mathematical Models of Cognitive Science	4
Paper 4	Research Methods	4
Elective 1	Statistical Methods for Biology	4
Practical 1	Practical 1	6
		26
	Semester II	
Paper 5	Social Cognition and Culture.	4
Paper 6	Neuro Basis of Cognitive Science.	4
Paper 7	Computational Intelligence.	4
Paper 8	Philosophy of Mind	4
Practical 2	Practical 2	6
		22
	Semester III	
Paper 9	Consciousness Studies	4
Paper 10	Cognitive Neuro psychological Rehabilitation.	4
Elective 2	Research Methods	4
Elective 3	Elective	4
Practical 3	Practical 3	6
		22
	Semester IV	
	Summer Project	2
	Thesis and viva voce examination	12
		14
	Total Credits	84

SEMESTER - I

PAPER 1: DEVELOPMENTAL COGNITIVE SCIENCE - 4 CREDITS

Unit I:

Introduction to Cognitive Science: Organization of Nervous system: Cognition in the Brain. Sensation & representation. Principles of Cognitive Neuroscience.

Unit II:

Development of perception: Theoretical approaches to perception, Deficits in perception. Attention and consciousness. Development of Object Recognition /Understanding, Development of Face Recognition. Development of Spatial cognition and Cognitive Map.

Unit III:

Memory: Models of memory, Processes, Development of Explicit Memory and Implicit memory, Practical Applications of Cognitive Psychology in improving memory processes.

Unit IV:

Development of Speech and Language: Understanding spoken language: Speech perception, constituent structure, transformational grammar and factors affecting comprehension. Selecting the content of speech, speech errors, gestures, social context of speech. Nature and Acquisition of language; Bilingualism and Multilingualism, Neuropsychology of Language. Reading: Bottom -up and Top - down processes, Reading and writing skills.

Unit V:

Decision-making and reasoning: Deductive reasoning and inductive reasoning. Problem-solving and Creativity.

Reference Books

1. Matlin, M. (1994). Cognition. Prism Indian Books
2. Solso, R. L. (2004). Cognitive Psychology (6th ed). Delhi: Pearson Education.
3. Sternberg, R.J. (2007). Cognitive Psychology. Australia: Thomson Wadsworth.

PAPER 2: PRINCIPLES OF NEUROSCIENCE - 4 CREDITS

Unit I:

Anatomy of the Brain: Major anatomical sub-divisions of the human brain, the surfaces anatomy and interior structure of cortical regions. Anatomical connectivity among the various regions. The blood supply to brain and the CSF system, cyto- architecture and modular organization in the brain. Neuronal Signaling: The membrane property and ion channels of neurons for electrical signaling, action potential, the role of synapses and neurotransmitters in inter neuronal communication. Recording the nerve action potential.

Unit II:

Biochemistry of Central Nervous System: Biochemical constituents of Brain; Brain function and importance of Glucose; Metabolic aspects of Central Nervous System; Biochemical aspects of Metabolic defects. Neural Transmission: Neurotransmitters and Neuromodulators including Neuropeptides; Pharmaco-chemical aspects of Neurotransmitters; Neurotransmitter dysfunction in behavioral disorders.

Unit III:

Concept of Inheritance: Structure and Function of Chromosomes; Genetics aspects of major psychoses; Genetic abnormalities in Mental Retardation; Genetic Counselling.

Unit IV:

Neurobiology of Sensory and Motor Systems: The organization of sensory system in terms of receptors, relay neurons, Thalamus and cortical processing of different sensations. Principle motor mechanisms of the periphery (muscle spindle), Thalamus, basal ganglia, brain stem, cerebellum and cerebral cortex. Neurobiology of Drives and Motivation: Mechanisms of Aggression, Hunger, Thirst and Sex

Unit V:

Regulation of Internal Environment: Role of limbic, autonomic and the neuroendocrine system in regulating the internal environment. Reticular formation and other important neural substrates regulating the state of sleep/wakefulness. State of consciousness/ brain death.

Reference Books

1. Sigh, V. (2004). Textbook of Clinical Neuroanatomy. Elsevier.
2. Shepherd, G.M. (1983). Neurobiology. Oxford University Press.

PAPER 3: MATHEMATICAL MODELS OF COGNITIVE SCIENCE - 4 CREDITS

Unit I:

Philosophy of Mathematics: Philosophical issues about or related to mathematics, including the existence and nature of basic mathematical objects such as numbers and sets, how we can come to have knowledge of such objects, the status of mathematical truth, the relation of mathematics to logic, and whether classical logic can be called into question.

Unit II:

Cognitive Science of Mathematics: Empirical investigation of the nature of mathematics. How the human mind/brain creates abstract concepts, such as infinity, infinitesimals, imaginary numbers, or zero: embodiment, creativity, and history. Cognitive approaches that connect mathematics to human thought in general.

Unit III:

Cognitive Foundations of Mathematics: Nature of mathematics as an empirical question subject to methodological investigations of an interdisciplinary nature, involving hypothesis testing and appropriate theoretical interpretations. Mathematics as a unique type of human conceptual system, which is sustained by specific neural activity and bodily functions; Cognitive mechanisms that make human imagination, abstraction, and notation-making processes possible.

Unit IV:

Analogy and Conceptual Systems: Human thought and meaning are deeply tied to the capacity for mapping conceptual domains onto each other, including common schemas and performing mental simulation. The course examines major aspects of this cognitive activity including metaphor, conceptual blending and embodied cognition

Unit V:

Logic: Introduction to the aims and techniques of formal logic. The logic of truth functions and quantifiers. The concepts of validity and truth and their relation to formal deduction. Applications of logic and the place of logic in philosophy. The central results of modern logic: the completeness of predicate logic, recursive functions, the incompleteness of arithmetic, the unprovability of consistency, the indefinability of truth.

Reference Books

Russell, B. (1919). Introduction to Mathematical Philosophy. George Allen & Unwin, Ltd.

Thagard, P. (1996). Mind: An introduction to cognitive science, PHI.

PAPER 4: RESEARCH METHODS IN COGNITIVE SCIENCE - 4 CREDITS

Unit I:

Design and Analysis of Experiments:

Introduction to mathematical foundations of probability and statistical decision theory. Decision theory is applied to the problem of designing and analyzing experiments.

Unit II:

Research Designs: Issues in design, implementation and evaluation of research in cognitive science. Surveys a variety of theoretical and methodological approaches to the study of human cognition. Topics include language structure, language processing, concepts and categories, knowledge representation, analogy and metaphor, reasoning, planning and action, problem solving, learning and expertise and emotion.

Unit III:

Neuropsychological approaches to understanding human cognition neuropsychological assessment techniques; measurement and interpretation of Event Related Potentials (ERPs)

Unit IV:

Brain imaging techniques such as MRI; experimental methods; methods in sleep research; methods in the recording and analysis of human movement.

Unit V:

Introduction to programming and algorithms, Computational Models of Cognitive Processes, applications of computational models, from cognitive psychology to neuropsychology. Examination of the structure and function of parallel - distributed processing models.

Reference Books

1. Kerlinger. (1964). Foundations of Behavioral Research.
2. Rohrbaugh, J W. (1990). Event Related brain potentials – Basic issues & applications, Oxford University Press: NY.

SEMESTER – II

PAPER 5: SOCIAL COGNITION - 4 CREDITS

Unit I:

Understanding Individuals and Groups - Construction of social reality: sense of self, others and groups. Attention, encoding, memory organization and retrieval of social information. Social categorization: Activation and application of social cognition. Person identification, trait inferences, stereotyping, prejudice, social projection. Social cognition across cultures

Unit II:

Current Issues in Attitude Research: Attitude formation. Experimental designs in attitude research. Techniques to measure explicit and implicit attitude. Theoretical controversies in attitude research. Attitude change

Unit III:

Social Cognition, Affect and Motivation-current states and goals affect the construction of social reality -experiments designs in social cognition, affect and motivation-theoretical issues in motivation and social cognition, affect and motivation - theoretical issues in motivation and social cognition how the social reality impacts basic processes

Unit IV:

Judgment and Decision - Judgment and decision making. Normative and descriptive models of judgments and choice. the axioms of probability, Bayesian networks, decision theory and game theory. probability biases and choice anomalies. Current psychological models of judgment and choice including heuristics and biases; prospect theory; decision field theory; sampling approaches and rational analysis models. The implications of this research for practical decision-making, and the use of decision aids.

Unit V:

Culture and Cognition-. Evolutionary and cognitive perspective of culture. Culture, symbols, and social interaction. Identity construction: individual and collective; class, gender, race, and religion; object, place, and event. Ancestry and descent; marked and unmarked identities; lifestyles, commuters, and integrators; the cognitive politics of identity. Belief systems: ideology, religion, science; interaction between believing and belonging.

Reference Books

1. Augoustinos, M. (1996). Social Cognition. Sage Publication.
2. Myers, D. (2010). Social Psychology. McGraw-Hill.
3. Hewstone, M. (1989). Causal attribution: From cognitive processes to collective beliefs.
4. Oxford: Blackwell.
5. Fiske, S.T. & Taylor, S.E. (1991). Social cognition. New York: McGraw-Hill.

PAPER 6: NEUROPSYCHOLOGICAL BASIS OF COGNITIVE SCIENCE- 4 CREDITS

Unit I:

Frontal lobe syndrome: Disturbances of regulatory functions. Attentional processes, Emotions, Memory and Intellectual activity; Language and Motor functions.

Unit II:

Temporal lobe syndrome: Special senses, hearing, Vestibular functions and integrative functions; Disturbances in learning and memory functions, language emotions, time perception and consciousness.

Unit III:

Parietal and Occipital lobe syndromes: Disturbances in sensory functions and body schema perception, Agnosias and Apraxias; Disturbances in visual space perception; color perception, writing and reading ability.

Unit IV:

Neuropsychological profile of various Neurological Conditions: Huntington's disease, Parkinson's disease, Progressive Supranuclear Palsy, Thalamic degenerative disease, Multiple sclerosis, cortical and subcortical dementias, Alzheimer's dementia, AIDS dementia complex etc.

Unit V:

Cognitive aberrations- Neural basis of conditions such as Parkinson's and disorders, and the neurobiology of sensory systems.

Reference Books

1. Eberhard, J.P. (2009). Brain Landscape. Oxford University Press.
2. Singh, V. (2004). Textbook of Clinical Neuroanatomy. Elsevier.
3. Jaaskelainen, L.P & Ventus. (2002). Introduction to Cognitive Neuroscience. Publishing APS

PAPER 7: COMPUTATIONAL INTELLIGENCE AND NEUROSCIENCE- 4 CREDITS

Unit I:

Human and artificial intelligence: Information possessing theories, alternative approaches to intelligence. Concepts of artificial intelligence.

Unit II:

Multidisciplinary computational approaches: study of creativity, learning {Learning theory (supervised/ unsupervised/ reinforcement learning)}. Learning Classifiers, Knowledge and inference, emotion and motivation.

Unit III:

Computational aspects of perceptual systems: Perception of different (visual, auditory and tactile) modalities. Multi-level (neural, psychological, computational) analysis of cognitive phenomena. Integrated theories of natural and artificial cognitive systems. Information - theoretical, control - theoretic and decision - theoretic approaches to neuroscience. Computer simulation.

Unit IV:

Introduction to Programming for Cognitive Science: Fundamentals of Computer programming are introduced. Topics will include fundamentals of computer architecture, variables, functions, and control structures; writing, testing and debugging programs; programming style and basic software design.

Unit V:

Cognitive consequences of technology: The role of cognition and computation in the development of state-of-the art technologies such as human computational interaction in aviation, air traffic control, medical diagnosis, robotics and tele robotics and the design and engineering of cognitive artifacts.

Reference Books

1. Russel and Norvig. (2012). Artificial Intelligence- A modern approach. TMH.
2. Poole, D.L. & Mack worth, A.K. (2010). Artificial Intelligence: Foundations of Computational Agents. Cambridge University Press.
3. Ethem Alpaydin. (2010) Introduction to Machine learning. The MIT Press.
4. Laurene Fausett, (2004). Fundamentals of Neural Networks. Person.

PAPER 8: PHILOSOPHY OF MIND - 4 CREDITS

Unit I:

Classics of Western Philosophy - Introduction to Western philosophical tradition through the study of selected major thinkers such as Plato, Aristotle, Lucretius, Descartes, Hobbes, Leibniz, Locke, Berkeley, Hume, Kant, Nietzsche and Marx. Emphasis on changes of intellectual outlook over time, and the complex interplay of scientific, religious and political concerns that influence the development of philosophical ideas.

Unit II:

Schools of Indian Philosophy- An overview- Different school of thought, upanishadic concepts, Buddhist concepts, Jain school of thought, Yoga school of thought, Nyaya and Vaiseshika, Charka - Materialism,

Unit III:

Moral Problems and Good Life. Introduction to important philosophical debates about moral issues and what constitutes a good life: what is right, what is wrong, and why? How important are personal happiness, longevity, and success if one is to live a good life? When is it good for you to get what you want? To what extent are we morally obliged to respect the rights and needs of others? What do we owe the poor, the discriminated, our loved ones, animals and fetuses?

Unit IV:

Bioethics: Ethical questions that have arisen from the growth of biomedical research and the health- care industry since World War II. Should doctors be allowed to help patients end their lives? If so, when and how? Should embryos be cloned for research and / or reproduction? Should parents be given control over the genetic make - up of their children? What types of living things are appropriate to use as research subjects? How should we distribute scarce and expensive medical resources? Draws on philosophy, history, and anthropology to show how problems in bioethics can be approached from a variety of perspectives.

Unit V:

Moral Psychology: An examination of philosophical theories of action and motivation in the light of empirical findings from social psychology, sociology and neuroscience. Topics include belief, desire, and moral motivation; sympathy and empathy; intentions and other committing states; strength of will and weakness of will; free will; addiction and compulsion; guilt, shame and regret; evil; self- knowledge and self- deception; virtues and character traits.

Reference Books

1. Radhakrishnan, S. Indian Philosophy.
2. Dutta, D. & Chatterjee, S. (2007). An Introduction to Indian Philosophy. Rupa Publications
3. Billington, R. (2009). Living Philosophy, An Introduction to Moral Thought , 3 rd Edition.

SEMESTER – III

PAPER 9: CONSCIOUSNESS STUDIES - 4 CREDITS

Unit I:

Minds and Machines: Introduction Consciousness Studies. Can computers think? Is the mind an immaterial thing? Alternatively, is the mind the brain? How can creatures like ourselves think thoughts that are about things? Can I know whether your experiences are the same as mine when we both look at raspberries, fire trucks, and stoplights? Can consciousness be given a scientific explanation?

Unit II:

Philosophy of Quantum Mechanics: Quantum mechanics is said to describe a world in which physical objects often lack “definite” properties, indeterminism creeps in at the point of “observation”, ordinary logic does not apply, and distant events are perfectly yet inexplicably correlated. Examination of these and other issues central to the philosophical foundations of quantum mechanics, with special attention to the measurement problem, no- hidden – variables proofs, and Bell’s with special attention to the measurement problem, no – hidden- variables proofs, and Bell’s Inequalities. Rigorous approach to the subject matter nevertheless neither presupposes nor requires the development of detailed technical knowledge of the quantum theory.

Unit III:

History and evolution of Consciousness: Views by different philosophers definition of consciousness, functions of consciousness, Pharmacology of the brain, Review of standard drugs, their effect on the brain and consciousness, Mental lesions and their effect on consciousness (phantom limbs, commissurotomy, hemineglect, anosgnosia)

Unit IV:

Concept of Consciousness- Status and traits of consciousness, the persistent paradox of psychic phenomena, Computational models of consciousness, Quantum mechanic theories of consciousness, functions of consciousness, Pharmacology of the brain, Review of standard drugs, their effect on the brain and consciousness, Mental lesions and their effect on consciousness (phantom limbs, commissurotomy, hemineglect, anosgnosia)

Unit V:

Spiritual Cognition- Concept of spiritually, spiritual intelligence, Intuition, Spiritual and cognitive development, Spiritual cognitive therapy and its process, Cognitive deficits and spirituality. Buddhist Psychology

Reference Books

1. Dehaene, S. (2014). Consciousness and the brain – Deciphering how the brain codes our thoughts .Viking Penguin , USA .
2. Bransden & Joachain. (2000). Quantum Mechanics, second edition, Prentice Hall.
3. Gallagher, S & Zahavi, D. (2008). The Phenomenological mind- An Introduction to Philosophy of mind and Cognitive Science. Roulledge.

PAPER 10: COGNITIVE NEUROPSYCHOLOGICAL REHABILITATION

4 CREDITS

Unit I:

Cognitive Remediation in Learning Disability and Neuropsychological Rehabilitation in Brain Dysfunction and Epilepsy

Unit II:

Neuropsychological assessment and syndrome analysis and Rehabilitation in Minimal brain Dysfunction. Epilepsy, Mental Retardation and Learning Disabilities, Aphasias, Apraxia and Agnosias.

Unit III:

Neuropsychological Rehabilitation in Brain Injured and Spinal Cord injured patients

Unit IV:

Plasticity and Restoration of Brain Function, Computer assisted neuropsychological rehabilitation and training.

Unit V:

Functional Human Brain Mapping: QEEG, ERP, PET, SPECT, FMRI in Neuropsychological Rehabilitation

Reference Books

1. Principles of Neuropsychological Rehabilitation, Prigatano, G.P. (1999). Oxford University Press: NY
2. Neuropsychology, a clinical approach, Walsh K. (1994), Churchill Livingstone: Edinburgh.
3. Developmental Psychopathology, 2nd Edition , Volume Two: Developmental Neuroscience, Edited by Dante Cicchetti & Donald J. Cohen, © 2006 by John Wiley & Sons, Inc.

ELECTIVE 1

PAPER: STATISTICAL METHODS FOR BIOLOGY- 4 CREDITS

Unit 1:

Numerical Methods to Represent Variation. Importance and Scope of Statistics, Data Types, frequency distribution, Graphical Representation. Methods (Histogram, Bar Charts, Pie Charts), Measures of Center Tendency (Mean, Median, Mode,) and Dispersion (Standard Deviation, Variance) Advantages and Disadvantages, Co-Efficient of Variance.

Unit 2:

Basic Terminology, Definition of Probability, Basic Laws of Probability, Types of Probability, Additional Rule of Probability and Multiplication Rule of Probability, Probability Distribution- Bernoulli. Distribution, Binomial Distribution, Poisson distribution and Normal Distribution- Simple Problems.

Unit 3:

Sampling Methods. Collection of Data, Census Method, Concept of Population, Sample, Sampling, Sample Size, Sampling. Error, Advantages and Disadvantages of Sampling Method, Necessity of Sampling, Types of Sampling. Methods, Types of Random Sampling Methods – SRS, Stratified Random Sampling, Systematic Random. Sampling And Cluster Sampling.

Unit 4:

Testing of Hypotheses. Statistical Hypotheses-Null and Alternative, Level of Significance, Type I and Type II Error, Critical. Region, Power of the Test, P Value, Degrees Of Freedom, Chi-Square Test for Independence of Attributes and Goodness of Fit, Student's t Test: One Sample t Test and Paired t Test, F Test.

Unit 5:

Regression and Analysis Of Variance. Simple Linear Regression, Multiple Linear Regression (Definition, Assumptions, Applications, and Examples) ,Analysis of Variance –Introduction ,Definition of ANOVA, Assumption , Test Of ANOVA, Types Of ANOVA, Construction of One Way Analysis of Variance.

Reference Books

1. Fundamentals of Biostatistics: Veer Bala Rastogi
2. Fundamentals of Mathematical Statistics: S.C. Gupta and V. K. Kapoor
3. Fundamentals of Statistics: S.C. Gupta
4. Biostatistics, Snedger and Gohrran.
5. Introductory Statistics for Biology 2nd Edition, R. E. Parker

ELECTIVE 2

PAPER: RESEARCH METHODS 2- 4 Credits

UNIT I:

Tasks used for measuring memory: Recall versus recognition task, intelligence and importance of culture in testing, sensory stores, short term store and long term store

UNIT II:

Memory models: Atkinson & Shiffrin's memory model with experimental methods, levels of processing model, integrative model, neuroscience & integrative model with working memory

UNIT III:

The concept of intelligence and memory, multiple memory system, exceptional memory and neuropsychology, outstanding memory, deficient memory – Amnesia – Alzheimer's disease

UNIT IV:

Memory retrieval – short term memory – long term memory, serial processing, exhaustive and self terminating processing, intelligence and retrieval

Processes of forgetting and memory distortion, interference theory and decay theory

Constructive nature of theory, autobiographical memory, effect of context on memory

UNIT V:

Memory landscape: Mental images, maps and propositions

Mental representation of knowledge, communicating knowledge, pictures versus words, dual code theory, images and symbol, limitations of mental images

Mental manipulations of images-principles of visual advertising, neuroscience and functional equivalence

Reference Books

1. H, Eichenbaum. (2002). The Cognitive Neuroscience of Memory. Oxford University.
2. Sternberg, R.J. (2007). Cognitive Psychology. Australia: Thomson Wadsworth.

ELECTIVE 3

PAPER: PSYCHOMETRICS- 4 Credits

Unit I:

Test construction: Measurement scales, Classification of tests, General steps in test construction, uses and limitations of psychological tests and testing, Ethical issues in psychological testing. Scaling techniques: psychophysical and psychological scaling methods. Rating scales.

Unit II:

Item Analysis: Types of item, Guidelines for item writing, meaning and purpose of item analysis, Power and speed tests, Item difficulty, index of discrimination, Item characteristic curve, Item response theory.

Unit III:

Reliability: Meaning of reliability, Index of reliability. Test-retest reliability, Internal consistency reliability, Alternate-form reliability, scorer reliability, Reliability of speed tests, Factors influencing reliability of test scores

Unit IV:

Validity: Meaning of Validity, Construct validity, Content validity, Criterion validity. Factors influencing test validity, Relationship between validity and reliability

Unit V:

Normality: Norm-referenced and criterion referenced tests, Age-equivalent norms, Percentile norms, Standard score norms. Steps in developing norms-Defining target population, Selecting sample from target population, Standardizing conditions.

Reference Books

1. Anastasi, A. & Urbina, S. (1997). Psychological testing. N.D.: Pearson Education.
2. Kaplan, R.M. & Saccuzzo, D.P. (2007). Psychological Testing: Principles, Applications, and Issues. Australia: Thomson Wadsworth
3. Gregory, R.J. (2005). Psychological testing: History, principles and applications. New Delhi: Pearson Education.
4. Singh, A.K. (2006). Tests, Measurements and Research Methods in Behavioural Sciences. Patna: Bharati Bhavan.

SEMESTER IV

Summer Project-2 Credits

Thesis and viva voce examination-12 Credits

M.Sc (Cosmetic Science)
Department of Life Sciences,
JSS University, Mysore

JSS University, Mysore: Department of Life Science
Post Graduate Program in Cosmetic Science
Syllabus - M. Sc. – Cosmetic Science

	Semester I	Credits
Paper 1	Basic human Anatomy and Physiology	4
Paper 2	Cosmetics -- principles	4
Paper 3	Fundamentals of Nanotechnology	4
Paper 4	Analytical techniques	4
Electives 1	Fundamentals of Biochemistry and Bio-molecules	4
Practical 1	Human Anatomy and Physiology	6
	Total	26
	Semester II	
Paper 5	Cosmetics Biology	4
Paper 6	Cosmetics Formulation Science	4
Paper 7	Cosmeceuticals	4
Paper 8	Herbal Science	4
Electives 2	Genetics.	4
Practical 2	Formulation Science	6
	Total	26
	Semester III	
Paper 9	Cosmetics – Analysis and Evaluation	4
Paper 10	Statistical Methods for Biology	4
Paper 11	Applied Microbiology	4
Paper 12	Industrial Cosmetics	4
Electives 3	Environmental aspects of Nanomaterials	4
Practical 3	Cosmetics – Analysis & Evaluation	6
	Total	26
	Semester IV	
	Summer Project:Marketing case studies Dissertation and Viva-Voce examination	2
	Project work – Dissertation and viva voce examination	12
	Total	14
	Total Credits	92
Minimum credits to be completed for the degree : 78		

Semester I

Paper 1: Basic Human Anatomy & Physiology

4 CREDITS

Unit-I

1. Introduction

Definition, scope of anatomy and physiology, basic terminologies.

2. General cellular anatomy and physiology

Cell, cell junctions, transport mechanisms, homeostasis, ion channels.

3. Tissues

Definition classification of tissues, their location, characteristics and Functions.

4. Body fluids and blood

Body fluids, composition and functions of blood, haemopoiesis, mechanism of coagulation. Blood grouping and its significance, lymphatic system.

Unit-II

5. Human skeleton

Structure, composition, classification and function of bones. Identification and few salient features of important bones of axial and appendicular skeleton. Classification of joints, types of movements.

6. Cardio-Vascular system

Anatomy and physiology of heart. Blood circulation, blood pressure

Unit-III

7. Digestive system

Physiology with special reference to liver, pancreas and intestine..

8. Respiratory system

Anatomy of respiratory tract. Transport of oxygen and carbondioxide

9. Urinary system

Structure and function of kidney

10. Skeletal muscle

Physiology of muscle contraction, definition of myasthenia gravis

Unit-IV

11. Nervous system

a. Definition and classification of nervous system

e. Anatomy and functions of cerebrum, cerebellum, brain stem (pons, medulla and mid brain), hypothalamus, thalamus, basal ganglia

g. Cranial nerves- names and their functions

h. Autonomic nervous system-Anatomy and functions of sympathetic and parasympathetic nervous system

Unit- V

12. Endocrinology

Physiology of pituitary, thyroid, parathyroid, adrenal and pancreas.

13. Reproductive system

Sex hormones, menstrual cycle

14. Definition of the term “pharmacology”

Basic understanding of the terms: Pharmacodynamics, Pharmacokinetics, Pharmacogenetics, adverse drug reactions, and pre-clinical & clinical studies. (4h)

References

1. Fundamentals of Anatomy and Physiology for Student Nurses by John Wiley and Sons
2. Anatomy and Physiology for Nurses, by Watson
3. Anatomy and Physiology for Nurses by Evelyn C. Pearce
4. Physiology and Anatomy: A Basis for Nursing and Health Care by Sigrid Rutishauser
5. Anatomy and Physiology for Nurses and Students of Human Biology by Sears, W.Gordo
6. Anatomy and Physiology for Nurses, by Ross, Jean R.W.
7. Anatomy and Physiology for Nurses by Tony William Alph
8. Anatomy and Physiology for Nurses by Evelyn Pearce
9. Basic & clinical Pharmacology by Katzung B.G.

Semester I
Paper- 2: Cosmetic Principles:
4 CREDITS

Unit-1

Regulatory definition of Cosmetics.

Broad classification of cosmetic products for skin, hair and oral care.

Application of various product forms in cosmetics: Solutions, creams, lotions, ointment, paste, gels, sticks, tablets, capsules, powders and aerosols. Examples from marketed product.

Product Development::

Generation of data

Requirement of a successful formula

Product development process: Defining the product, selection & sources of ingredients, formula optimization, test batches.

Unit-2

Cosmetic Ingredients

Water: Special consideration for cosmetics use.

Surfactants: Classification and application in cosmetics – Foaming agents, emulsifiers, and solubilizers.

Emollients, humectants and rheological additives: Classification and application in cosmetics

Antioxidants, antimicrobial and chelating agents used as preservatives,. Factors affecting effectiveness of antimicrobial preservatives.

Perfume: Classification of perfumes. Perfume ingredients listed as allergens in EU guidelines.

Unit-3

Suspensions and Emulsions:

Suspensions: Definitions, general method of preparation, flocculated and de-flocculated suspension, Stoke's law

Emulsions: Definition, classification, general method of preparation of a cosmetic emulsion, stability of emulsion – creaming, cracking and phase inversion. Multiple emulsions, concept of HLB and miscelles.

Unit-4

Micrometrics: Particle size and distribution, average particle size, number and weight distribution, particle number, methods of determining particle size, optical microscopy, sieving, sedimentation measurements, particle shape, specific surface, methods of determining surface area, permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness and flow properties.

Unit - 5

Rheology: Newtonian systems, law of flow, kinematic viscosity, effect of temperature on viscosity, non-Newtonian systems – Plastic, pseudoplastic and dilatant system, thixotropy determination of viscosity, capillary, falling ball and rotational viscometers.

References

1. Harry's Cosmeticology – Wilkinson, Moore, seventh edition, George Godwin.
2. Cosmetics – Formulation, Manufacturing and Quality Control, P.P. Sharma, 4th edition, Vandana Publications Pvt. Ltd., Delhi.
3. Drugs and Cosmetic act/rules by govt. of India Publication
4. European Union regulation for cosmetics.
5. Poucher's Perfumes, Cosmetics and Soaps, Hilda Butler, 10th Edition, Kluwer Academic Publishers
6. Handbook of Cosmetic Science and Technology, 3rd Edition, André O. Barel, Marc Paye, Howard I. Maibach, Marianne Mahieu Informa Healthcare USA, Inc.
7. Theory and practice of industrial pharmacy by Lachmann
8. E.A.Rawlins, Bentley's text book on pharmaceuticals, 8th edition, 1997.

Semester I

PAPER 3: FUNDAMENTALS OF NANOTECHNOLOGY

4 CREDITS

Unit I:

Fundamentals and overview of Nanoscience and Technology, History of nanoscience, properties at nanoscale – theory and definition, electronics, optical and magnetic properties at the nanoscale.

Unit II:

Types of nanomaterials, inorganic - metal and metal oxides, organic – self-assembly structures, liposomes, micelles, nanoemulsions and polymeric nanoparticles, carbon based systems – carbon nanotubes (CNTs), bucky balls and graphene.

Unit III:

Synthesis of nanomaterials. Top-down method – lithography, ball milling and etching, Bottom-up method – colloidal method of synthesis, wet-chemistry synthesis and self-assembly.

Unit IV:

Materials used in the synthesis of nanoparticles, organic-based synthetic polymers, phospholipids, surfactants, inorganic salts, natural biopolymers

Unit V:

Characterization of nanomaterials, electronic microscopy techniques, SEM and TEM, optical spectroscopy techniques, UV-vis absorption and fluorescence spectroscopy, dynamic light scattering, Scanning Probe Microscopy, Atomic force microscopy and scanning tunneling microscopy.

References:

1. Nanoscale Science and Technology, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, **2005**, ISSN: 978-0-470-85086-2.
2. Introduction to Nanotechnology, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, New Jersey, **2003**, ISSN: 978-0-471-07935-9.
3. Bio-Inspired Nanomaterials and Nanotechnology, Edited by Yong Zhou, Nova Science, **2005**, ISSN: 978-1608761050.
4. Nano:The Essentials: Understanding Nanoscience and Nanotechnology, T.Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, **2008**, ISSN: 978-0071548298.
5. Nanocrystals: Synthesis, Properties and Applications, C. N. R. Rao, P. J. Thomas and G. U. Kulkarni, Springer, New York, **2007**, ISSN: 978-3-54068751-1.
6. Nanochemistry: A Chemical Approach to Nanomaterials, Geoffrey A. Ozin, Royal Society of Chemistry, Cambridge, UK, **2005**, ISSN: 978-1847558954.

Semester I

Paper-4: Analytical Techniques -

4 Credits

Unit-I:

Spectroscopy

- a. UV-Visible Spectroscopy: Electronic transitions, Photometric laws, instrumentation and application.
- b. IR Spectroscopy: Principles, Modes of vibrations, instrumentation and application.

Unit-II:

Chromatography-

- a. Introduction, classification, Principles of separation
- b. General principles, instrumentation and applications of Paper Chromatography, Thin Layer Chromatography and High Performance Thin Layer Chromatography

Unit-III:

- a. Introduction to NMR, Mass and Raman Spectroscopy
- b. Introduction to HPLC and GC Techniques

Unit-IV

a. Introduction to Electrochemical Methods of Analysis:

Conductometry (Principles and Conductometric titrations) and Potentiometry (Principles, Electrodes, measurement of pH, Potentiometric Titrations)

b. Introduction to Thermal Methods of analysis:

Theory and applications of Thermo Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC) and Thermo Mechanical Analysis (TMA).

Unit-V:

- a. Analytical method development and Validation
- b. Quality assurance in Cosmetic Industry

References

1. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.
2. Principles of Instrumental Analysis - Douglas A Skoog, F. James Holler, Timothy A. Nieman, 5th edition, Eastern press, Bangalore, 1998.
3. Vogel's Text book of quantitative chemical analysis - Jeffery, Basset, Mendham, Denney, 5th edition, ELDS, 1991.
4. Chromatographic Analysis of Pharmaceuticals, John A. Adamovics, 2nd Edition.
5. Practical Pharmaceutical Chemistry, Part two, A. H. Beckett & J. B. Stenlake – 4th Edition.
6. Instrumental Methods of Chemical Analysis – B. K. Sharma – 9th Edition.
7. Instrumental Methods of Analysis – Hobert H. Willard, 7th Edition.
8. Organic Spectroscopy – William Kemp, 3rd Edition

Semester I

Electives 1: FUNDAMENTALS OF BIOCHEMISTRY AND BIOMOLECULES

4 CREDITS

Unit I:

Carbohydrates: Structure and classification of carbohydrates

Chemistry of monosaccharides: Pentoses, hexoses, deoxyglucose, amino sugars, muramic acid, neuraminic acid. Linkages in sucrose, lactose and maltose, trehalose and glycosides.

Isolation of polysaccharides: Homopolysaccharides and heteropolysaccharides, starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell wall polysaccharides, blood group polysaccharides, pectin and pectic polysaccharides.

Structural elucidation of carbohydrates: graded acid hydrolysis, periodate oxidation, methylation, acetylation, GC-MS, IR and NMR.

Glycobiology: Glycoproteins; N- and O-glycosylation, lectins, carbohydrates in tissue engineering.

Proteoglycans; aggrecan, syndecan, and decorin.

Unit II:

Amino acids: Nomenclature, classification and buffering properties of amino acids, zwitterionic structure, reaction of amino acids, unusual amino acids, non protein amino acids.

Peptide bond: Features of the peptide bond, naturally occurring peptides; glutathione, enkephalins and endorphins. Chemical synthesis of peptides; Khorana's solution phase synthesis, Merrifield's solid phase synthesis.

Determination of amino acid compositions: Acid and base catalyzed hydrolysis, separation, quantification, determination of N and C terminal residues, determination of site of glycosylation and type of linkage (o-glycosyl and n-glycosyl).

Elucidation of structure of proteins - Isolation of proteins; overview of purification and criteria of purity.

Determination of primary structure: Sequencing strategies; N-terminal and C-terminal, sequencing methods. Automated sequencers. Determination of S-S bond position. Secondary structure of protein; α , β sheet, β -bend, β -turn and super secondary structures. Secondary structure prediction methods; Ramachandran plot, Chou and Fasman algorithm. Tertiary and quaternary structures

Factors responsible for protein folding and confirmation: Anfinsen's experiment. Weak forces of interaction; hydrogen bonding, Vander Waal's forces, London force, ionic interactions, hydrophobic interactions, S-S bridges, peptide bond, glycosidic bond, phosphodiester bond, and allolysine. Denaturation and renaturation of proteins, molten globule. 3D Structure of myoglobin, hemoglobin, immunoglobulin, collagen, chymotrypsin and keratin. Chaperons and Levinthal paradox.

Unit III:

Lipids: Classification of lipids; oils, fats, and waxes. Occurrence and physico chemical properties of fatty acids, esters of fatty acids, cholesterol, phospholipids, glycolipids, sphingolipids, cerebrosides and gangliosides.

Lipid mediators: Eicosanoids, prostaglandins, leukotrienes, prostacyclins, thromboxanes, DAG and ceramide

Unit IV:

Nucleic Acids: Nitrogenous bases, nucleosides, nucleotides, physicochemical properties. Isolation of DNA and RNA from biological sources (microbes, plants and animals). Purification of nucleic acids, physicochemical properties of nucleic acids, melting of DNA, T_m ; factors affecting T_m , Cot curve, classification of DNA based on cot curve. Chemical reactions of DNA and RNA; Nucleotides as regulatory molecules, enzyme cofactors and mediators of chemical energy in cells.

Sequencing of DNA: Maxam Gilbert method, dideoxy method. Chargaff's rule, secondary structure of DNA. Watson and Crick model; B and Z DNA, other models of DNA structure. Types of RNA, secondary structure of tRNA and cloverleaf model; Other secondary structural features in DNA, stem loop structure, palindromic sequences, cruciforms. DNA protein interaction; zinc finger, leucine zipper, helix-

turn-helix, other motifs, DNA bending and kinks

Unit V:

Porphyrins – Structure and properties of porphyrins – Heme, chlorophyll and cytochromes. Reactive oxygen species and detoxification mechanisms.

Vitamins – Water soluble and insoluble vitamins, structure and function, deficiency symptoms.

References::

- 1) Lehninger Principles of Biochemistry - 5th edition David I Nelson and Michael M. Cox
- 2) Biochemistry – 5th edition Jeremy M. Berg; John I. Tymoczko and Lubert Stryer
- 3) Biochemistry – 4th edition Donald Voet and Judith G. Voet
- 4) Outlines of Biochemistry – 5th edition Erice Conn and Paul Stumpf
- 5) Text book of Biochemistry – 4th edition Edward Staunton west; Wilbert R. Todd; Howard S. Mason and John T. Van Bruggen

Semester I

Practical-1: Anatomy and Physiology – 6 credits

- 1.. Microscopic study of different tissues.
2. Blood experiments:
 - a. Study of appliances used in hematological experiments
 - b. Determination of total Red Blood Corpuscles (RBC) count
 - c. Determination of White Blood Corpuscles (WBC) count
 - d. Estimation of hemoglobin
 - e. Estimation of Differential Leukocyte Count (DLC)
 - f. Estimation of Erythrocyte Sedimentation Rate (ESR)
 - g. Determination of Blood groups.
 - h. Determination of Bleeding and Clotting time
3. To record human heart rate, and pulse rate.
4. Recording of human body temperature and Body Mass Index(BMI).
5. Determination of tidal volume & vital capacity.

Semester II
Paper-5: Cosmetics – Biology -
4 Credits

Unit-I

1. Structure and function of skin with detailed emphasis on epidermis, dermis and hypodermis
2. Types of Skin and Hyperkeratotic Condition

Unit-II

3. The Development and physiology of Baby Skin, Differences between baby's skin and adult skin, Frequent Skin Problems in Newborns, The Care of Baby Skin
4. Age-Associated Changes in Human Skin: Morphological and Histological Changes,
5. The cosmetic care of elderly skin. Racial (Ethnic) Differences in Skin Properties

Unit-III

6. Mechanisms of allergic reaction and skin conditions
7. General Concepts of Skin Irritancy: Principles and Molecular mechanisms of Skin Irritation, Irritancy and Skin Irritant Evaluation and Symptoms, Factors Predisposing to Cutaneous Irritation, Cosmetic and Occupational Irritants.

Unit-IV

8. Safety Terminologies: Contact Dermatitis, Irritant Contact Dermatitis (Irritation), Allergic Contact Dermatitis, Photo-irritant Contact Dermatitis, Photoirritation or Phototoxicity, Photoallergic Contact Dermatitis, Contact Urticaria Syndrome, Acnegenicity, Sensitive Skin
9. Alternate safety testing methods (substitute animal testing)- cell line techniques

Unit-V

10. Anatomy of tooth & Gums
11. The Structure and Properties of Hair & hair growth cycle
12. Anatomy and physiology of nail
13. Physico-chemistry and Aesthetics of nail
14. Anatomy and physiology of eye

References

1. Harry's Cosmeticology – Wilkinson, Moore, seventh edition, George Godwin.
2. Poucher's Perfumes, Cosmetics and Soaps, Hilda Butler, 10th Edition, Kluwer Academic Publishers
3. Handbook of Cosmetic Science and Technology, 3rd Edition, André O. Barel, Marc Paye, Howard I. Maibach, Marianne Mahieu Informa Healthcare USA, Inc.
4. Cosmetic formulation of skin care products – Eric Jungerman (Cosmetics and science technical series 3)

Semester II

Paper-6: Cosmetic formulation science

4 Credits

Unit-I:

Dermal Delivery: Factors affecting penetration through skin. Permeation enhancers. Ionotophoresis.

Site specific skin care needs: Face, eyelids, lips, hands, feet, nails & cuticle, scalp, neck, body, and underarms

Skin hydration, skin lipids, natural moisturizing factors, dry skin and ways to moisturize skin.

Skin Cleansing products: soap and chemistry of soap making, evolution of syndet bars, face wash and body wash, their formulation differences and skin benefits.

Unit II

Skin creams: Classification of skin creams based on their cosmetic benefits and their physicochemical properties.

Requirements of Ideal skin cream

Building blocks and formulation of cold cream, vanishing cream, moisturizing cream, body lotion and moisturizing gels. Skin benefits of petroleum jelly.

Face mask – benefits and application of clay based, peel off and tissue face mask.

Building blocks and formulation of hand-made soap, face wash, clay based mask and peel off mask.

Unit III:

Requirements of an Ideal shampoo.

Shampoo Building blocks and formulations

Mechanism of hair conditioning.

Building blocks and formulation of Hair conditioners and hair oils

Baby shampoo

Classification of hair dyes. Chemistry and formulation of Para Phenylene diamine based hair dyes.

Unit IV

Requirements of an ideal toothpaste.

Oral care: Building blocks and formulation of toothpaste and mouth wash

Color Cosmetics: Building block and formulation of Lipsticks, mascara, and nail polish.

Unit V

Building blocks and formulation of Face and body powder, Shaving cream, After shave, depilatories and hair straightening products.

Deodorants and antiperspirants , Active ingredients and mechanism of action.

References

1. Harry's Cosmeticology – Wilkinson, Moore, seventh edition, George Godwin.
2. Drugs and Cosmetic act/rules by govt. of India Publication
3. European Union regulation for cosmetics.
4. Cosmetics – Formulation, Manufacturing and Quality Control, P.P. Sharma, 4th edition, Vandana Publications Pvt. Ltd., Delhi.
5. Poucher's Perfumes, Cosmetics and Soaps, Hilda Butler, 10th Edition, Kluwer Academic Publishers

6. Handbook of Cosmetic Science and Technology, 3rd Edition, André O. Barel, Marc Paye, Howard I. Maibach, Marianne Mahieu Informa Healthcare USA, Inc.
7. Cosmetic formulation of skin care products – Zoe Diana Draelos and Lauren A. Thaman

Semester II

Paper-7: Cosmeceuticals

4 credits

Unit I

a) Features of cosmetic product regulation in the European Union -- Ingredients, Safety assessment, Efficacy data.

Labelling requirements for cosmetic products.

Evolution of Cosmetics to Cosmeceuticals. Japanese and USFDA regulation for Quasi drugs and OTC cosmetics.

b) Environmental and safety concerns of certain cosmetic ingredients that are debated and discussed – Examples: nano size inorganic sunscreens, parabens, triclosan, formaldehyde liberator, polythene beads, petroleum oils, sodium & ammonium lauryl sulfates, triclosan, phthalates.

c) Private body (Cosmos) guidelines on green cosmetics with respects to use of colors, preservatives, emulsifiers and excipients, challenges in green formulation.

- In each category listed below a case study will be conducted on a marketed product addressing the condition. Case study will be based on labeled ingredients and claim.

Unit- II

Skin Pigmentation and wrinkles

Skin Pigmentation: Melanogenesis, and ethnic differences.

Ways to control skin pigmentation: Tyrosinase inhibitors, melanosome transfer – examples of actives.

Building blocks and formulation of an anti blemish cream.

Case study on a skin lightening product.

Differences between skin bleaches and skin lightening products.

Skin Wrinkles: Factors that leads to skin wrinkles. Role of antioxidants in reducing skin wrinkles.

Building blocks and formulation of an anti wrinkle product.

Case study on an anti-aging / anti-wrinkle product.

Unit-III

Sun protection: Solar spectrum and wavelength, UV A and UV B rays of sun. skin damages caused by over exposure to sun, organic and in-organic sunscreens, SPF and tan-protection.

Challenges in developing sunscreen formulation.

Global regulatory aspects of sunscreen products.

Case study on sunscreen products.

Unit-IV:

Acne, Prickly heat and dandruff

Causes and current treatment.

Building blocks for the development of anti-acne, prickly heat and anti-dandruff formulation.

Case study on marketed products.

Unit-V:

Common problems associated with teeth, gums and oral cavity.

Halitosis, plaque, cavities, sensitive teeth. Basic understanding of the cause.

Role of antimicrobial, antioxidant and astringents for oral care.

Denture cleansers.

Building blocks and formulation of an anti- cavity, and tooth sensitivity relief toothpaste.

Case study on marketed products.

References

1. Drugs and Cosmetic act/rules by govt. of India Publication
2. European Union regulation for cosmetics
3. Cosmetics – Formulation, Manufacturing and Quality Control, P.P. Sharma, 4th edition, Vandana Publications Pvt. Ltd., Delhi.
4. Harry's Cosmeticology – Wilkinson, Moore, seventh edition, George Godwin.

5. Poucher's Perfumes, Cosmetics and Soaps, Hilda Butler, 10th Edition, Kluwer Academic Publishers
6. Handbook of Cosmetic Science and Technology, 3rd Edition, André O. Barel, Marc Paye, Howard I. Maibach, Marianne Mahieu Informa Healthcare USA, Inc.
7. Cosmetic formulation of skin care products – Zoe Diana Draelos and Lauren A. Thaman

Semester II

Paper- 8: Herbal Science

4 Credits

Unit-I:

Introduction: Definition, present status, future scope & development of Herbal Science

Classification of herbs: Alphabetical, biological, chemical, taxonomical, pharmacological, chemotaxonomical & serotaxonomical classifications -

Basic principles involved in the alternative system of medicine and their application in skin, hair and oral care:

Ayurveda, Siddha, Unani and Homeopathy .

Unit-II:

a) Study of the following herbs with specific emphasis on source, collection & preparation, constituents, chemical tests, substitutes and adulterants.

Bael, Gum acacia, black catechu, myrobalan, castor oil, chaulmoogra oil, cinnamon, centella and lemon grass.

b) Source , collection and adulterants of Honey and bees wax.

Unit-III:

Adulteration of crude herbal extracts & their detection by different methods of evaluation

WHO Guidelines for the assessment of Herbal Drugs

Definition, need and methods of herbal preparation standardization

Stability testing of herbal extracts

Unit IV

Principles of methods of extraction of phyto-constituents from herbs:

Maceration, decoction, Hydraulic press, Soxhlet distillation, solvent extraction, enfleurage, eucelle, and supercritical fluid extraction, microwave extraction.

Unit-V:

Role of Herbs in Cosmetics

Hair care preparation: Henna, Amla, Hibiscus, Bhringaraj

Skin Care preparation: Aloe vera, Turmeric, Sandal wood

Oral care preparation: Babool, Neem, Clove.

References:

1. Trease, G.E. and Evans, W.C. "Trease and Evans' Pharmacognosy" WB Saunders Co. Ltd., London, Philadelphia, Toronto, Sydney, Tokyo (1994, 2005).
2. James Bobbers, Marilyn K, Speedice & Verro E. Tylor. Pharmacognosy and pharmacobiotechnology" Williams & Wilkins., 1996
3. Louis Appell. The Formulation and Preparation of Cosmetics, Fragrances and Flavors
4. WHO Guidelines – website <http://www/who.int/druginformation>
5. Remington's Pharmaceutical Sciences. Mack Pub. Co.; 17th edition
6. Pulok K. Mukherjee. Quality Control Herbal Drugs Business Horizons; Reprint 2012 edition
7. V. Rajpal Standardization of Botanicals Volume-1-2 Second Edition | 2011
8. A.P. Purohit, C. K. Kokate, S. B. Gokhale. Text Book of Pharmacognosy Nirali Prakashan.

Semester II

Electives 2: GENETICS 4 CREDITS

Unit I:

Introduction to Genetics, Introduction, Scope and significance of genetics

Principle of Genetic Transmission: Mendel's Experiments, Symbols and terminology, Principle of dominance and segregation, Principle of independent assortment, Mendelian inheritance and probability (Multiplication and Addition rules).

Unit II:

Extension of Mendelism: Allelic variation and gene function, Incomplete dominance, co (dominance, multiple allele, Gene action (from genotype to phenotype), Gene interaction, penetrance, expressivity, epistasis, pleiotropy, interaction with environment.

The chromosomal basis of Mendelism: Chromosomes – chromosome number, Chromosome theory of inheritance, Experimental evidence, non disjunction as proof of chromosome theory, chromosomal basis of Mendel's principles of segregation and independent assortment, Sex linked genes in humans.

Genetic disorder - Color blindness, Cystic fibrosis, Down syndrome, Duchenne muscular dystrophy,

Hemophilia, Klinefelter syndrome, Sickle-cell disease, Turner syndrome

Unit III:

Mutations: Spontaneous, Induced mutation, Conditional lethal mutations –Base substitution mutation, Missense, Nonsense and Silent mutations; Chemical, Physical and Biological mutagenesis and Detection of mutations.

Concept of gene: Fine structure of gene, Split gene, Jumping gene, Overlapping gene & multiple genes.

Unit IV:

Sex Determination: Sex chromosomes, Chromosomal basis of sex determination in C.elegans, Drosophila, Man and Plant Example: Lichnis (Melandrium).Molecular basis of sex determination in C.elegans, Drosophila and Man.

Dosage compensation: Genic balance, Gene dose, Molecular basis of dosage compensation in Drosophila and man.

Unit V:

Molecular anatomy of eukaryotic chromosome –Centromere, Telomere, Nucleosome, Nucleomere, Kinetochore, Chromosome banding.

References:

1. Genetics – Principle and Analysis – Hart and Jones.
2. Principles of Genetics – Snustad and Simmons.
3. Genetics – A Continuity of Life– Daniel J. Fairbanks, W. Ralph Anderson.
4. Atherly A G, Girtton, J R and Mc Donald J F, 1999. The Science of Genetics, Saunders College Publishing, Harcourt Brace College Publishers.
5. Brooker R.J. 1999. Genetics. Analysis and Principles. Ed. Benjamin Cummings. California, Gardner E J, Simmons M J, Snustad D P 1991. Principles of Genetics. John Wiley & Sons, Inc.
6. Griffith A J F, Miller J H, Suzuki D T, Lewontin R C, Gelbert W M.1996. An introduction to Genetic Analysis. W.H. Freeman and Co. New York
7. Strickberger, M. W. 1976. Genetics. Macmillan New York
8. Watson, J. D., Baker T. A., Bell S. P., Gann A., Levine M., Losick R. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Delhi, India.
9. Klug, W S, and Cummings M. R. 1998. Essentials of Genetics, 3rd Ed. Prentice Hall, Upper Saddle River, NJ.
10. Hartl, D L & Jones E W 2006. Essential genetics: a genomics perspective (4th Ed), Jones and Bartlett Publishers, Boston.
11. Tamarin R. H. 2002. Principles of Genetics. Tata-McGraw Hill, Seventh Edition.
12. Lewin B., Gene IV, V, VI. Oxford University press, Oxford.

Semester II
Practical- 2-Formulation science
6 credits

1. Design and development of
 - Face wash
 - Moisturizing cream,
 - cold cream
 - vanishing cream.
 - Moisturizing gel
 - Body lotion
 - Shampoo
 - Hair conditioner
 - Toothpaste
 - Lip Balm
- 2 Assignments on green formulation design for all the above products.
- 3 Design and development of a cosmeceutical product
- 4 Design and development of a herbal cosmetic.
- 5 Design and development of hand made soaps.

Semester III
Paper-9: Cosmetics-Analysis & Evaluation–
4 Credits

Unit-I:

Determination of acid value, ester value, Saponification value, rancidity, moisture, ash, Volatile matter, heavy metals, fineness of powders, density, viscosity of cosmetics raw materials and finished products

Unit-II:

General methods of analysis of following raw material used in cosmetic manufacture as per BIS: Castor oil, Mineral oil, SLS, SLES, Calcium carbonate, Sorbitol, Methyl parahydroxy benzoate, cetyl alcohol, isopropyl myristate, Talc, Boric acid, glycerine, Titanium Dioxide, Para Phenylene diamine

Unit-III

Indian standard specifications laid down for sampling and testing of various cosmetics in finished forms such as baby care powders, skin care products, dental products, personal hygiene preparations, lips sticks, hair products and skin creams by the Bureau Indian Standards.

Unit-IV

Principles of equipment to measure product performance of skin and hair care products - Sebumeter, corneometer, trans epidermal water loss, Skin color, hair tensile properties, hair combing properties.

Unit-V:

Principles of performance evaluation of shampoos, antiperspirants, deodorants, sunscreens, foam baths and abrasiveness of dentifrices.

References

1. Cosmetics – Formulation, Manufacturing and Quality Control, P.P. Sharma, 4th edition, Vandana Publications Pvt. Ltd., Delhi
- Indian Standard specification, for raw materials, BIS, New Delhi.
2. Indian Standard specification for 28 finished cosmetics BIS, New Delhi
- Harry's Cosmeticology
3. Wilkinson, Moore, seventh edition, George Godwin.
4. Poucher's Perfumes, Cosmetics and Soaps, Hilda Butler, 10th Edition, Kluwer Academic Publishers
5. Handbook of Cosmetic Science and Technology, 3rd Edition, André O. Barel, Marc Paye, Howard I. Maibach, Marianne Mahieu Informa Healthcare USA, Inc.

Semester III
Paper-10: Statistical Methods for Biology
4 Credits

Unit 1: Descriptive Statistics

Importance And Scope Of Statistics, Data Types, frequency distribution, Graphical Representation Methods (Histogram, Bar Charts, Pie Charts), Measures Of Center Tendency (Mean, Median, Mode,) And

4. Biostatistics, Snedger And Gohrran.

5. Introductory Statistics For Biology 2nd Edition, R. E. Parker

Spread (Standard Deviation, Variance) Advantages And Disadvantages, Co-Efficient Of Variance.

Unit 2: Probability:

Basic Terminology, Definition Of Probability, Basic Laws Of Probability, Types Of Probability, Additional Rule Of Probability And Multiplication Rule Of Probability, Probability Distribution- Bernoulli Distribution, Binomial Distribution And Normal Distribution

Unit 3: Sampling Methods

Collection Of Data, Census Method, Concept Of Population, Sample, Sampling, Sample Size, And Sampling Error, Advantages And Disadvantages Of Sampling Method, Necessity Of Sampling, Types Of Sampling Methods, Types Of Random Sampling Methods – SRS, Stratified Random Sampling, Systematic Random Sampling And Cluster Sampling.

Unit 4: Testing of Hypotheses

Statistical Hypotheses-Null and Alternative, Level Of Significance, Type I And Type II Error, Critical Region, Power Of The Test, P Value, Degrees Of Freedom, Chi-Square Test For Independence Of Attributes And Goodness Of Fit, Student's t Test: One Sample t Test and Paired t Test, F Test.

Unit 5: Regression and Analysis Of Variance

Simple Linear Regression, Multiple Linear Regression (Definition, Assumptions, Applications, And Examples) ,Analysis Of Variance –Introduction ,Definition Of ANOVA, Assumption , Test Of ANOVA, Types Of ANOVA, Construction Of One Way Analysis Of Variance.

References:

- 1.. Fundamentals Of Biostatistics : Veer Bala Rastogi
- 2.Fundamentals Of Mathematical Statistics: S.C. Gupta And V. K. Kapoor
3. Fundamentals Of Statistics: S.C. Gupta

Semester III
Paper-11: Applied Microbiology
4 Credits,

Unit I:

History of Microbiology. Principles of classification of microbes; morphological, metabolic and molecular criteria for the classification, A brief introduction to major group of bacteria. Ultra structure of bacteria.

Unit II:

Microbial Cultivation: Nutritional types requirements of bacteria. Cultivation of bacteria: Pure culture techniques different media. Culture media and preparation: Preservation of cultures, aerobic and anaerobic culture techniques. Batch and synchronous cultures. Growth curve and factors influencing growth

Unit III:

Control of Microbial growth: Principles and techniques, Physical and Chemical methods. Disinfection, Method of action of disinfectants. Methods of testing disinfectants.

Unit IV:

Microbial physiology: Staining characteristics, Gram staining, AFB staining, florescent staining, serological characteristics: -surface antigen, capsular antigen & flagellar antigen, Cultural characteristics, Photosynthetic microorganisms, cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Bacterial aerobic respiration, Bacterial anaerobic respiration: introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria. Mechanism of oxygen toxicity. Bacterial transport system-ABC, Sec pathway, PTS, role of permeases in transport, different permeases in E. coli, Microbial drug resistance.

Unit V:

Microbial Diversity: Human microbial flora in application, General properties of fungi, fungal classification, economic importance of fungi, Mycoplasma, Actinomycetes, Archeobacteria (extremophiles) and microbial algae. General properties of virus, lifecycle

References:

1. Microbial Physiology and Metabolism by Caldwell D.R. 1995 Brown Publishers.
2. Microbial Physiology by Moat A.G. and Foster J. W. 1999.. Wiley.

3. Prokaryotic Development by Brun. Y.V. and Shimkets L.J. 2000. ASM Press.
4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York.
5. Applied Microbial Physiology by Rhodes.
6. Principles of bacteriology, virology and immunology Vol I Topley and Wilson Zinser, Microbiology
7. Microbiology , Prescottt, Harley and klien
8. Foundations in Microbiology Talaro and Talaro
9. Text book of Microbiology, R Ananthanarayanan C K J Panicker
10. Microbiology, Pelczar, Chan and Kreig

Semester III

Paper-12: industrial cosmetics:

4 credits

Unit-I:

a) Indian regulation for cosmetics:

Regulatory provisions relating to import of cosmetics

Misbranded and spurious cosmetics

Regulatory provisions relating to manufacture of cosmetics – Conditions for obtaining licence, prohibition of manufacture and sale of certain cosmetics, loan licence, offences and penalties.

Unit II

Equipments used and manufacturing process of shampoo, creams and toothpaste.

Indian regulatory requirement for factory premises : Location and surroundings, designing of plant layout, building, lighting, ventilation, water supply, disposal of waste, first aid, packaging facilities, sanitation in manufacturing premises and health clothing & sanitary requirement of staff.

Unit-III:

Significance of pilot plant scale up studies.

Stability studies:

Change in Parameters to be observed.

Photo-stability

Accelerated stability testing – Temperature & Humidity, Freeze-thaw test, Stress test.

Aerosol product stability studies.

Technology transfer of formulations from R&D to factory – Quality assurance documentations required as per regulatory guidelines.

Unit-1V:

Packaging: Functions:

Packaging materials:

Plastics: Type of plastics and application.

Metal, Glass, laminates, paper and paper boards.

Considerations for selecting containers, product packaging material compatibility.

Unit V

Industrial Management: Principles of management, financial management, material management, Plant maintenance management, inventory management, production planning and control.

Introduction to ISO 9000, 14000 and 22000

Importance of patent and intellectual property rights.

References

1. Drugs and Cosmetic act/rules by govt. of India Publication
2. European Union regulation for cosmetics
3. Cosmetics – Formulation, Manufacturing and Quality Control, P.P. Sharma, 4th edition, Vandana Publications Pvt. Ltd., Delhi.
4. Harry's Cosmeticology – Wilkinson, Moore, seventh edition, George Godwin.
5. Peter, F.Drucker, Management-tasks, responsibilities, practices, Allied publishers pvt ltd, Mumbai 2003.

Semester III
Electives 3. Environmental aspects of nanomaterials

4credits

Unit I:

Environmental pollution: Environmental fate and transport of Nanomaterials, physical-chemical interactions, aggregation and deposition, definition of air pollution, water pollution and ground pollution, contribution of nanoparticles in aggravating pollution,

Unit II:

Toxic Impacts of Nanomaterials: Exposure and risk assessment, dose-response, mechanisms of toxicity, definition of eco-toxicity, routes of entry of nanomaterials into the environment, cytotoxicity of nanomaterials

Unit III:

Health effects of nanoparticles: Sources of nanoparticles, epidemiological evidence, entry routes into the human body – Lung, Intestinal Tract, Skin, effect of nanoparticle size and charge, effects of nanoparticles on - cardiovascular, liver and gastrointestinal and nervous system, coagulation and thrombosis, blood-brain barrier

Unit IV:

Environmental application of nanomaterials: Environmental Remediation, nanoparticles reactivity, fate, and lifetimes in the subsurface, ground water remediation with nanoparticles, nanomaterials for water and wastewater treatment

Unit V:

Microbial interaction with nanoparticles: Applications and emerging opportunities in the area of nanoparticle interaction with microbes, detection of microbial pathogens with nanotechnology, nanozymes for biofilm removal

References:

1. Environmental Biotechnology, Alan Scragg, Pearson Education Limited, England, **2007**, ISSN: 0199228612, 9780199228614.
2. Environmental Biotechnology, S.N. Jogdand, Himalaya Publishing House, Bombay, **2006**.
3. Wastewater Engineering – Treatment, Disposal and Reuse, Metcalf and Eddy, Inc., Tata Mc Graw Hill, New Delhi, **2013**, ISSN: 0073401188, 9780073401188.
4. Environmental chemistry, A.K. De, Wiley Eastern Ltd, New Delhi, **2009**,ISSN: 8122426174, 9788122426175.
5. Introduction to Biodeterioration, D. Allsopp, C. Gaylarde and K.J. Seal, ELBS/Edward Arnold, **2004**, ISSN: 0-521-821355, 0521528879.
6. Biotechnology for Wastewater Treatment, P Nicholas Cheremisinoff, Elsevier Science, **2013**,ISSN: 0080946453, 9780080946450

7. Biotechnological Methods of Pollution Control, SA Abbasi and E Ramaswami, Universities Press, India, **1999**, ISSN: 8173710988.
8. Environmental Biotechnology, Concepts and Applications, Hans-Joachim Jordening and Josef Winter, Winter-VCH, **2005**, ISSN: 3-527-30585-8.
9. Environmental Biotechnology: Principles and Applications, Bruce Rittmann and Perry McCarty, Mc Graw Hill, **2001**, ISSN: 0072345535, 9780072345537.

Semester III

Practical- 3-Cosmetics -analysis

6 credits

1. Determination of Iodine value.
2. Determination of hydroxyl value and acetyl value.
3. Determination of acid value and saponification value.
4. Qualitative and quantitative analysis of rancidity in hair oils and Lipsticks
5. Determination of Fluorides in tooth paste by Potentiometry
6. Determination of aryl amine content and Developer in hair dye
7. Determination of foam height and SLS content of Shampoo.
8. Determination of total fatty matter in creams (Soap, Skin and hair Creams)
9. Detection and Determination of Perfumes by Gas chromatography
10. Analysis of antioxidants in cosmetics by HPLC
11. Analysis of formaldehyde in cosmetics by colorimetry
12. Moisture and ash analysis of finished cosmetics

Semester- IV

Summer Project

2 Credits

(Marketing case studies- dissertation and Viva Voce Examination)

Project work, dissertation and viva Voce exam 12 credits

M. Sc. ENVIRONMENTAL SCIENCES

Course overview

M. Sc. ENVIRONMENTAL SCIENCES

	Semester I	Credits
Paper 1	Principles of Environmental Sciences	4
Paper 2	Environmental Microbiology and Biotechnology	4
Paper 3	Environmental Chemistry	4
Paper 4	Environmental Earth Science	4
Elective 1	Statistical Methods for Biology	4
Practical I	Environmental Biology, Chemistry & Earth Science	6
		26
	Semester II	
Paper 5	Environmental Toxicology	4
Paper 6	Remote Sensing & GIS	4
Paper 7	Water Resource and Ground Water Hydrology	4
Paper 8	Environmental Economics and Management	4
Elective 2	Bio-Energy Technologies OR Environmental Impact assessment	4
Practical II	Environmental Toxicology, Microbiology & Biotechnology	6
		26
	Semester III	
Paper 9	Water and Waste Water Treatment Techniques	4
Paper 10	Waterborne Disease and Chemical Agents	4
Paper 11	Environmental Safety and Health Management	4
Paper 12	Environmental Pollution and Law	4
Elective 3	Environmental Nanoscience OR Water Resource Management and Sustainable Development	4
Practical III	Water Treatment Techniques, Waterborne Disease and Chemical Agents	6
		26
	Semester IV	
	Summer Project	2
	Field/Industrial Visit report and Viva	2
	Thesis and viva voce examination	10
		14
	Total Credits	92

SEMESTER I

PAPER 1: PRINCIPLES OF ENVIRONMENTAL SCIENCES

4 CREDITS

Unit I:

Definition, scope and interdisciplinary nature of environmental science, environmental factors: structure, composition of Atmosphere, Lithosphere, Biosphere and Hydrosphere.

Unit II:

Biogeochemical Cycles of major environmental elements and significance: Carbon, Nitrogen, Phosphate, Sulphate, Hydrogen, Oxygen, Mode of energy transmission.

Unit III:

Ecology: Definition, subdivision, ecosystem- Terrestrial, Aquatic, Grass, flow of energy, food chain, food web, trophic level, ecological pyramid, eco-tone, edge effect

Unit IV:

Biomes and Habitat: Classification of biomes – Tundra, Taiga, Grassland, Desert, Evergreen and deciduous forests, Tropical rain forests and their characteristics, flora and fauna; Classification of Aquatic Habitats – Fresh water pond, Wetlands, Beels, Rivers – their characteristics, flora and fauna; Marine Habitats – Pelagic, Benthic, Inter-tidal Estuarine; Mangroves – their characteristics, flora and fauna

Unit V:

Conservative biology: Biodiversity conservation, Wildlife management, Ex-situ and in-situ Conservation, Protected area networks in India, important projects, Role of local community in conservation, national conservation policies: National Forest policy, biodiversity Act, Wildlife protection Act. Concept of Endangered, endemic and extinct species, Red data Book.

References:

1. Environmental Science– The natural environment and human impact (2nd Edition) (2000): A. R. W. Jackson and J. M. Jackson, Longman
2. Environmental Science (2001): S. C. Santra, New Central Book Agency (P) Ltd
3. Introduction to Environmental Science and Engineering (2nd Ed.) (2004): G. M. Masters, Pearson Education Pvt. Ltd.
4. Environmental Science (6th ed) (1997): Jr. G. T. Miller, Wadsworth Pub. Co.

5. Fundamentals of Environmental Science (2004): G. S. Dhaliwal, G. S. Sangha and P. K. Raina, Kalyani Publication.
 6. General Climatology (4th Edition) (1994): Critchfield H. J.
 7. Microbial Ecology (4th Edition) (2000): Atlast. R.M and Bartha, R., Addison Wesley Longman Inc.
 8. Ecology Principles & Applications (2nd Edition) (2008) : J. L. Chapman & M. J. Resis, Cambridge University Press.
 9. Dimensions of Environmental and Ecological Economics (2005): N. C. Sahu & A. K. Choudhury (Ed), Universities Press
 10. Fundamentals of Ecology (2006): Odum Eugene, Cengage Learning.
 11. Cell Biology (2010) : Verma, P. S., Agarwal, V. K. S Chand and Company Ltd, New Delhi, India.
 12. Evolution and Ecology (2010): Verma. P. S., Agarwal V. K., S Chand and Company Ltd, New Delhi, India
 13. A text book of Environmental Science (2012) : Vidya Thakur, Scientific publisher, India.
 14. Aquatic Ecosystems (2003) : Kumar, A P H Publishing Corporation, India
 15. Microbiology Fundamentals and Application (6th Edition) (2010) : Purohit, Agrobios.
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PAPER 2: ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

4 CREDITS

Unit I:

General Microbiology- History and scope of microbiology, Classification, Ultrastructure of Prokaryotic and Eukaryotic cell, Sterilization techniques used in microbiology, Preparation of media for isolation and culture of microorganisms - Microbial growth and multiplication of bacteria, virus and fungi - MPN, total cell count - Nature of virulence, toxins, Microbes and Nutrient cycles, Microbial communication system, Quorum sensing, Microbial fuel cells, Prebiotics and Probiotics.

Unit II:

Microbial Interactions- Interactions among microbial populations, commensalism, mutualism and parasitism, examples of interaction with microorganisms, plants, animal and human being. Microbial interaction in soil: Symbiotic N₂ fixation, Denitrification, Mycorrhiza, Cyanobacteria and ecological significance.

Unit III:

Significance of Microorganism- Microbes in the degradation of wastes, Bioremediation-Its role in Environmental management, advantages and disadvantages, Control of pests and diseases by microorganisms, Treatment of solid and liquid industrial wastes, Microbial degradation of pesticides. Microbes in metal extraction, mineral leaching and mining, copper extraction by leaching and microbes in petroleum product formation.

Unit IV:

Sewage and waste water treatment and solid waste management, chemical measure of water pollution, conventional biological treatment, role of microphyte and macrophytes in water treatment; Recent approaches to biological waste water treatment, composting process and techniques, use of composted materials.

Unit V:

Role of environmental biotechnology in management of environmental problems, Bioremediation, advantages and disadvantages; In situ and ex-situ bioremediation; slurry bioremediation; Bioremediation of contaminated ground water and phytoremediation of soil metals; microbiology of degradation of xenobiotics.

References:

1. Microbiology Fundamentals & Application (6th edition) (2010): S. S. Purohit, Student Edition.
2. Fermentation Microbiology and Biotechnology (3rd Edition) (2012) : E . M. T. El. Mansi, C.F. A. Bryce, B. Dahhou, S. Sanchez, A. L. Demain, A. R. Allman, C R C press.
3. Environmental Microbiology (2014): P D Sharma.
4. Biology of Microorganisms(7th Ed.) (1994): Brock TD, Madigan MT, Martinko JM and Parker J Prentice Hall, New Jersey, USA.
5. Manual of Industrial Microbiology & Biotechnology (3rd Edition) (2010): Richard H. Baltz et al.,ASM press.
6. Microalgae: Biotechnology and Microbiology (1995), Cambridge University Press.
7. Text Book of Microbiology (7th Edition) (2005): Ananthanarayan and Paniker.
8. Raina M. Maier, Ian L. Pepper, Charles P. Gerba - Science. Environmental Microbiology
9. Ehrlich HL (1996) Geomicrobiology, Marcel Dekker Inc., New York.
10. Eweis JB, Ergas SJ, Change DPY and Schroeder ED (1998) Bioremediation – Principles, McGraw-Hill Inc., New York.
11. Joseph C Daniel (1999) Environment Aspects of Microbiology. 1st Edition, Bright Sun Publications, Chennai.

12. Pelczar MJ Jr., Chan ECS and Kreig NR (1993) Microbiology, Tata McGraw Hill, Delhi.
 13. Reed G, Prescott and Dunn's (1987) Industrial Microbiology, 4th Edition, CBS Publishers.
 14. Subba Rao N S (2004) Soil Microbiology. 4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
 15. A text book of Biotechnology (Revised edition)(1993): R.C Dubey, Chand Publication.
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PAPER 3: ENVIRONMENTAL CHEMISTRY

4 CREDITS

Unit I:

Concept and scope of Environmental Chemistry, Basic Chemistry: organic compounds (Alkanes, Alkenes, Alkynes, Aldehydes, alcohols, Ketones), carboxylic acids, esters, Amines, aromatic carbons, Stoichiometry, Chemical Thermodynamics: Gibb's energy; chemical potential; Gibb's phase equilibria; equilibrium of chemical reactions; Chemical Kinetics: Simple reaction mechanisms; order of chemical reactions; law of mass action.

Unit II:

Atmospheric chemistry, Chemical composition of Air: Classification of elements, chemical speciation, Particles, ions and radicals in the atmosphere, Chemical processes for formation of inorganic and organic particulate matter, Thermochemical and photochemical reactions in the atmosphere, CFC's, Oxygen and Ozone chemistry, chemistry of air pollutants, photochemical smog.

Unit III:

Water chemistry: properties of water, unusual physical properties, hydrogen bonding in biological systems, unusual solvent properties, changes in water properties by addition of solute, role of water in the environment, Acid base reactions, solubility of gases in water, The carbonate system, radionuclides, concept of DO, BOD, COD, TOC in water, redox potential, Marine water systems.

Unit IV:

Soil Chemistry: Formation, constituents and properties of soils, Sorption processes in the soil, ion change, and adsorption of contaminants in soil: Adsorption isotherms,

Buffering capacity, Cation exchange, pH measurement, acidity and alkalinity, Redox properties of soil, Transport processes in the soil and importance.

Unit V:

Instrumentation: Principle, merits and demerits of the techniques: Neutron activation analysis, Isotope dilution analysis, Calorimetric, Colorimetry, Atomic Absorption Spectroscopy, Gas Chromatography, HPLC, Ion Exchange Chromatography, and Polarography, XRF, XRD etc.,

References:

1. Environmental Chemistry (5th Edition) (2003): A. K. De, New Age International.
 2. Environmental Chemistry (11th Edition) (2007): B K Sharma, Krishna Prakshan media.
 3. Environmental Chemistry (3rd Edition) (2011): Gay W vanlon & Stephen J duffyOUP Oxford Publication.
 4. Environmental Chemistry (5rd Edition) (2012): Colin &Michael Cann, W.H Freeman Publication.
 5. Principles of Environmental Chemistry (2005): James Girard, John and Bratlett Learning.
 6. Chemistry of the Environment (2002): Ronald Albert bailey, Academic Press
 7. Industrial Chemistry (1991): B K Sharma, Krishna Prakshan media
 8. A text book of Environmental Chemistry & Pollution Control (2006): S. S. Dara,S. Chand Limited.
 9. Introduction to Instrumentation in Life Sciences (2013) : Prakash Bisen & Anjana Sharma, CRC press.
 10. A text book of Organic Chemistry (2008): P.S. Kalsi, Macmillan India limited.
 11. A text book of Physical Chemistry (2nd Edition) (2007): A.S. Negi, New Age International.
 12. Instrumentation (1st Edition) (2009): U. A. Bakshi & A.V. Bakshi, Technical Publications, Pune.
 13. Environmental Soil Chemistry (2013): Donald L Sparks,Academic Press.
 14. Environmental Chemistry - A global perspective (3rd Edition) (2000): G. W. Vantoon & S. J. Duffy; Oxford university Press.
 15. Soil and Water Chemistry An Integrative Approach (2nd Edition) (2004): Michael. E. Essington, CRC press.
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PAPER 4: ENVIRONMENTAL EARTH SCIENCE

4 CREDITS

Unit I:

Earth Materials- Gross composition and physical properties of important minerals and rocks; properties and processes responsible for mineral concentrations; nature and distribution of rocks and minerals in different units of the earth and different parts of India.

Unit II:

Surface features and Processes- Physiography of the Earth; weathering, erosion, transportation and deposition of Earth's material; formation of soil, sediments and sedimentary rocks; energy balance of the Earth's surface processes; important physiographic features and river basins in India.

Unit III:

Interior of the Earth, Deformation and Tectonics- Basic concepts of seismology and internal structure of the Earth, Physico-chemical and seismic properties of Earth's interior, Concepts of stress and strain, Behaviour of rocks under stress; Folds, joints and faults, Earthquakes: causes and measurement, Interplate and intraplate seismicity, Paleomagnetism, sea floor spreading and plate tectonics.

Unit IV:

Natural hazardous- Climatic variability and climate change, introductory ideas about air pollutions and global warming. Earth's processes: concepts of residence time and rate of natural cycles (elements in sea water). Geological Hazards: Catastrophic geological hazards, Study of floods, landslides, earthquakes, volcanism and avalanche, Perception of the hazards and adjustments to hazardous activities.

Unit V:

Oceans and Atmosphere- Elementary ideas about weather systems, Climates of India, Indian Monsoon, Hypsography of the continents and ocean floor: continental shelf, slope, rise and abyssal plains, Physical and chemical properties of sea water and their spatial variations, Ocean currents, waves and tides, important current systems, thermohaline circulation and the oceanic conveyor belt, Major water masses of the world's oceans.

References:

1. Earth Science & The Environment (4th Edition) (2007): Thomson & Truck, Thomson Learning Inc.
2. Boundary layer climates (1978): T. R. Oke; Methuen & Co. Ltd

3. Introduction to Micrometeorology (1988): S. Pal Arya; Academic Press
 4. General Meteorology (1974): H. R. Byers; McGraw-Hill
 5. An Introduction to Climate (1968): G. T. Trewartha; McGraw-Hill
 6. Environmental Geology (1987): K. S. Valdiya; Tata McGraw-Hill
 7. Atmospheric Science – An introductory survey (1977): J. M. Wallace and P. V. Hobbs; Academic Press
 8. Lets Review earth Science The physical setting (3rd Edition) (2007): Edward J Denecke Jr., Barron's Educational Series, Inc.
 9. Earth Science (Revised Edition) (2005): Maria Chona Sulti- Branganza, Phillipine copyright, Rex Book Store, Inc.
 10. The Basics of Earth Sciences (2003): Robert E. Krebs, Greenwood Press.
 11. Ocean Acidification (Reprinted) (2012): Jean –Pierre Gattuso and Lina Hansoon, Oxford University press.
 12. A text book of Geology (Reprint)(2004): P. C. Sanjeeva Rao & D. Bhaskar Rao, Discovery Publishing House.
 13. Rocks & Minerals (1969) : Nelson W Hyler, Grosset & Dunlap.
 14. Whole Earth Geophysics (1999): Robert J Lillie, Prentice Hall.
 15. Earth's Dynamic Systems (8th ed) (1999): Hamblin: Prentice Hall
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ELECTIVE 1: STATISTICAL METHODS FOR BIOLOGY

4 CREDITS

Unit I:

Numerical Methods to Represent Variation- Importance and Scope of Statistics, Data Types, frequency distribution, Graphical Representation Methods (Histogram, Bar Charts, Pie Charts), Measures of Center Tendency (Mean, Median, Mode,) and Dispersion (Standard Deviation, Variance) Advantages and Disadvantages, Co-Efficient of Variance.

Unit II:

Probability- Basic Terminology, Definition of Probability, Basic Laws of Probability, Types of Probability, Additional Rule of Probability and Multiplication Rule of Probability, Probability Distribution-Bernoulli Distribution, Binomial Distribution, Poisson distribution and Normal Distribution-Simple Problems.

Unit III:

Sampling Methods- Collection of Data, Census Method, Concept of Population, Sample, Sampling, Sample Size, Sampling Error, Advantages and Disadvantages of Sampling Method, Necessity of Sampling, Types of Sampling Methods, Types of

Random Sampling Methods – SRS, Stratified Random Sampling, Systematic Random Sampling And Cluster Sampling.

Unit IV:

Testing of Hypotheses- Statistical Hypotheses-Null and Alternative, Level of Significance, Type I and Type II Error, Critical Region, Power of the Test, P Value, Degrees Of Freedom, Chi-Square Test for Independence of Attributes and Goodness of Fit, Student's t Test: One Sample t Test and Paired t Test, F Test.

Unit V:

Regression and Analysis Of Variance- Simple Linear Regression, Multiple Linear Regression (Definition, Assumptions, Applications, and Examples) ,Analysis of Variance –Introduction ,Definition of ANOVA, Assumption , Test Of ANOVA, Types Of ANOVA, Construction of One Way Analysis of Variance.

References:

1. Fundamentals of Biostatistics: Veer Bala Rastogi
2. Fundamentals of Mathematical Statistics: S.C. Gupta and V. K. Kapoor
3. Fundamentals of Statistics: S.C. Gupta
4. Biostatistics, Snedger and Gohrran.
5. Introductory Statistics for Biology 2nd Edition, R. E. Parker

**PRACTICAL I: ENVIRONMENTAL BIOTECHNOLOGY & MICROBIOLOGY,
CHEMISTRY, EARTH SCIENCE.**

6 CREDITS

Environmental Microbiology

Apparatus used for a microbiological laboratory; Sterilization and Disinfections; Media preparation: semi-synthetic, synthetic media and semisolid; culture media – Nutrient agar; Enrichment media preparation; Gram staining. Safety in microbiological laboratory.

Bacteriology of drinking water and domestic sewage -MPN techniques for total coliform; Faecal coliform (thermotolerant coliform) MPN test; Faecal Streptococci (FS) MPN test; Membrane filtration techniques for faecal coliform and total coliform; P-A coliform test; Seven hour – coliform test.

Environmental Biotechnology

Plasmid DNA isolation and DNA quantitation: Plasmid minipreparations Agarose gel Electrophoresis - Microorganisms from polluted environment/Soil /Water/Air - Microbial degradation of textile dyes/pesticides/hydrocarbons and oils.

Techniques for collection, Cultivation and analysis of protein present in Azolla and Spirulina - Vermicomposting: Collection, preparation and analysis of composted material for NPK, moisture holding and microbial load

Environmental Chemistry: The experiments are related to -

1. Analysis of water and effluent - Physical parameters, Chemical parameters, Nutrient parameters and Bacterial parameters.
2. Volumetric analysis of water and soil samples by EDTA titration.
3. Turbidimetric experiment - Estimation of sulphates
4. Potentiometric experiments - Estimation of halides in water samples
5. Colorimetric experiments - Estimation of Fe^{2+} , Fe^{3+} and Ni^{2+}
6. Estimation of alkali metals in various samples by flame-photometry
7. Analysis of soils for NPK, Na, Ca.

Environmental Earth Science: The experiments are be related to -

1. Familiarization with meteorological instruments and their use
2. Studies related to upper air and surface weather including coding and decoding of meteorological parameters
3. Presentation and interpretation of wind data (wind rose)
4. Studies of thin sections of selective igneous, metamorphic and igneous rocks
5. Study of geological maps and drawing of sections across geological structures
6. Determination of Soil Texture
7. Use of survey instruments - theodolite, dumpy level and plane table
8. Field study to a local environmentally important area

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SEMESTER II

PAPER 5: ENVIRONMENTAL TOXICOLOGY

4 CREDITS

Unit I:

Introduction to toxicology, scope of toxicology subspecialties of toxicology, description and terminology of toxic effects, factors influencing toxicity, drug toxicity, Biochemical basis of toxicity: mechanism of toxicity and receptor mediated events, acute and chronic toxicity, Selective toxicity, Dose response relationship-graded response time action curves, threshold limit value, LC₅₀ & LD₅₀, Margin of safety and toxicity curves.

Unit II:

Bioaccumulation and Biomagnifications of toxic materials in food chain, Toxicology of major pesticides-Environmental impacts of pesticides, biotransformation, biomonitoring, programs and parameters of biomonitoring, concept of bioindicator, bioindicator groups and examples, Basic concepts of Environmental forensics.

Unit III:

Concepts of Bioassay: types, characteristics, importance and significance of bioassay, field based microbial bioassay for toxicity testing, Bioassay test models and classification. Immunotoxicity, histotoxicity, cell toxicity, Bio-sensors and Bio-markers: Concept and approach, advantages and disadvantages, Molecular marker to toxicants-metabolites as indicators, protein induction, cytochrome P450 enzymes, stress proteins and metallothioneins

Unit IV:

Toxicity Testing and Indicators: Principles of toxicity testing, Methods of toxicity evaluation at cellular and molecular level by in-vitro and in-vivo methods, Monitoring approaches- indicator populations and indicator species, Lacustrine communities as indicators of ecosystem stress, Bacterial, algal and invertebrate microbiotests, Model ecosystems- microcosms and mesocosms,

Unit V:

Occupational Hazards and Safety: Environmental and occupational safety: definitions, concept and scope, Occupational exposure, Occupational hazards and diseases, Control of toxic materials and protection measures, Toxicity of biohazards, Toxicity of air, water and soil.

References:

1. Environmental biology and Toxicology, by Sharma P.D. Rastogi and Lamporary., 1994.
 2. Environmental pollution and Toxicology by Meera Asthana and Astana D.K., Alka printers, 1990.
 3. Toxicology, by A.Sood, Sarup and sons New Delhi, 1999
 4. Text book of Preventive and Social Medicine, by Park J.E. and Park K., Banosidas Bharat Publishers, Jabalpur, 1985
 5. Environmental Epidemiology, by Anisa Basheer, Rawat Publication Jaipur, New Delhi 1995.
 6. Toxicology, Biochemistry and Pathology of Mycotoxins, by Kenji Uroguchi a mikio, Yamazadi Kodanshoa Ltd., Tokyo, 1978.
 7. Environmental Toxicology Current Developments (2005): J. Rose,Taylor & francis e library.
 8. Principles of Environmental Toxicology (2002): Ian. C. Shaw and John Chadwick, Taylor & francis e library.
 9. Introduction to Environmental Toxicology- Wayne .G. Landis, Ming Ho Yu, 3rd Ed. (2002) Lewis Publishers, CRC press , NY
 - 10.Ecotoxicology, Schuurmann, G., and Market, G., (1998), A. John Wiley & Sons, In.
 - 11.Hand book of Environmental Risk Assessment and Management, Peter Callow (1998), Blackwell Science, London.
 - 12.Information Resources in Toxicology: Wexler, Philip et al, 2000. 3rd ed. Academic press, 2000.
 - 13.Environmental Toxicology-Biological and Health effects of Pollutants. Ming Ho Yu, Humio Tsunado and Masashi Tsunoda. CRC press. 3rd Edn. (2011).
 - 14.Essentials of Toxicology – Klassen CD, Watkn J.B (2003) 3rd Ed., Mc Grew Hill, New York
 - 15.Environmental Toxicology and Chemistry. Crosby, Donald. G. 1998. Oxford University Press.
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PAPER 6: REMOTE SENSING & GIS

4 CREDITS

Unit I:

Principles of Remote Sensing- Concepts of Remote Sensing, Physics of remote sensing, effects of atmosphere, Principle of scanner and CCD array, Spectral reflectance of earth's surface features in different wavelength region of electromagnetic spectrum: spectral characteristics of surface features (rocks, soils, vegetations, water).

Unit II:

Space Imaging- Landsat, SPOT, IRS, NOAA, RADARSAT, INSAT satellites and their sensors, Orbital characteristics, Data products. Thermal remote sensing: Basic principles, characteristics of image and their uses. Applications of Remote Sensing in environmental monitoring: Land use mapping, forest survey in environment.

Unit III:

Microwave remote sensing- Basic definitions and principles, RADAR, SLAR, SAR; General characteristics, spectral resolution and interpretation. Digital Image Processing: Principles, Image Rectification, Image enhancement and Mosaicing. Image classification, Supervised, Unsupervised, Ground truth data and training set manipulation.

Unit IV:

Aerial Photography- Fundamentals of photogrammetry, areal cameras, planning of aerial photography, principle of stereo photography, parallax and measurement of height & slope Elements of image interpretation, convergence and evidence, interpretation keys; Interpretation of photographs and images for environmental analysis

Unit V:

Geographical Information System (GIS)- Basic principles, Raster and vector data, Map projection, Topology creation, Overlay analysis, Data structure and Digital cartography Global Positioning System (GPS): Basic principles, Applications to environmental studies

Reference:

1. Basics of Remote Sensing & GIS (2005): Dr. S. kumar
2. Essentials of GPS (2004): N. K. Agarwal; Spatial Networks Pvt. Ltd., Hyderabad
3. Environmental Modelling with GIS and Remote Sensing (2002): Andrew K Skidmore, Taylor & Francis.

4. GIS and Remote Sensing Techniques (2009): Manishika Jain, Himansu Publications.
 5. GIS A visual Approach (2nd Edition) (2001): Brus E Davis, Onword Press.
 6. Arc Hydro – GIS for Water resources(2002) : David R Maidment, ESRI press.
 7. Remote Sensing of the Environment – An earth resource perspective: J. R. Jensen; Pearson Education
 8. Geographic Information Systems: Martin, Routledge
 9. An Introduction to GIS: Heywood, Pearson
 10. Remote S sensing in Land Evaluation: Yadav; Rajesh Pub.
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PAPER 7: WATER RESOURCE & GROUND WATER HYDROLOGY

4 CREDITS

Unit I:

Water Resources- Introduction of water resources, distribution and supply: Global, national and regional; hydrological cycle, Water resource type: surface water, ground water; Causes of water resource depletion: Use and overuse of water resources, Methods for managing water resources: Ground water recharging, rain water harvesting; Watershed management: Concept, and objectives, land use planning, flood control; Wetlands: definition, importance and classification.

Unit II:

Reservoir Capacity & Yield, Flow-Duration Curve, Reservoir Planning, Reservoir Sediment Distribution, Cost Benefit Analysis, Conjunctive Water-Use Planning, Flood Routing, Reservoir Operation, Inter-Basin River Water, Transfers and interlinking rivers, Financial Analysis, Environmental Aspects.

Unit III:

Groundwater Hydrology, Occurrence of groundwater, Ground water zones, and Groundwater System. porosity, permeability and types of Aquifers. The Water Table, ground water flow, functions and Topography, Ground water depletion, Ground water Quality, Ground water pollution, Saltwater Intrusion, Changes in Ground water Quality.

Unit IV:

Water bearing materials, aquifer types & Hydraulic properties of aquifers, Laws of groundwater movement & well hydraulics, Use of tracer techniques in groundwater hydrology, Groundwater flow in ditches & galleries tapping different types of aquifers

Unit V:

Analysis of Test pumping data for various conditions & deviations, Evaluation of well loss parameters, Well drilling, development & design, Methods of artificial groundwater recharge, Groundwater Management by conjunctive use, Groundwater Assessment & Balancing, Seawater intrusion in coastal aquifers, Planning for regional groundwater development.

References:

1. Water Resource Engineering (2nd Edition) (2011): Larry W.Mays, John Wiley and Sons, Inc.
 2. Water Resources (2010): Shimon C Anisfeld, Island Press.
 3. Water resource Engineering: Principle & Practice (2009): Satya N Challa Murthy, New Age International Publisher.
 4. Principles of Water Resources: History, Development, Management, and Policy (3rd Edition) (2010): Thomas V Cech, John Wiley and Sons, Inc.
 5. Hydrology & Water Resource Engineeering (2014): S. K. Garg, Khanna Publishers, Delhi
 6. Water Supply Engineering, Vol.1 (25th Edition) (2014): S. K. Garg, Khanna Publishers, Delhi
 7. Engineering Hydrology (2nd Edition) (2008): Jayaram Reddy, Laxmi publications Pvt. Ltd., New Delhi
 8. Hydrology and Water Resource Engineering (5th Edition) (2000): R.K.Sharma & T.K. Sharma, Dhanapati Rai Publications.
 9. Engineering Hydrology (3rd Edition) (2008): K Subramanya, Tata Mc GrawHill Publishing Company Ltd., New Delhi.
 10. Physico – Chemical Process for Water quality (1st Edition) (1974): Weber. W.J, Ann Arbor, John Wiley and Sons, Inc.
 11. Applied Ground Water Hydrology and Well Hydraullics (2nd Edition) (2001): Michael Kasenow, Water Resource Publication, LLC.
 12. Groundwater (1979) : Freeze, R.A. & Cherry, J., Prentice Hall Inc.
 13. Analysis & Evaluation of Pumping Test Data (1991): Kruseman, G.P. and Deridder, N.A., ILRIPublication No. 47, The Netherlands.
 14. Groundwater Hydrology (1980): Todd, D.K, John Wiley and Sons, Inc.
 15. Water resource System (1st Edition) (2013): Sanjay Gupta, Vayu Education of India.
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PAPER 8: ENVIRONMENTAL ECONOMICS AND MANAGEMENT

4 CREDITS

Unit I:

Environmental Economics- Concept of ecological economics; environmental economics and principles; cost-benefits analysis; instrument for Environmental Control: Marginal Costs and Benefits (waste disposal cost), Regulatory Policy, Economic Incentives (price rationing, quality rationing, liability rule), the economics of environmental quality; economic valuation of environmental services; trade and environment; externalities, Biophysical limits to economic growth: the Malthusian, neoclassical, ecological economic perspectives.

Unit II:

Resource Conservation and Management- Ecosystem structure, Materials recycling, Succession, equilibrium, stability, resilience and complexity, Concept of resources; resource taxonomy; exhaustive resources and renewable and recyclable resources; resource management, conservation principle, The laws of matter and energy (laws of thermodynamics), and ways; conservation strategies, The Law of diminishing returns, Carrying capacity, Net present Value, Trade-offs.

Unit III:

Environmental management fundamentals and goals- Approaches to environmental management; Sustainable development, Environmental management challenges, Environmentalism, ecologism and the Green Movement, Social aspects of resource use and total economic value, environmental ethics, Global environmental problems and economics, Environmental accounts, environmental trade and importance.

Unit IV:

Environmental management systems- Environmental system principles: Polluter pays principle, User pays principle (or resource pricing principle), Precautionary principle, Subsidiary principle, Intergenerational equity principle; Tools: Standards, monitoring, modeling, eco-auditing and management strategies; different Environmental management systems; perspectives of environmental management policy in India, ISO Systems & certification procedure.

Unit V:

Approaches adopted to promote environmental management in business: Industrial ecology, Ecological engineering, Pigouvian taxes, Green marketing, Consumer protection bodies, Eco-labelling, Total quality management, Covenants, Life-cycle assessment, Greenwashing, Green energy and technology, International law and

sovereignty issues, International conferences (Stockholm) and agreements; Participatory environmental management: education and awareness, Facilitators, International bodies and NGOs.

References:

1. Environmental Economics (2nd edition) (2010) : Charles D Kolstad, Oxford Press.
 2. Natural Resources & Environmental Economics (4th Edition) (2011): Roger Perman, Yue Ma, Michael Common, David Maddison, James Mcgilvray, Addison Wiley & Sons.
 3. Uberoi, N K 1999 Environmental Management, New Delhi Publ. Excel Books
 4. Modern Urban and Regional Economics (2013): Phillip Mc Cann, Oxford Publisher.
 5. The Earthscan reader in Environmental economics, Markandya, A. 1992
 6. Intermediate Environmental Economics (2nd Edition) (2012) : Charles D Kolstad, Oxford Press.
 7. Environmental Economics: An Indian Perspective (Illustrated Edition) (2001) : Rabindra N Bhattacharya, New Delhi, New York Oxford University Press.
 8. Environmental Management (2009): T.V Ramchandra & Vijay Kulkarni,Energy & resource Institute.
 9. Environmental Managementfor Sustainable Development (2nd Edition) (2006) : C. J Barrow, Taylor & Francis group.
 - 10.Environmental Management Systems and Certification (2006): Phillip Weib & Jorg Bentlage,Batlic University Press.
 - 11.Environmental Planning and Managemnt (2007) : Christian Madu, Pace university New York.
 - 12.Sustainable Development & Environmental Management – Experiences and Case studies (2008): Corrado Clini, Ignazio Musu, Maria Lodovica Gullino,Springer.
 - 13.Environmental Economics Theory & Applications (2007): Kathar Singh, Sage India.
 14. A Text Book of Environmental Economics (2008): K.V Pavithran,New Age International limited Publisher.
 - 15.Environmental Economics: Theory, Management & Policy (2009) (2nd Edition) : M. L. Jingan 7 C.K Sharma.
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ELECTIVE 2- ENVIRONMENTAL IMPACT ASSESSMENT

4 CREDITS

Unit I:

Introduction- Environmental Impact Assessment (EIA) - Environmental Impact Statement (EIS)- Environmental Risk Assessment (ERA) - Legal and Regulatory aspects in India - Types and limitations of EIA - Terms of Reference in EIA- Issues in EIA - national - cross sectoral – social and cultural.

Unit II:

Components and Methods- Components - screening - setting - analysis - prediction of impacts - mitigation. Matrices - Networks - Checklists. Importance assessment techniques - cost benefit analysis - analysis of alternatives - methods for Prediction and assessment of impacts - air - water - soil - noise - biological - cultural - social - economic environments. Standards and guidelines for evaluation. Public Participation in environmental decision making.

Unit III:

Quality Control- Trends in EIA practice and evaluation criteria - capacity building for quality assurance. Expert System in EIA -use of regulations and AQM

Unit IV:

Documentation and Monitoring- Document planning - collection and organization of relevant information - use of visual display materials – team writing - reminder checklists. Environmental monitoring - guidelines - policies - planning of monitoring programs. Environmental Management Plan. Post project audit.

Unit V:

Case Studies- any Case studies of EIA of developmental projects.

References:

1. Canter, L.W., " Environmental Impact Assessment ", McGraw Hill, New York, 1996.
2. Environmental Impact Statements, Bregman, J. I., (1999) Lewis Publishers, London.
3. Environmental Assessment, Singleton R, Castle, P and Sort, D (1999), Thomas Telford Publishing, London.
4. Effective Environmental Assessment, Eccleston, C. H., (2000) Lewis Publishers, London.
5. Environmental Impact Assessment- A Comprehensive Guide to Project and Strategic Planning, Eccleston, C.H., (2000) John Wiley and Sons.
6. Environmental Management, N.K. Uberoi (2009), Excel Books, New Delhi, India.

7. ISO 14000 Environmental Management, David L Goetsch and Stanley B David (2001), Prentice hall Inc., New Jersey, USA.
8. Terms of Reference for EIA report for activities/ Projects requiring Environmental Clearance (2009), Administrative Staff College of India, Hyderabad.
9. Environmental Impact Assessment for Science, Art, Management and other Post graduate courses(2007), Manual Published by Indian Institute of Technology, Roorkee, India
10. Guidelines to project proponents for preparation of EIA report (2010), Manual Published by State Level Expert Appraisal Committee, Gujarat, India.
11. Environmental Life Cycle Analysis, David F Ciambrone (1997), Lewis Publishers, New York, USA.
12. Environmental Management an Indian Perspective, S.N. Chary and Vinod Vyasulu (2000), Macmillan India Limited, New Delhi, India.
13. Energy technology and Directions for the Future, John R Fanchi (2004), Elsevier Academic Press, Burlington, MA, USA.
14. Environmental Politics and Policy, Walter A Rosenbaum (1991), Affiliated East West Press Pvt. Ltd., New Delhi, India.
15. Environmental Impact Assessment for Science, Art, Management and other Post graduate Courses (2007), Manual Published by Indian Institute of Technology, Roorkee, India

ELECTIVE 2- BIO-ENERGY TECHNOLOGIES

4 CREDITS

Unit I:

Photosynthesis and Biomass composition, Ultimate and proximate analyses, Heating value, Biomass resources, Modes of biomass utilization for energy, Biomass conversion processes, Characteristics of biomass fuels.

Unit II:

Biogas production, Types of substrates, Process parameters, Digester design, Operational Problems, Biogas kinetics, Gas cleaning, Thermal and electrical conversion, High rate anaerobic digestion systems, Sludge utilization, Ethanol production processes, Distillation, Biodiesel: Preparation, characteristics and applications.

Unit III:

Biomass combustion reactions, Combustion systems, Wood stoves and industrial combustion systems, Fluidized bed combustion systems, Phase theory, Densification, Types of devices, Performance parameters, Feed preparation, Properties of densified fuels, Applications, Charcoal production, Dendrothermal power generation.

Unit IV:

Pyrolysis, Slow and fast pyrolysis, Biomass gasification: Types of gasifiers, Fluidized bed gasification, Equilibrium and kinetic considerations, Gas cleaning, Thermal applications, Decentralised power generation.

Unit V:

Waste and its characteristics, Waste generation, collection, separation, treatment and storage, Waste management, Waste conversion technologies: Landfill, incineration, gasification, Energy from sewage treatment, Energy from industrial wastes, Environmental impacts, Policy and economics.

Reference:

1. Charles.Y. Wereko-Brobby and Essel B. Hagan (1996), Biomass Conversion and Technology, JohnWiley & Sons.
2. T.B. Reed (1988), Biomass Gasification, Noyes Data Corporation.
3. D.D. Hall and R.P. Grover (1987), Biomass Renewable Energy, John Wiley, New York.
4. Gerhard Knothe, Jon Van Gerpen and Jurgen Krahel (2005), The Biodiesel Handbook.
5. Bioenergy Options for a Cleaner Environment: in Developed and Developing (2004) : Ralph E.H. Sims, Elsevier.
6. Sustainable Bioenergy Production - An Integrated Approach (2013) : Hans Ruppert, Martin Kappas, Jens , Springer.
7. Anaerobic Biotechnology for Bioenergy Production Principles and Applications(2011): Samir Khanal, Wiley Publishing.
8. Bioenergy Economy: A Methodological Study on Bioenergy-Based Therapies (2010): Farzad Goli, Xilbris Corporation.
9. Bioenergy: Opportunities and Challenges (2015): R. Navanietha Krishnaraj, Jong-Sung Yu, CRC Press
10. Bio-energy for Rural Energisation (1997): R. C. Maheshwari, Pradeep Chaturvedi, Concept Publishing Company.
11. Bioenergy and Biofuel from Biowastes and Biomass (2010): Samir K. Khanal, Rao Y. Surampalli, Tian C. Zhang, Buddhi P. Lamsal, R. D. Tyagi, C. M. Kao American Society of Civil Engineers, Technology & Engineering .
12. Energy Security and Development: The Global Context and Indian Perspectives (2015): B. Sudhakara Reddy, Sergio Ulgiati, Springer.
13. Green Technology: Earth-friendly Innovations (2008) : Geeta Sobha.
14. Green Technology: An A-to-Z Guide (2011): Dustin Mulvaney, Sage Publication
15. Green Investing: The Case of India (2015): Gagari Chakrabarti, Chitrakalpa Sen, Springer.

PRACTICAL II: ENVIRONMENTAL TOXICOLOGY, REMOTE SENSING AND GIS APPLICATIONS

6 CREDITS

Environmental Toxicology

Plant Bioassays: Estimation of protein content of biological samples – Pesticides and Metal Tolerance- microbes and Plant Bioassays - Estimation of heavy metals in soil, plant and animal materials, Animal Bioassays: *In-vitro* and *In-vivo* Cell toxicity Assays- Cell viability and Cytotoxicity - Toxicity assays – Nematodes / Earthworms - Animal Bioassays – Fish LC50, Micronucleus assay, Comet assay, Melanophore Index - Determination of Animal LD50, Probit Analysis and Graphical method.

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SEMESTER III

PAPER 9: WATER AND WASTE WATER TREATMENT TECHNIQUES

4 CREDITS

Unit I:

Physico-chemical Treatment- Methods of water treatment, Optimized design, plant control and operational variables, Preliminary treatment process of Wastewater Treatments: Physical treatments: Principles, flow measurement, screening, grit removal - Chemical treatments: Principles of chemical treatment, coagulation, flocculation, and sedimentation.

Unit II:

Biological Treatment- Principle of biological treatment, microbial growth and their kinetics for substrate removal, technical considerations in biological treatment. Aerobic Process: Activated sludge, Oxidation ponds, Trickling filter, Towers, Rotating discs and Rotating drums, Oxidation ditch – Anaerobic Process: Anaerobic digestion, Anaerobic filters, Upflow anaerobic sludge blanket reactors (UASB), Bioreactors for waste water treatments: Reactor types and design.

Unit III:

Advance Treatment- ultra filtration, Disinfections (UV, Ozonization), water softening, Demineralization, Reverse osmosis, Color & odor removal by activated carbon, Iron removal.

Unit IV:

Application of Nanotechnology- Applications and emerging opportunities, Nanofibers and Nanobiocides, Nanozymes for Biofilm Removal, Nanofiltration and nanomembranes, Nanomaterials and nanocatalyst in water and waste water treatment applications, Potential Risks of using nanotechnology in water treatment.

Unit V:

Industrial waste water treatment- Selection of appropriate unit operations for the treatment and flow chart of wastewater treatment plant for Dairy and food, Pulp & Paper, Electroplating, Textile, Distillery.

References:

1. Water and waste Engineering, Vol.I and II, Fair, G.M. Geyer T.C. and Okun. D.A. (1984): John Wiley and Sons.

2. Waste water treatment processes, Metcalf and Eddy Inc. Academic Press, New York. (2003 & 1979)
 3. Standard Methods for Examination of Water and Waste Water American Public Health Association (5th Ed) (1980)
 4. Water and waste water Engineering, Vol.I and II, Fair, G.M. Geyer T.C. and Okun. D.A. (1984): John Wiley and Sons.
 5. Wastewater Treatment Plants: Planning, Design & Operation (2nd Edition) (1999): Syed R Qasim, CRC Press.
 6. Wastewater Treatment (3rd Edition) (2002): M Henze, Springer.
 7. Water & Wastewater Treatment- A guide for non eng. Professional (2001): Jonnae E Drinan, CRC Press.
 8. Wastewater Treatment- Advanced Processes & Technologies (2013): D.G. Rao, R. Senthil Kumar, J Anthony Byrne, S. Feroz, IWA Publishing, CRC Press.
 9. Industrial Wastewater Treatment (Eastern Economy Edition) (2008): A.D Patwardhan, Prentice hall of India Private Limited.
 10. Wastewater Microbiology (3rd Edition) (2005): Cabriel Bitton, John Wiley & Sons.
 11. Physical – Chemical Treatment of Water & Wastewater (2003): Arcadio P Sincero & Gregoria A Sincero, IWA Publishing, CRC Press.
 12. Wastewater Engineering (2nd Edition) (2005) : B.C. Punmia, Ashok Jain, Laxmi publications Ltd.
 13. Advances in Membrane Technology for Water Treatment (2015): Angelo Basile, Alfredo Cassano, Navin K Rastog, Elsevier Limited.
 14. Nanotechnology for Water Treatment & Purification (2014) : Anming Hu & Allen Appleby, Springer International Publishing.
 15. Green Nanotechnology (2011) : Geoffrey B. Smith, Claes-Goran S. Granqvist, CRC Press.
-

PAPER 10: WATER BORNE DISEASES AND CHEMICAL AGENTS

4 CREDITS

Unit I:

Introduction, Waterborne diseases caused by pathogenic microorganisms, Epidemiology: Amoebiasis, Cryptosporidiosis, Giardiasis, Microsporidiosis, Schistosomiasis, Dracunculiasis, Fasciolopsiasis, Ascariasis, Botulism, Cholera, *E. coli* Infection, *M. marinum* infection, Salmonellosis, Typhoid fever, SARS, Hepatitis A, Poliomyelitis, Polyomavirus infection, Desmodermis infection.

Unit II:

Human health impact of chemical agents: trace metals (fluoride, lead, cadmium and mercury), Acrylamide, Benzene, dichloroethane, vinyl chloride, Pesticides (Organophosphates, Carbamates, Paraquat and Endosulfan) and disease Epidemiology.

Unit III:

Water Safety in Distribution Systems: Types of Water Transmission or Distribution System, Components of Water Transmission or Distribution Systems, Identify hazards and hazardous events and assess the risks, Microbial hazards, Chemical hazards (Disinfection by-products, Chemicals from pipe materials and fittings, Water treatment chemicals), Physical hazards, Water quality integrity,.

Unit IV:

Risk assessment in water distribution systems (Semi-quantitative risk assessment, Quantitative microbial risk assessment) Validate control measures, Drinking-water Quality standards and Guidelines, Standard operating and management procedures, surveillance, audits and inspections, Capacity building.

Unit V:

Fate, Transport and effects of Contaminants: chemical concentration, mass balance approach, physical transport of chemical agents in surface and ground water, Air-water exchange, contaminants in sediments.

References:

1. Waterborne disease: Epidemiology and ecology: Paul R. Hunter 1997. Chichester John Wiley and Sons Ltd.
 2. Water Safety in Distribution Systems, WHO, Geneva, Switzerland.
 3. WHO (2001) Sustainable Development and Healthy Environments. Sanitation on Ships. Compendium of outbreaks of foodborne and waterborne disease and Legionnaires' disease associated with ships, 1970-2000.
 4. Water borne Diseases- Epidemiology & Ecology (1997): Paul R Hunter, Wiley and Sons Ltd.
 5. Microbiology of Water Borne Diseases – Microbiological aspects and risks (2014): Steven L. Percival, Marylynn V. Yates, David Williams, Rachel Chalmers, Nicholas Gray, Elsevier Ltd.
 6. Water Borne Pathogens (2Edition) AWWA Manual 2006.
 7. Microbial Water borne Pathogens (2004) : T. E. Cloete, J Rose, N.H. Neil, T Ford, IWA Publishing.
 8. Water Borne diseases in India (2007): Atanu Sarkar, Srikanth K Panigrahi, Manak Publications.
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9. Perspectives in Environmental Health (2005): Vector & Water borne Diseases: Amit Krishna De, Aniruddha Mukhopadhyay, Originals.
 10. Water & Human Health (1983): Frederick Eugene McJunkin, Development Information Center.
 11. Water no longer taken for granted (2007): Sandra M Alters, Thomson/ Gale.
 12. Reviews of Environmental Contamination & Toxicology (2013): David M. Whitacre, Springer.
 13. Water & Sanitation Related Diseases and the Environment (2011) : Janine M. H. Selendy, Wiley and Sons Ltd.
 14. Vector Borne Diseases in India : Environmental Health & Policy perspectives (2007) : Atanu Sarkar, Srikanth K Panigrahi, Manak Publications.
 15. Flood Hazards & Health (2006): Roger Few, Franziska Matthies, Earthscan.
-

PAPER 11: ENVIRONMENTAL SAFETY AND HEALTH MANAGEMENT

4 CREDITS

Unit I:

Introduction, importance of environmental safety in industry, Occupational Health Hazards, Promoting Safety, Safety and Health training, Importance of environmental safety, role of safety department, Safety committee and Function, Concept and Significance of ISO standards and internal auditing, Industrial Pollution, Accident and Environmental Damage, Conservation of Environment, Restoration of ecosystem

Unit II:

Concept of work safety and health, development and accident prevention: accident, workplace injuries and damage, work environment; Occupational: Characteristics of Occupational Illness, Human Resources Important to Occupational Health Practice, Ethical Considerations; Risk assessment: Risk Assessment Basics, Exposure Assessment, Dose–Response Assessment, Comparative Risk Analysis, Risk Communication.

Unit III:

Occupational Health: The causes of work related ill health and the steps to control and prevent it, The appropriate measures to control the hazards associated with work related ill health including: (a) Noise, (b) Repetitive strain injury (RSI), (c) Display screen equipment (DSE), (d) Viral and bacterial infections, e.g. legionnaires disease, hepatitis B. (e) Stress.

Unit IV:

General Working Environment: That the following are all features of a healthy and safe workplace: (a) Workstations, (b) Room dimensions and space, (c) Floors & Gangways, (d) Stairways, (e) Lighting, (f) Temperature, (g) Ventilation, (h) Housekeeping –Safe storage, Falling objects, (j) Toilets and Washing Facilities, (j) Smoking, (k) Welfare provision, (l) Personal hygiene, (m) First Aid provision, (n) Rest Areas, The importance of safety signs and their usage, Principles of accidents prevention & First aid, Plant layout for safety.

Unit V:

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000 OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM, health, safety and environmental management system. Safety Management: Structure, Function and responsibilities, The competent person in relation to safety legislation - duties and responsibilities, Concept for training, application of computer, multimedia, communication, The importance of reporting potential health and safety hazards.

References:

1. Fundamental principles of occupational health and safety (2008) : Benjamin O. Alli, International Labour Office
2. Introduction to Occupational Health in Public Health Practice (2009): Bernard J. Healey, Kenneth T. Walker, Wiley & sons Ltd.
3. Technical & Ethical Guidelines for Worker's Health Surveillance : International Labour office, 1998.
4. Handbook of Occupational Safety and Health (1999): Louis J. Diberardinis, Wiley & sons Ltd.
5. Chemical Process Industry Safety (2014): K.S.N.Raju, Tata Mc Graw Hill Publication.
6. Safety & Health Essentials –OSHA Compliance for Small Businesses (2001): William Martin, James Walters, Elsevier.
7. Environmental Hazards: Assessing Risk and Reducing Disaster (6TH Edition) (2013): Keith Smith, David N. Petley, Routledge.
8. Physical and Biological Hazards of the work place(2 Edition Illustrated) (2002) : Peter H. Wald, Gregg M. Stave Proctor and Hughes, Wiley & Sons Ltd.
9. Chemical Hazards of the Workplace (5th Edition) (2004): Gloria J. Hathaway, Nick H. Proctor, James P. Hughes, Wiley & Sons Ltd.
10. Disaster Management future challenges and Opportunities (2007): Jagbir Sing, I.K. International.

11. Industrial Safety & Health (1 Edition) (2006): Amit Kumar Gupta, Laxmi Publication Ltd.
 12. Practical Industrial Safety, Risk Assessment and Shutdown Systems (2004) : Dave Macdonald, IDC Technologies
 13. Industrial Safety & health Management (6th Edition) (2010): C. Ray Asfahl, David W. Rieske, Prentice Hall.
 14. Industrial Hazards & Plant Safety (2002): Sanjoy Banerjee, CRC Press.
 15. Industrial Safety Management (2005): L M Deshmuk, Tata Mc Graw Hill Publication.
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PAPER 12: ENVIRONMENTAL POLLUTION & LAW

4 CREDITS

Unit I:

Noise Pollution- Types, sources and consequences, sampling methods and standard, pollution control measurement by technological and legislation aspects (Noise Pollution (Regulation and Control) Rules, 2000, Amendments), Case studies; Radio-active Pollution: Radio-active Pollution: Types, sources and consequences, sampling methods and standard, pollution control measurement by technological and legislation aspects (related laws and acts), Case studies; Thermal Pollution: Radio-active Pollution: Types, sources and consequences, sampling methods and standard, pollution control measurement by technological and legislation aspects (related laws and acts), Case studies.

Unit II:

Solid-waste Pollution- Types, sources and consequences, sampling methods, Classification of waste (Domestic, Industrial, Municipal, Electronic, Hospital, Nuclear, Agriculture), concept on 5R, Energy production, bio-manure etc., pollution control measurement by technological (Secure landfill and pyrolysis) and legislation aspects (The Hazardous Wastes Rules 2009, MSW Rules 2000), Case studies

Unit III:

Air Pollution- Types, sources and consequences, sampling methods and standard, Concept on atmospheric inversion and convection, bio-monitoring and sensor, Air pollution Indices, air quality modeling, particulate matter (PM 10 PM 2.5), organic vapours, CO₂ Equilibria, Smog, PAH and health risk, pollution control measurement by technological (catalytic converters and materials, scrubbers, electrostatic precipitation, Filters, Adsorption, AOP) and legislation aspects (The Air (Prevention and Control of Pollution) Act 1981, amended 1987, Rules 1982 & 1983), Case studies,

Unit IV:

Water Pollution- Types (ground water, surface water and marine water), sources and consequences, sampling methods and standard, pollution control measurement by technological and legislation aspects (The Water (Prevention and Control of Pollution) Act, 1974, amended 1988), Case studies; Soil Pollution: Types, sources and consequences, sampling methods and standard, pollution control measurement by technological and legislation aspects, Case studies

Unit V:

Environmental laws and policies in India- introduction, importance, Constitutional and statutory laws in India: Environmental (protection) Act and rules (1986) and importance, The Forest (conservation) Act 1980, Wildlife protection Act 1972, The National Environment Tribunal Act 1995, The Public Liability Insurance Act, 1991, amended 1992, Role of CPCB in pollution control, Ministry of environment and Forest: Environmental Clearance (EIA notification 2006, recent updates), standard guidelines (authorization and clearance), National Green Tribunal, international environmental laws and importance.

References:

1. Environmental radioactivity(1997): M. Eisendbud, Academic press.
2. Energy, Waste and the Environment: A Geochemical Perspective (2004): R. Gieré, Peter Stille, Geological Society of London
3. Understanding Environmental Pollution(3rd Edition) (2010) : Marquita K. Hill, Cambridge University
4. Air Pollution: Health And Environmental Impacts (2010): Bhola R. Gurjar, Luisa T. Molina, C.S. P. Ojha, CRC Press.
5. Air Pollution (26th Reprint) (2007) : M N Rao & H V N Rao, Tata Mc Graw Hill Publication.
6. Environment Pollution & Management (2003): A. Kumar, C Bohra. L.K. Singh, APH Publishing Corporation.
7. Environmental Pollution Monitoring and Control (2004) :S. M. Khopkar, New Age International Publisher.
8. Handbook of Environmental Law (2009): P.B Sahasranaman, Oxford University Press.
9. Water Pollution: Causes, Effects and Control (2006): P. K. Goel, New Age International Publisher.
10. Water Pollution (2009): A. K. Tripathi, S. N. Pandey, APH Publishing Corporation.
11. Soil Pollution & Soil Organics (2008): P.C.Mishra, APH Publishing Corporation.
12. Soil Pollution – Origin, Monitoring & Remediation (2004): Ibrahim Mirsal, Springer.
13. Noise Pollution (2009) : S.K Agarwal, APH Publishing Corporation.
14. Constitution of India [Referred articles from Part-III, Part-IV and Part-IV-A].

ELECTIVE 3: ENVIRONMENTAL NANOSCIENCE

4 CREDITS

Unit I:

Environmental pollution- Environmental fate and transport of Nanomaterials, physical-chemical interactions, aggregation and deposition, definition of air pollution, water pollution and ground pollution, contribution of nanoparticles in aggravating pollution. Green nanoscience, Approaches to safe nanotechnology, Green synthesis.

Unit II:

Toxic Impacts of Nanomaterials- Exposure and risk assessment, dose-response, mechanisms of toxicity, definition of eco-toxicity, routes of entry of nanomaterials into the environment, cytotoxicity of nanomaterials. Nanotoxicology – Methods for toxicity studies of nanoparticles, toxicology of carbon nanoparticles, and toxicology of metal nanoparticles.

Unit III:

Health effects of nanoparticles- Sources of nanoparticles, epidemiological evidence, entry routes into the human body – Lung, Intestinal Tract, Skin, effect of nanoparticle size, shape and charge, effects of nanoparticles on - cardiovascular, liver and gastrointestinal and nervous system, coagulation and thrombosis, blood-brain barrier.

Unit IV:

Environmental application of nanomaterials- Environmental Remediation, nanoparticles reactivity, fate, and lifetimes in the subsurface, ground water remediation with nanoparticles, nanomaterials for water and wastewater treatment.

Unit V:

Microbial interaction with nanoparticles- Applications and emerging opportunities in the area of nanoparticle interaction with microbes, detection of microbial pathogens with nanotechnology, nanozymes for biofilm removal. Ethics in Research and Development, ethics in medical applications, ethics in nanomedicine.

References:

1. Environanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin
 2. Nick Kanello Poulos. CRC press, 2011.
 3. Inorganic Nanoparticles: Synthesis, Application and Perspectives. Edited by Claudia Altavilla and Enrico Ciliberto. CRC Press, 2011.
 4. Nanostructured conductive polymers. Edited by Ali Eftekhari. Wiley, 2010.
 5. Adsorption and diffusion in nanoporous material by Rolando M.A. Raque Malherbe. CRC press, 2007.
 6. Introduction to Nanoscience by Gabor L. Hornyak, Joyde.
-

ELECTIVE 3: WATER RESOURCE MANAGEMENT AND SUSTAINABLE DEVELOPMENT

4 CREDITS

Unit I:

Water as a global issue- key challenges and needs – concept of Integrated water resources management (IWRM) within the broader context of development – Complexity of the IWRM process – Examining the key elements of IWRM process.

Unit II:

Economic view of water issues- economic characteristics of water good and services, Non-market monetary valuation methods, Water economic instruments, policy options for water conservation and sustainable use: Case studies. Pricing: distinction between values and charges – Private sector involvement in water resources management (PPP): objectives, options, processes, experiences through case studies, Links between PPP and IWRM.

Unit III:

Water for food production- ‘blue’ versus ‘green’ water debate, Virtual water trade for achieving global water security, Irrigation efficiencies, irrigation methods and current water pricing. Irrigation: Water User’s Association, Types and Levels of Operation and Organisation in irrigation System, User roles in irrigation Management, Role of Community Organiser, The context of Participation.

Unit IV:

Remote Sensing and GIS for Water Resources- Spatial data sources – 4M GIS approach water resources system – Thematic maps, Rainfall and runoff modeling, Groundwater modeling, Water quality modeling, Flood inundation mapping and

Modelling, Drought monitoring, Cropping pattern change analysis, Performance evaluation of irrigation commands. Site selection for artificial recharge - Reservoir sedimentation.

Unit V:

Water Legal and Regulatory Settings- Basic notion of law and governance: principles of international and national law in the area of water management. River water disputes, Integrated river basin development.

References:

1. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
 2. Technical Advisory Committee, Regulation and Private Participation in Water and Sanitation section, Technical Advisory Committee Background paper No:1. Global water partnership, Stockholm, Sweden, 1998.
 3. Mollinga. P. et al “ Integrated Water Resources Management”, Water in South Asia Volume I, Sage Publications, 2006.
 4. Water Resource Engineering (2nd Edition) (2011): Larry W.Mays, John Wiley and Sons, Inc.
 5. Water Resources (2010): Shimon C Anisfeld, Island Press.
 6. Water resource Engineering: Principle & Practice (2009): Satya N Challa Murthy, New Age International Publisher.
 7. Water resource System (1st Edition) (2013): Sanjay Gupta, Vayu Education of India.
 8. Environmental Managementfor Sustainable Development (2nd Edition) (2006) : C. J Barrow, Taylor & Francis group.
 9. Integrated Water Resources Management in Practice: Better Water Management (2009): R. L. Lenton, Mike Muller, Global Water Parternship.
 10. Water Resources Management: Principles, Regulations, and Cases 1996) : Neil S. Grigg, Mc Grew Hill, New York
 11. Water Management in India (2004): By P. C. Bansil, Concept Publishication Company.
 12. Water Resources Systems Planning and Management (2003): Sharad K. Jain, V.P. Singh, Elsevier.
 13. India's Waters: Advances in Development and Management (2011): Mahesh Chandra Chaturvedi, CRC Press.
 14. Water Resources Systems (2005): Vedula & Majumdar, S Vedula P P Mujumdar, Mc GrawHill Publishing Company Ltd., New Delhi.
 15. Proceedings: First IWRS Symposium on Integrated Water Resources Management for Drinking, Agriculture, and Industry: Policies and Issues, Jan. 24-25, 1987, Hyderabad, A.P.
-

**PRACTICAL III: WATER AND WASTEWATER TREATMENT TECHNIQUES,
WATERBORNE DISEASES AND CHEMICAL AGENTS**

6 CREDITS

- Determination of Chlorine demand, free residual chlorine,
- Na and K in Sewage sample and wastewater and natural water.
- Determination of chloride, acidity and alkalinity of raw sewage, wastewater and natural water,
- Determination of Ts, TSS, TDS in water and wastewater,
- Determination of COD and BOD,
- Jar test, Estimation of Total Coliform.
- Culture techniques for the detection of microorganisms
- Molecular techniques for the detection of microorganisms
- Epidemiology – water borne diseases.

SEMESTER IV

Summer Project - 2 credits

Field / Industrial Vist report and Viva – 2 credits

Thesis and Viva Voce Examination – 10 credits

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M.Sc GEOINFORMATICS

Course Overview

Objective

Post Graduate Degree in GeoInformatics, offered by JSS University, is well designated program, Geoinformatics is the synergy of multiple disciplines, namely GIS (Geographical Information System), Remote Sensing, Photogrammetry, GPS (Global Positioning System), Information Technology and Geodesy. Now a days GeoInformatics has emerged as an effective tool which can be applied in all the fields, such as Environment, Health, Socio-economics, Disaster management, Crime analysis and Resource Management, etc. GeoInformatics deals with spatial and non-spatial data where acquisition, management, analysis and dissemination methods are followed. Application of Geoinformatics is mainly oriented to real world management problems pertaining to natural and man-made environment. Geoinformatics is an increasingly pervasive information processing system and its ubiquitous nature poses new research challenges and provides new opportunities for novel implementation, helps to analyze large datasets, understanding of terrestrial process and human activities which improve socio – economic viability and enhance environmental quality. Geoinformatics is an emerging field catering to Societal, Industry and Scientific needs of the country and has attained a unique position in Global space.

The M.Sc. in GeoInformatics aims to provide conceptual knowledge on GIS, remote sensing and related fields, Information Technology, and hands-on training in GIS, data interpretation, digital image processing, digital photogrammetry, digital cartography and GPS. The course contents have been designed keeping in view the emerging trends in the field of Geoinformatics and the increasing needs of skilled manpower for the viable society.

Carrier opportunities

Geoinformatics can be applied in every imaginable discipline. Career opportunities lie in both Government and Private sectors related to land resource management, integrated emergency management, water and wastewater management, disaster

management, risk assessment and management, transportation, urban planning, environment, hydrology, forestry, agriculture, military, mining, business, health, defence, space research, geology and several related fields. Candidates could find placements as GIS specialists, analysts, developers, disaster management officers, industrial specialists, urban management & Planners and teaching professionals, etc. Geoinformatics has a burgeoning market through wide ranging applications in diverse fields and highly paid job opportunities in practically every sector.

Eligibility

The candidate should have passed any Degree from recognised university, with at least 50% aggregate marks at undergraduate level.

M.Sc. Geoinformatics

	Semester I	Credits
Paper 1	Fundamentals of Mathematics	4
Paper 2	Fundamentals of Computer Sciences	4
Paper 3	Introduction to Spatial Data Sources	4
Paper 4	Introduction to Remote Sensing	4
Elective 1	Statistical Methods for Biology	4
Practical 1	Techniques of Interpretation in spatial data	6
		26
	Semester II	
Paper 5	Introduction to GIS and GPS	4
Paper 6	Introduction to Spatial Data Analysis	4
Paper 7	Digital Cartography	4
Paper 8	Digital Image Processing	4
Elective 2	Geoinformatics for Hydrology	4
Practical 2	Image Processing and Analysis in GIS	6
		26
	Semester III	
Paper 9	Advances in Geo informatics	4
Paper 10	Photogrammetry	4
Paper 11	Application of GIS and Remote Sensing in Natural Resources Management	4
Paper 12	Geodatabase for GIS	4
Elective 3	Advances in Public Health Geoinformatics	4
Practical 3	Advance in GIS and Remote Sensing	6
		26
	Semester IV	
	Summer Project	2
	Thesis and viva voce examination	12
		14
	Total Credits	92

SEMESTER I

PAPER 1: FUNDAMENTALS OF MATHEMATICS 4 CREDITS

Unit I:

Trigonometry and Analytical Geometry-Trigonometric functions, trigonometric ratios of standard angles, allied angles, compound angles
Cartesian rectangular coordinate system, distance formula, section formula, straight lines, slopes, types of straight lines. Application in solving life science problems

Unit II:

Elementary Mathematics-Solutions of simultaneous linear equations, quadratic equations, progressions, permutations and combinations,

Unit III:

Matrices & Determinants-Introduction to Matrix, Transpose of a Matrix, Elementary row and column operations of Matrix, determinants, Properties of determinants (Without Proof) Rank of a Matrix, Minor and Co-factors Inverse of a matrix.

Unit IV:

Numerical Method-Gauss Jordan, Jacobi and Gauss side methods, Newton-Raphson method. Transcendental function- Logarithmic and exponential functions, Application in solving Biological science problems

Unit V:

Vector Algebra-Definition, Types of Vectors, two and three dimensional vectors, Scalar (dot) and Vector (cross) product . Application in solving Biological science problems

Reference:

1. T.B : SCHAUM Series books of calculus , vectors, statistics & matrices
 2. Pharmaceutical Mathematics with Application to Pharmacy – PharmMed Press, A Unit of
BSP Books Pvt Ltd, 4-4-309/316, Giriraj Lane, Sultan Bazar, Hyderabad – 500 095 -
Panchaksharappa Gowda D.H.
 3. Introduction to Mathematics for life scientist – Publisher- Springer (India) Pvt. Ltd-
Edward
Batschelet
-

PAPER 2: FUNDAMENTALS OF COMPUTER SCIENCES

4 CREDITS

Unit I:

Computer Fundamentals: Operating systems, Data base Management System, Concepts of Hardware & Software, and Basics of Internet & HTML.

Unit II:

Data Communication, Computer Graphics, Object Oriented programming with C++, Introduction to C language, Web programming and Java Script

Unit III:

Networking, Software Engineering, Advance Java programming, RDBMS.

Unit IV:

Visual Basics, Data Structure using C++, Java Programming, Computer Architecture.

Unit V:

Asp.net programming using C++, VB.net and XML, Software quality and Testing, (Project)

Reference:

1. Computer programming with C by E, Balaguruswamy.
 2. Elements of Statistics by Gupta.
-

PAPER 3: INTRODUCTION TO SPATIAL DATA SOURCES

4 CREDITS

Unit I:

Map and Scales- History of maps, Map scales, Map projections, enlargement, reduction, types and conversions, symbolization, Representation of statistical data on maps,

Unit II:

Topographical maps- Introduction to SOI topographical maps, numbering, scale, grid reference, signs etc, study and interpretation of SOI maps, Identification of land forms and cultural features from toposheets.

Unit III:

Aerial Photos- Basics of Aerial Photography, Historical development - principles of photography- types and uses - camera and films used, Interpretation keys for aerial photography.

Unit IV:

Remote Sensing Data- Remote Sensing Images: Basics of Remote sensing images, types of data products, visual interpretation of remote sensing images.

Unit V:

GPS Data- Introduction - Historical development - various GPS software products and peripherals System overview - Space Segment - GPS Satellite Systems, application of GPS.

Reference:

1. Prithvish Nag, M. Kudrat, Digital Remote Sensing, concept publishing company, New Delhi.
2. Ganesh, A., and Narayana Kumar, R., (2006). GPS Principles and Applications, Satish Serial Publishing House, Delhi.
3. Kumaraswamy, K. (2003) Remote Sensing for Environmental Studies, Department of Geography, Bharathidasan University, Tiruchirappalli.
4. Prithvish Nag, Thematic Cartography, Ashok kumar mittal, Concept publishing company, New Delhi.
5. Ramesh P A, Fundamentals of Cartography, Concept publishing Co., New Delhi.

**PAPER 4: INTRODUCTION TO REMOTE SENSING
4 CREDITS**

Unit I:

Development of Remote Sensing- Definition, types , chronological development, international remote sensing centres, Indian remote sensing centres and their activities, new satellite programs of India.

Unit II:

Remote Sensing System - Elements of EMR - wavelength regions – energy interaction in atmosphere – Absorption – scattering - atmospheric windows – terrestrial interaction – spectral reflectance curves – active and passive remote sensing.

Unit III:

Satellites and Sensors: Types of satellites – platforms – satellite characteristics: orbits and swaths – scanning methods – FOV and IFOV - resolution: spatial, spectral, radiometric and temporal – hyperspectral sensors and imaging - pixel size and scale.

Unit- IV:

Remote Sensing Satellites: Orbit - sensor characteristics and applications of Weather satellites: GOES, NOAA, METEOSAT, INSAT - Land observation satellites: LANDSAT, SPOT, IRS, IKONOS, GEOEYE, WORLDVIEW - Marine observation satellites: Seasat, Nimbus: CZCS, MOS, SeaStar: SeaWiFS, Oceansat.

Unit -V:

Thermal Remote Sensing: Plank's blackbody law – displacement law and emissivity effects - heat capacity, thermal conductivity - thermal inertia – diurnal heat effects – thermal property of objects – thermal sensors – thermography – thermal image interpretation.

Reference:

1. Curran P.J (1985) Principles of Remote Sensing, Longman, London.
 2. Lillisand T.M and R.W. Kiefer (1994) Remote Sensing and Image Interpretation (3rd edition). John Wiley & Sons, New York.
 3. Sabins F.F Jr. (1987) Remote Sensing: Principles and Interpretation, W.H.Freeman & Co., New York.
 4. Campbell. J.B. (2002) Introduction to Remote Sensing, Taylor and Francis, London.
 5. Alexey Bunkin and Konstantin Voliak (2001) Laser Remote Sensing of the Ocean, John Wiley and Sons., New York.
 6. Gibso, P., and Clare H. Power, (2000) Introductory Remote Sensing: Principles and Concepts, Routledge, London.
 7. Hayesm L., (1991) Introduction to Remote Sensing, Taylor and Francis Publication, London.
 8. Kumaraswamy, K. (2003) Remote Sensing for Environmental Studies, Department of Geography, Bharathidasan University, Tiruchirappalli.
 9. Gupta. R. P (2005) Remote Sensing Geology (2nd Edition), Springer India, New Delhi.
-

ELECTIVE 1: STATISTICAL METHODS FOR BIOLOGY

4 CREDITS

Unit I:

Numerical Methods to Represent Variation-Importance and Scope of Statistics, Data Types, frequency distribution, Graphical Representation Methods (Histogram, Bar Charts, Pie Charts), Measures of Center Tendency (Mean, Median, Mode,) and Dispersion (Standard Deviation, Variance) Advantages and Disadvantages, Co-Efficient of Variance.

Unit I:

Probability-Basic Terminology, Definition of Probability, Basic Laws of Probability, Types of Probability, Additional Rule of Probability and Multiplication Rule of Probability, Probability Distribution-Bernoulli Distribution, Binomial Distribution, Poisson distribution and Normal Distribution-Simple Problems.

Unit III:

Sampling Methods-Collection of Data, Census Method, Concept of Population, Sample, Sampling, Sample Size, Sampling Error, Advantages and Disadvantages of Sampling Method, Necessity of Sampling, Types of Sampling Methods, Types of Random Sampling Methods – SRS, Stratified Random Sampling, Systematic Random Sampling And Cluster Sampling.

Unit IV:

Testing of Hypotheses- Statistical Hypotheses-Null and Alternative, Level of Significance, Type I and Type II Error, Critical Region, Power of the Test, P Value, Degrees Of Freedom, Chi-Square Test for Independence of Attributes and Goodness of Fit, Student's t Test: One Sample t Test and Paired t Test, F Test.

Unit V:

Regression and Analysis Of Variance-Simple Linear Regression, Multiple Linear Regression (Definition, Assumptions, Applications, and Examples) ,Analysis of Variance –Introduction ,Definition of ANOVA, Assumption , Test Of ANOVA, Types Of ANOVA, Construction of One Way Analysis of Variance.

Reference:

1. Fundamentals of Biostatistics: Veer Bala Rastogi
2. Fundamentals of Mathematical Statistics: S.C. Gupta and V. K. Kapoor
3. Fundamentals of Statistics: S.C. Gupta
4. Biostatistics, Snedger and Gohrran.
5. Introductory Statistics for Biology 2nd Edition, R. E. Parker

SEMESTER II

PAPER 5: INTRODUCTION TO GIS AND GPS 4 CREDITS

Unit I:

Definitions, Evolution of GIS, Components of GIS, Representation of spatial entity in raster and vector models, raster and vector data structures, Advantages and limitations. Georeferencing/Image Registration and projections, Spatial Data and Non Spatial Data and Spatial Topology.

Unit II:

Basic file structures (flat, Sequential and Indexed), Tabular Database and its advantages, types, operations, adapting database to GIS; Representation of spatial entity in raster and vector models, raster Data quality and data standards: Concepts - Definition - Components and assessment of data quality.

Unit III:

Spatial Data Input and Editing: Integrated GIS database - Encoding methods of data input: keyboard, manual digitizing scanning and automatic digitizing methods, electronic data transfer - data editing: methods of developing and correcting errors in attributes and spatial data: reproduction, transformation and generalization - edge matching and rubber sheeting - integrated database.

Unit IV:

Data Analyzing Operation in GIS: Terminologies - Measurements of lengths, perimeter and area in GIS-queries - reclassification - buffering and neighbourhood functions - Raster and Vector overlay method: point-in-polygon, line-in-polygon and polygon-on-polygon - problems of Raster and Vector overlays - Spatial interpolation - Analysis of surfaces - Network analysis (shortest path problem, traveling problem, location and allocation of resources).

Unit V:

Introduction to GPS- Historical development - various GPS software products and peripherals System overview - Space Segment - GPS Satellite Systems – new Programmes - Control Segment - satellite tracking - User segment – land navigation - marine navigation - survey instruments - Recent trends.

Reference:

1. An Introduction to Urban Geographic Information Systems (Huxhold, WE, Oxford University Press, 1991)

2. Linda L. Hill, Georeferencing: The Geographic Associations of Information (2006); Past Time, Past Place: GIS for History (2002), edited by Anne Kelly Knowels.
 3. Ganesh, A., (2006). Dimensions of Geomatics, Bharathidasan University, Tiruchirappalli.
 4. Ganesh, A., and Narayana Kumar, R., (2006). GPS Principles and Applications, Satish Serial Publishing House, Delhi.
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PAPER 6: INTRODUCTION TO SPATIAL DATA ANALYSIS

4 CREDITS

Unit I:

Spatial Organization: Spatial structure - Spatial arrangements – Spatial organizations – Process: physical, economical and social and spatial organizations.

Unit II:

Spatial Analysis: Location and distributions of phenomena; interaction of people, goods and services between places and regions. Spatial data for GIS - Creation of spatial data (Raster, Vector & Non spatial) - Conceptual model for spatial problems.

Unit III:

Spatial Analysis of point entity: Mapping distance - Straight line distances – Allocations - Cost Weight Distances - Mapping density – Neighborhood - Centographic: Mean, Median and Standard Distance - Gravity model.

Unit IV:

Spatial analysis of line entity: Accessibility – Network – Connectivity - Detour index - Shortest path.

Unit V:

Spatial analysis of area entity / surface : Zonal Statistics – Contour – Slope - Aspect, Hill shade, View shed, TIN, DEM, DTM, Density , Trend surface - Interpolations and their types.

Reference:

1. Abler, R., Adams, J. S., and Gould P., (1972). Spatial Organization: The Geographer's View of the World, Prentice-Hall, London.
2. Burrough, P. A., (1986). Principles of Geographical Information Systems for Land Resource Assessment, Oxford University Press Inc., New York.
3. Heywood, I., Corneliuss, S., and Carver, S., (2001). An Introduction to Geographical Information Systems. Parsian Education (Singapore) Pvt. Ltd., 2nd Indian Reprint Indian Branch, Delhi.

4. Mitchell, A., (1999). The ESRI Guide to GIS Analysis Volume 1: Geographical Patterns and Relationships, Environmental Systems Research Institute, Inc., Red Lands, California.

PAPER 7: DIGITAL CARTOGRAPHY

4 CREDITS

Unit I:

Cartography: Cartography today – Nature of Cartography – History of Cartography – Cartographic Visualization – Web Cartography – Graticule – Cartometry – Map Characteristics - Modern Trends.

Unit II:

Basic Geodesy: Earth-Map Relationships – Basic Geodesy – Map Projections – Scale – Reference and Coordinate system – Transformation: Basic Transformation & Affined Transformation.

Unit III:

Data base Creation: Sources of data – Ground Survey and Positioning – Remote Sensing data collection – Census and sampling – data – Models for digital cartographic information – Map digitizing.

Unit IV:

Map Design : Cartographic design – Colour theory and models – Colour and pattern creation and specification – colour and pattern – Toponymy and lettering in maps – Map compilation – Demography and Statistical mapping.

Unit V:

Digital map making: Process of Map Productions: Non-photographic systems – Multiple reproduction processes. Computer application in Cartography – Computer mapping - Remote sensing and cartography - use of air photographs and satellite images – GIS & GPS application in cartography.

Reference:

1. Burrough, P.A., (1986). Principles of Geographical Information Systems for Land Resource Assessment, Oxford University Press Inc., New York.
2. Geogre P. Kellay, (1979). Map Projections, B.I. Publications, New Delhi.

3. Keates, J.S., (1973). Cartographic Design and Production, Longman Inc., London.
 4. Menno Jan Kraak, and Ormeling, F., (2004). Cartography - Visualization of Geospatial Data (2nd Edition), Pearson Education, New Delhi.
 5. Misra, R.P., and Ramesh, A., (2002). Fundamentals of Cartography, Concept Publishing Company, New Delhi.
 6. Arthur H. Robinson, (1995). Elements of Cartography, John Wiley & Sons, New York.
 7. Arthur H. Robinson et al., (2004). Elements of Cartography, John Wiley & Sons, New York
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PAPER 8: DIGITAL IMAGE PROCESSING

4 CREDITS

Unit I:

Introduction: Satellite images and resolution characteristics - Image processing software and associated technologies - Properties of digital remote sensing data classification of satellite data products: sensor, level of pre-processing and media based - image storage formats.

Unit II:

Preprocessing and Rectification: radiometric, geometric distortions and corrections - Non - systematic error and corrections - image transformation, ground control points and re-sampling techniques: Nearest Neighbour, Bilinear interpolation, Cubic Convolution.

Unit III:

Image Enhancement - spatial filtering techniques: Contrast stretch - liner and nonlinear - Low frequency filtering - high frequency filtering - gradient / directional filters: edge detection and edge enhancement - non-gradient filters - Image colour space transformation and band ratioing.

Unit IV:

Image Classification Techniques and pattern recognition: band suitability – supervised classification - training sites - spectral signatures and signature evaluation - Image classifiers - unsupervised classification.

Unit V:

Multi-layer modelling & multi-spectral analysis, Terrain analysis & Fly simulation, DEM generation & ortho-rectification.

Reference:

1. Lillisand. T.M., and Kiefer, P.W., (1998). Remote Sensing and Image Interpretation, John Wiley & Sons, New York.
 2. Prithvish Nag, and Kudrat, M., (1998). Digital Remote Sensing, Concept Publishing Company, New Delhi.
 3. Paul Gibson, and Clare H. Power, (2000). Introductory Remote Sensing: Digital Image Processing and Applications, Routledge Publisher, London.
 4. Leica Geosystem GIS & Mapping, (2009). Leica Photogrammetry Suite OrthoBASE & OrthoBASE Pro Users Guide, Atlanta.
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**ELECTIVE 2: GIS FOR HYDROLOGY
4 CREDITS****Unit I:**

Hydrologic Cycle, Hydrological parameters, porosity, permeability, specific yield, types of aquifers. Watershed Management: Watershed characterization, delineation and codification, watershed problems and management strategy. Geoinformatics approach for watershed prioritization.

Unit II:

Remote Sensing in Surface- Subsurface Water Exploration: Application of remote sensing in hydro- geomorphological interpretation for ground water exploration, water quality monitoring through remote sensing.

Unit III:

Operational Applications in Water Resources: Flood prediction, drought evaluation, snow cover mapping and reservoir sedimentation evaluation.

Unit IV:

Geoinformatics Models in Water Resources: Geo informatics based Runoff and hydrological modelling, flood Hazards modelling, snowmelt runoff modelling.

Unit V:

Case Studies: Hydro-geomorphological mapping in Plateau region, Flood Prone zone mapping in Indo- Gangetic Plains, Water harvesting Initiatives in Urban built up the lands.

Reference:

1. Schultz, G A and Engman E T 2000. Remote Sensing in Hydrology and Water Management, Springer- Verlag, Berlin, German.
2. Lillisand T M and Keifer R W 1994. Remote Sensing and Image interpretation John Willey and Sons, New York.
3. Jenson J R 2000 Remote Sensing of the environment- An Earth Resources Perspective, Prentice Hall Inc.
4. P S Roy (2000) Natural Disaster and their Mitigation Published by Indian Institute of Remote Sensing (IIRS) 2000.

PAPER 9: ADVANCES IN GEOINFORMATICS

4 CREDITS

Unit I:

Introduction to Geospatial Technology and History of Geospatial Technology,

Unit II:

Open Geospatial Consortium (OGC) Standards, Metadata standards. Advanced Spatial Analysis and Modelling, Geo database and Geo database Modelling.

Unit III:

Resource Mapping, The Geoweb - Web Services, Introduction to Programming for Geospatial Technologies(including web/ server) and Introduction to Web Application and development, Location-based services.

Unit IV:

Cloud Computing in Geo- ICT, Advances in GML for geospatial Applications, Geospatial technologies in urban Environments.

Unit V:

Crowd Sourcing, Advanced Data Conversion and recent in data acquisition and management, Data sharing and Accessibility policies and Utilisation of open sources software's in Geo- ICT.

Reference:

Advances in Spatio- Temporal Analysis: in : ISPRS Book series. X Tang, Y Liu. J Z Lang W Kainz-2007.

PAPER 10: PHOTOGRAMMETRY

4 CREDITS

Unit I:

Introduction: Historical Development and Fundamentals of aerial photography, Vertical and Oblique aerial photography, Classification of Aerial Film Cameras, Digital cameras, Components of aerial Cameras, Camera Calibration, Photogrammetric Applications and Products.

Unit II:

Scale, Geometry and Ground Coverage of Aerial Photographs, Area calculation & Flight Planning.

Unit III:

Binocular and Stereoscopic vision, Conditions for Stereovision, Photographic overlap Image Parallax, Height determination from stereo pairs - Parallax Equation, Ground Control.

Unit IV:

Co-ordinate Systems used in Photogrammetry, Relief distortion and Tilt distortions, Rectification, Ortho Rectification, Height determination from single photograph, Planimetric map compilation, Digital Elevation Model (DEM), Digital orthophotos.

Unit V:

Principles of digital photogrammetry: hardware & software requirements, image measurement, orientation procedure, epipolar geometry, aerotriangulation, block Adjustment, mosaics of dtm & ortho images.

Reference:

1. Analytical Stereoplotter Advanced Exercises, System specifications, intro to softcopy photogrammetry
 2. Elements of photogrammetry with Applications in GIS, 3rd Ed, Paul R Wolf and Bon Dewitt.
 3. Keates J S (1973) : Cartographic Design and production, London
 4. Ramesh P A (2000) Fundamentals of Cartography, Concepts Publishing Co., New Delhi
 5. Rampal K K (1993): Mapping and Compilation, Concept Publishing Co., New Delhi
 6. Anson R W & Ormeling F J (1993) Basic Cartography, Vol.1, 2nd , Elsevier Applied Science, Publishers, London
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**PAPER 11: APPLICATION OF GIS AND REMOTE SENSING IN NATURAL
RESOURCES MANAGEMENT
4 CREDITS**

Unit I:

Resource Conservation: Remote sensing based land use- Land cover mapping for resource monitoring and management Sustainable development of natural resource.

Unit II:

Land Resource: Introduction to soil, mineral resource, remote sensing in mapping soil degradation, impact of surface mining on land resource.

Unit III:

Bio-Resource: Remote sensing application in agriculture, forest resource and wildlife habitat assessment, Mapping of forest density and type, issues in forest management.

Unit IV:

Energy Resources: Coal, Oil, and Nuclear Energy, non conventional energy resources, future potential and requirement of energy resources. GIS in Energy resources management.

Unit V:

Geo informatics Models in Resource Managements: Forest fire modelling, Wild Life Habitat Assessment Modelling, Soil Erosion Modelling, and Land Resources development Prioritization Modelling.

Reference:

1. Robert G Reeves; manual of Remote Sensing Vol II American Society of Photogrammetry and remote sensing, Falls Church
2. Donald A Davidson : Soils and land use Planning , Longman, London,1998
3. Robert W Colwell. Monitoring of Earth Resources from Aircraft and Spacecraft.

PAPER 12: GEODATABASE FOR GIS

4 CREDITS

Unit I:

Introduction to DBMS – types of DBMS – data models – ER model: concepts – design. GIS data model: Conceptualizing the real world in GIS.

Unit II:

Relational Data Base Management Systems: Concepts – Constrains – Relational Data base Design – Relational Models Extended with ADT. SQL – simple – complex –spatial join.

Unit III:

Representation of Spatial Objects: Geographic space modeling – Representation Modes – Representing the Geometry of a Collection of objects – Spatial data formats and Exchange formats – Object Oriented GIS

Unit IV:

Geodatabase: Arc Geodatabase – topology – defining the relationship class – geometric networks – Geocoding services – Building geodatabases with CASE tools.

Unit V:

Emerging Trends: Data Mining: concepts – application of data mining, Data Warehousing: Characteristics of Data Ware house – applications, Intelligence Decision making: Artificial Intelligence, Decision support system, Expert system – design – applications.

Reference:

1. Korth, H.F., Silberschatz, A., and Sudarshan, S., (2002). Database System Concepts (5th Edition), McGraw - Hill Book Company, New York.
2. Rigaux, P., Scholl, M., and Voisard, A., (2002). Spatial Databases: with Application to GIS, Morgan Kaufmann, New York.
3. Ramez Elmasri, and Shamkant B. Navathe, (2002). Fundamentals of Database Systems, 5th Edition, Pearson Education, New Delhi.
4. Building Geodatabase, (2002). GIS, ESRI Publication, Red Lands, California.
5. Thomas Ott, and Frank Swiaczny, (2000). Time-Integrative Geographic Information Systems, Springer, Berlin.

ELECTIVE 3: 3.1 ADVANCES IN PUBLIC HEALTH GEO INFORMATICS**4 CREDITS****3.1. Basic GIS Analysis for Public Health Data.****Unit I:**

Health GIS Data, GIS Spatial operations, Calculating rates, data aggregation, Health data mapping Aggregation rates

Unit II:

Point Pattern Analysis of Health data- Spatial point processes- K function

Unit III:

Spatial clusters of health events: point data for cases and controls, Categorization of methods- comparing point process summarizes- scanning local rates- nearest Neighbour Statistics.

Unit IV:

Spatial Clustering of Health events: Regional Count data, Categorization of methods- scanning local rates- Global indexes of spatial auto – correlation – goodness of fit statistics.

Unit V:

Spatial interpolation and spatial prediction models for health data, Linear regression models for independent data- linear recession models for spatially auto correlated data- spatial autoregressive models.

3.2 GIS For Public Health Planning and Management.

Unit I:

GIS for Public Health Services: Access to health services- accessibility measures- regression models for health data- health disparities.

Unit II:

Introduction to Remote sensing and health applications: Introduction to remote sensing- data extraction and classification – integrating GPS and accelerometer data

Unit III:

GIS and RS applications for diseases: Vector borne diseases- Water borne diseases- Cancers- Environmental related diseases like Asthma- Non- communicable diseases

Unit IV:

GIS and RS applications for Public Health care delivery system: Understanding Health disparities using GIS, GIS and RS applications for Disaster management

Unit V:

Advanced geo- spatial technology applications for public health data: Open Geospatial Consortium (OGC) Standards- Metadata standards- Geoweb-web Services- Introduction to Programming for Geospatial Technologies and Web Application and its Development- Cloud Computing in Geo- ICT.

3.3 History and Introduction to GIS in Public Health

Unit I:

Overview of course- History of Health GIS- Introduction to GIS and Public Health.

Unit II:

Analysis of Public Health data: Observation Data vs Experimental Data – Calculation of Rates and Risks, Standardization of rates, Basis Analytic tools.

Unit III:

Epidemiological study designs: Descriptive study – case control study- cohort study- Randomised controlled trial – uses of epidemiology

Unit IV:

Health Information System: Sources of Health Information- Census- Civil Registration Systems- Disease registries- Disease surveillance- Integrated Disease surveillance project- Population based surveys- National Family Health survey and District level household Survey.

Unit V:

Health Care delivery system: Understanding the primary health centre and sub centre with respect to staffing Pattern and job responsibilities of each staff.

SEMESTER IV

Summer project work – 2 Credits

Thesis and viva-voce examination – 12 Credits

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**OUTLINE AND SYLLABUS
FOR
POST GRADUATE DEGREE PROGRAMME
IN
MEDICAL PHYSICS
UNDER UGC CHOICE BASED CREDIT SYSTEM (CBCS)
FOR ACADEMIC YEAR
2015-16**



FACULTY OF LIFE SCIENCES

JSS UNIVERSITY

(Accredited by NAAC with 'A' Grade)

Mysuru - 570 015.

Karnataka, India.

M. Sc. MEDICAL PHYSICS

Choice Based Credit System (CBCS)

Overview of the program

Medical physics applies the principles of physical sciences to biomedical problems. This applied branch of physics is devoted to the application of concepts and methods from physics to the diagnosis and treatment of human disease. The courses deals with well-established and emerging areas of medical and health physics including clinical dose measurement, computing, health physics, instrumentation, medical electronics, medical imaging, physiological monitoring, physics of radiotherapy, radiobiology, and radiological imaging sciences. The coursework also contains an introduction to the clinical sciences.

Curriculum

The curriculum for MSc in medical physics program is a comprehensive coverage of physics, biology, electronics and computing in medicine. It introduces students to the physical and biological basis and clinical practice of medical physics to medicine. The course is designed to provide a technical introduction to the profession of medical physics.

Duration of the course

The course is for **two** years (4 semesters) under CBCS pattern.

Career Prospectus

Completing this qualification will equip you with key transferrable skills which will be relevant to your career and for the workplace, as well as providing you with a base knowledge and understanding of medical physics at postgraduate level. You will learn to critically evaluate current research and advanced in this field of study as well as evaluating a range of research methodologies. You will learn the basic science behind radiation protection of patients and staff and be able to discuss some of the ethical issues associated with imaging and radiotherapy. Students may go on to careers in clinical service as medical physicists in research-oriented hospital settings after clinical residency training; may consider development careers in industry in radiation therapy, diagnostic radiology, or nuclear medicine or nuclear energy; in governmental organizations as radiation safety experts, or pursue academic careers in university, industry or government organizations.

Eligibility

A graduate in BSc in physics, mathematics and chemistry from an UGC recognized university with science.

Scheme of Examination

	Semester I	Credits
Paper 1	Basics of Radiation Physics	4
Paper 2	Fundamentals of Biostatistics	4
Paper 3	Medical Electronics and Instrumentation	4
Paper 4	Nuclear Physics	4
Elective 1	Solid State Physics	4
Practical 1		6
		26
	Semester II	
Paper 5	Anatomy and Physiology	4
Paper 6	Radiation Biology	4
Paper 7	Radiation Dosimetry and Standardization	4
Paper 8	Radiation Detectors and Instrumentation	4
Elective 2	Applied Medical Imaging	4
Practical 2		6
		26
	Semester III	
Paper 9	External Beam Photon Therapy	4
Paper 10	Brachytherapy: Physical and Clinical Aspects	4
Paper 11	Physics of Nuclear Medicine	4
Paper 12	Radiation Protection, Safety and Standards	4
Elective 3	Recent Advances in Radiotherapy	4
Practical 3		6
		26
	Semester IV	
	Summer Project	2
	Thesis and viva voce examination	10
	Medical Physics Tutorial	02
	Total Credits	92

SEMESTER I

Paper 1. Basics of Radiation Physics

Unit 1. Fundamentals of Physics - Atomic Structure and nucleus - Introduction to physical principles of medical physics. Physical quantities measurements and units- force, work and energy-Temperature and heat. Rutherford's Nuclear Atomic model. Bohr's Atomic model. Ionization and excitation. Electronic configurations of atoms, Atomic number, Atomic Mass number and energy units. Nuclear energy levels. Discovery of Electron, Motion of Electron in electric fields, Motion of Electron in a Magnetic field, Motion of Electron in a crossed electric and magnetic fields, Mass of an electron. Theory of Nuclear composition, Proton-Neutron theory of nuclear composition. General properties of a nucleus, mass defect and atomic binding energy, significance of average binding energy, nuclear forces – meson theory of nuclear forces – nuclear models – liquid model – nuclear shell model.

Unit 2. Electromagnetic Radiations - Electromagnetic spectrum- Different sources of Non Ionizing and ionizing radiations, Radiofrequency, physical properties and their interaction with tissues- Sources of ionizing radiation, properties, shielding materials and medical applications. Radiation sources: Natural and artificial radioactive sources – Large scale production of isotopes – Reactor produced isotopes – Cyclotron produced isotopes – Fission products – industrial uses.

Unit 3. Ionizing Radiations - Directly ionizing radiation (charged particles): electrons, protons, α particles and heavy ions. Indirectly ionizing radiation (neutral particles): photons (X rays and gamma rays), neutrons. Sources of ionizing radiations. Classification of ionizing photon radiation. Non ionizing Radiation - Different sources of Non-Ionizing radiation-their physical; properties-first law of photochemistry-Law of reciprocity- - Electrical Impedance and Biological Impedance - Principle and theory of thermography – applications. Various types of optical radiations - UV, visible and IR sources - Lasers: Theory and mechanism- Laser Surgical Systems-Measurement of fluence from optical sources - Optical properties of tissues – theory and experimental techniques-interaction of laser radiation with tissues – photo thermal - photochemical – photo ablation – electromechanical effect.

Unit 4. Particle Accelerators and X-ray generators - Particle accelerators for industrial, medical and research applications - The Resonant transformer – Cascade generator – Van De Graff Generator – pelletron – Cyclotron – Betatron - Synchro – Cyclotron – Linear Accelerator – Klystron and magnetron – Traveling and standing wave Acceleration – Microtron - Electron Synchrotron – Proton synchrotron. Details of accelerators facilities in India.

X-ray generators - Discovery, production and properties of X-rays. Design of hot cathode and rotating anode tubes X-ray tube. Characteristics of continuous spectra. Basic requirements of medical diagnostic, therapeutic and industrial radiographic tube. Hooded anode tubes, Industrial X-ray tubes, X-ray tubes for crystallography – Rating of tubes – Safety devices in X-ray tubes – Ray proof and shockproof tubes – Insulation and cooling of X-ray tubes – Mobile and dental units – Faults in X-ray tubes – Limitations on loading. Electric Accessories for X-ray tubes, Filament and high voltage transformers. High voltage circuits. Half-wave and full-wave rectifiers. Condenser discharge apparatus.

Unit 5. Radiation Quantities and Units - Quantities to describe a radiation beam- particle flux and fluence- Photon flux and fluence- cross section- linear and mass absorption coefficient- stopping power and LET Activity – Curie – Becquerel. Exposure and its measurements – Roentgen, Radiation absorbed Dose- Gray – kerma – kerma rate constant - Electronic equilibrium - relationship between kerma, exposure and absorbed dose–Relative biological effectiveness (RBE) - radiation weighting factors.

References Books:

1. R.D. Evans: Atomic Nucleus (McGraw Hill).
2. I. Kaplan: Nuclear Physics (Narosa Publication House)
3. R.E. Lapp: Nuclear Radiation Physics (Prentice Hall)
4. L. Slack & K. Way: Radiations from Radioactive Atoms (Govt. Print. Off.).
5. R. Oliver: Radiation Physics in Radiology (Springer).
6. D.K. Cheng: Field and Wave Electromagnetics (Addison-Wesley).
7. S. B. Patel, Nuclear Physics: An Introduction – New Age International.
8. S. N. Ghosal, Nuclear Physics, S. Chand.
9. K.S. Krane, Introductory Nuclear Physics, Wiley India.
10. D.C. Tayal, Nuclear Physics, Himalaya Publishing.

Paper 2. Fundamentals of Biostatistics

Unit 1. Introduction to Biostatistics

Definition of Biostatistics, Aims of Bio-Statistics, Role of Biostatistics in Modern research, Brief History, Limitations of Statistical Methods, Application and Uses of Biostatistics, Descriptive and Inferential Biostatistics.

Unit 2. Representation of Bio- Metric Data:

Types of Variables – Continuous, Discrete, Dependent and Independent Variables, Scales Of Measurements - Nominal, Ordinal, Interval And Ratio Scales, Frequency Distributions, Class Intervals, Working Rule To Prepare a Frequency Table, Pie Chart ,Bar Chart, Stem And Leaf Dot Diagram, and Histogram, Measures of Central Tendency – Mean, Median and Mode, Measures of Variability – Standard Deviation and Variance, Coefficient of Variance.

Unit 3: Probability

Trial, Event, Sample Space, Definition Of Probability, Mutually Exclusive Events, Independent Event, Laws Of Probability-Simple Problems, Binomial Distribution ,Poisson Distribution and Normal Distribution: Properties-Problems. Standard deviation, root mean square deviation, standard error and variance, moments, skewness and kurtosis. Application to radiation detection, uncertainty calculations, error propagation, time distribution between background and sample, minimum detectable limit. Binomial distribution, Poisson distribution, Gaussian distribution, exponential distribution – additive property of normal variates, confidence limits, Bivariate distribution, Correlation and Regression, Chi-Square distribution, t-distribution, F-distribution.

Unit 4: Fundamentals of Testing Of Hypotheses

Null and Alternate Hypotheses, Type I and Type II Errors, Tests Of Significance, Parametric And Non-Parametric Tests, Level Of Significance and Power Of The Test, 'P' Value And Its Interpretation, Statistical Significance And Clinical Significance, 'Z' Test, Student's 't' Test: Paired and unpaired, 'F' Test. Monte Carlo: Random variables, discrete random variables, continuous random variables, probability density function, discrete probability density function, continuous probability distributions, cumulative distribution function, accuracy and precision, law of large number, central limit theorem, random numbers and their generation, tests for randomness, inversion random sampling technique including worked examples, integration of simple 1-D integrals including worked examples.

Unit 5: Analysis of Categorical Data

Analysis Of Variance-Introduction, Definition Of ANOVA, Assumption, Types Of ANOVA, Construction Of One Way And Two Way ANOVA, Correlation, Types Of Correlation, Karl Pearson's Correlation Coefficient, Regression, The Method Of Least Squares, The Regression Of X On Y, Wilcoxon Test, Mann-Whitney U Test. Computational Tools and Techniques - Computational packages: overview of programming in C++, MATLAB in data analysis and graphics.

Reference Books:

1. An Introduction to Biostatistics: Gurumani N.
2. Fundamentals of Biostatistics: Veer Bala Rastogi
3. Biostatistics: Vinod Kumar Bais
4. Fundamental of Mathematical Statistics: S C Gupta and V K Kapoor
5. Medical Biostatistics: Abhaya Indrayan Sanjeev B. Sarmukaddam.

Paper 3. Medical Electronics and Instrumentation

Unit 1. Medical Electronics - Semiconductor Devices – Intrinsic and extrinsic semiconductors, n-type and p-type semiconductors, pn-junction properties. Forward and reversed bias semiconductors. Zener and photo diode, PNP and NPN junction transistor. Transistor components characteristics, voltage regulator circuits, bipolar junction transistors - CB and CE configuration characteristic JFET and MOSFET. Integrated Circuits – Operational amplifiers (OPAM) and their characteristics. Differential Amplifier – Operational amplifier systems OPAM applications – Addition, Subtraction, Integration and Differentiation – Active amplifiers – Pulse Amplifiers – Decoders and Encoders – Microprocessors and associated peripherals – Power supplies – Regulated power supplies using ICs – AC-DC converter and RF power supplies – Switching mode power supplies – AC regulators.

Unit 2: Digital Circuit Systems: Boolean algebra and logic gates: OR, AND, NOT, NOR, NAND and EXOR gates and their truth table flip-flops, shift registers, counters, decoders and encoders, analog to digital converter and digital to analog converters. Microprocessors and associated peripherals, power supplies-regulated power supplies using IC'S, AC-DC converter and RF power supplies, switching mode power supplies, AC regulators. Logic gates - Boolean algebra - Boolean laws – De-Morgans theorem -Implementation of logic circuits from truth table

– Sum-of-Products method – Products-of-Sum method – Multiplexer and de-multiplexer circuits - BCD to Decimal decoders - Seven segment decoders - Decimal to BCD encoder - Half-adder and Full-adder. Types of Flip Flops: RS, Clocked RS, D-Flip Flop, Edge-triggered D Flip flop – J K Flip flop - Master slave JK Flip flop - Sequential logic circuits: Types of registers– Serial in - Serial out – Serial in – Parallel out – Parallel in Serial out – Parallel in Parallel out registers – Applications - Counters: Ripple counters - up, down and up-down ripple counters - Asynchronous and synchronous counters. A/D and D/A converters.

Unit 3. Biomedical Ultrasound & Medical Laser - Ultra sound generators, properties of ultrasound- waves and its propagation in biological tissues, Pulse echo techniques, Doppler principle, involvement in design of medical instruments- scan A, scan B. scan M, ultrasound motion senses, dynamics of blood flow, Physiological effects of ultrasound in therapy. Adverse effects of ultrasound waves. Introduction to laser, principle of operation of laser, laser tissue interaction, Different types of LASER. Attenuation of LASER in medicine, adverse effects of LASER.

Unit 4. Radiation Measuring Monitoring Instruments - Dosimeters based on condenser chambers – Pocket chambers – Dosimeters based on current measurement – Different types of electrometers – MOSFET, Vibrating condenser and Varactor bridge types – Secondary standard therapy level dosimeters – Farmers Dosimeters – Radiation field analyzer (RFA) – Radioisotope calibrator – Multipurpose dosimeters – Water phantom dosimetry systems – Brachytherapy dosimeters – Thermo luminescent dosimeter readers for medical applications – Calibration and maintenance of dosimeters.

Unit 5. Instruments for personnel monitoring – TLD badge readers – PM film densitometers – Glass dosimeters readers - Digital pocket dosimeters using solid state devices and GM counters – Teletector – industrial gamma radiography survey meter – Gamma area (Zone) alarm monitors - Contamination monitors for alpha, beta and gamma radiation – Hand and Foot monitors. Laundry and Portal Monitors - Scintillation monitors for X and gamma radiations - Neutron Monitors, Tissue equivalent survey meters – Flux meter and dose equivalent monitors – Pocket neutron monitors - Teledose systems. Instruments for counting and spectrometry – Portable counting systems for alpha and beta radiation – Gamma ray spectrometers – Multichannel Analyzer – Liquid scintillation counting system – RIA counters – Whole body counters – Air Monitors for radioactive particulates and gases. Details commercially available instruments and systems

References Books:

1. S.M. Sze: Semiconductor Devices: Physics and Technology (Wiley).
2. Millman and Halkias: Integrated Electronics (McGraw Hill).
3. Ramakant A. Gayawad: OPAMPS and Linear Integrated Circuits (Pearson Education).
4. A.P. Malvino: Electronic Principles (McGraw Hill).
5. L.A. Geddes & L.E. Baker: Principles of Applied Biomedical Instrumentation (Wiley).
6. W.R.Hendee & E.R.Ritenour: Medical Imaging Physics (Wiley-Liss).

Paper 4. Nuclear Physics

Unit 1. Radioactivity – General properties of alpha, beta and gamma rays. Laws of radioactivity. Laws of successive transformations. Natural radioactive series. Radioactive equilibrium – Alpha ray spectra – Beta ray spectra – Theory of beta decay – Gamma emission – Electron capture – Internal conversion – Nuclear isomerism – Artificial radioactivity – Nuclear cross sections – Elementary ideas of fission and reactors – Fusion.

Unit 2. Particle Accelerators - Particle accelerators for industrial, medical and research applications - The Resonant transformer – Cascade generator – Van De Graff Generator – pelletron – Cyclotron – Betatron - Synchro – Cyclotron – Linear Accelerator – Klystron and magnetron – Traveling and standing wave Acceleration – Microtron - Electron Synchrotron – Proton synchrotron. Details of accelerators facilities in India.

Unit 3. X-ray Generator - Discovery – Production – Properties of X-rays – Characteristics and continuous spectra – Design of hot cathode X-ray tube – Basic requirements of medical diagnostic, therapeutic and industrial radiographic tube – Rotating anode tubes – Hooded anode tubes – Industrial X-ray tubes – X-ray tubes for crystallography – Rating of tubes – Safety devices in X-ray tubes – Ray proof and shockproof tubes – Insulation and cooling of X-ray tubes – Mobile and dental units – Faults in X-ray tubes – Limitations on loading.

Unit 4. X-ray tubes – Filament and high voltage transformers – High voltage circuits – Half-wave and full-wave rectifiers – Condenser discharge apparatus – Three phase apparatus – Voltage doubling circuits – current and voltage stabilizers – Automatic exposure control – Automatic Brightness Control – Measuring instruments – Measurement of kV and mA – timers – Control panels – Complete X-ray circuit – Image intensifiers and closed circuit TV systems – Modern Trends

Unit 5. Interaction of Radiation with Matter - Interaction of electromagnetic radiation with matter Exponential attenuation – Thomson scattering – Photoelectric and Compton process and energy absorption – Pair production – Attenuation and mass energy absorption coefficients – Relative importance of various processes. Interaction of charged particles with matter – Classical theory of inelastic collisions with atomic electrons – Energy loss per ion pair by primary and secondary ionization – Dependence of collision energy losses on the physical and chemical state of the absorber – Cerenkov radiation – Electron absorption process – Scattering Excitation and Ionization – Radioactive collision – Bremsstrahlung – Range energy relation – Continuous slowing down approximation (CSDA) – straight ahead approximation and detour factors – transmission and depth dependence methods for determination of particle penetration - empirical relations between range and energy – Back scattering.

References Books:

1. Principles of Physics – Halliday Resnick And Jearl Walker. 9th Edition.
2. Introductory Nuclear Physics by Kenneth S Krane. ISBN-13: 858-0000516227. ISBN-10: 047180553X

ELECTIVE 1. Solid State Physics

Unit 1. Crystal structure - Crystalline state- Basic definitions- Lattice and basis-Lattice translational vector-Primitive cells and unit cells – Wigner –Seitz cell – Indexing of planes, directions and positions of atoms-crystal systems – Bravais lattices - Simple crystal structures (Hexagonal close packed structure, NaCl, CsCl, Diamond structure, Cubic ZnS structure) X-ray diffraction – Laue’s treatment-Braggs treatment – Laue’s method-Rotating crystal method-Powder method.

Unit 2. Thermal and Dielectric properties of solids - Dulong-Petits law – Einstein theory of specific heat – thermal conductivity – factors affecting thermal conductivity Basic definitions - Local field – Clausius Mossotti relation – Electronic, Ionic, orientational and total polarizability – measurement of Dielectric constants and its measurements Ferro electricity – Electrets – Hysteresis-Piezoelectricity - Applications.

Unit 3. Magnetic Properties of Materials - Terms and definitions used in magnetism – Classification of magnetic materials – Langevin theory of diamagnetism – Langevin theory of paramagnetism - Quantum theory of paramagnetism – Ferromagnetism – Spontaneous magnetization in ferromagnetic materials – Hysteresis curve of ferromagnetic materials – origin of Ferromagnetic domains – Bloch wall – Anti-ferromagnetism – Molecular field theory of anti-ferromagnetism – Ferrimagnetism.

Unit 4. Superconductivity and Semiconducting properties of solids Definitions: Critical temperature – critical magnetic field – Critical current – Persistent current - The Meissner effect – Type 1 and 2 superconductors – Intermediate state – Vortex state - London equations –BCS theory –DC and AC Josephsen effect - Applications. Semiconductors - Direct and indirect band gaps – Classification of semiconductors – Concentration of electrons in the conduction band – hole concentration in the valence band – Electrical conductivity in semiconductors

Unit 5. Optical Properties - Absorption processes- Photoconductivity – Photoelectric effect – Photovoltaic effect –Photoluminescence – Thermoluminescence – Fluorescence – Radioluminescence- Phosphorescence, color centers – Types of color centers – F-Centre - Generation of color centers. MASER and LASER

References Books:

1. Solid state Physics – R.J.Singh, Pearson, 2012 Edition
2. Solid State Physics: Structure and Properties of Materials, 2nd Ed. A.M.Wahab, Narosa Publishing house, New Delhi, India, 2007.
3. Elementary Solid State Physics: Principles and Applications, 4th Ed., M.A.Omar, Pearson Education Pvt. Ltd., Delhi, India, 2004.
4. Introduction to Solid State Physics, 7th Ed, C. Kittel, John –Wiley & Sons (Asia) Pvt Ltd., New Delhi, 1996.

Practicals for Semester 1

Electronics Lab

1. Zener regulated power supply and percentage of regulation.
2. Transistor characteristics- CB configuration.
3. Transistor characteristics- CE configuration.
4. Single stage R-C coupled transistor amplifier.
5. FET characteristics.
6. Single stage FET amplifier- CS configuration.
7. OP-Amp applications- Adder, Subtractor, Differentiator and Integrator.
8. Logic gates OR, AND, NOT, NOR and NAND Gates.
9. NAND gate as a universal gate.
10. Half adder and Full adder.
11. A/D and D/A converters.
12. Programs using C
13. Programs using MATLAB.
14. Programs using SPSS.
15. Characterization of Photosensitive diodes and heel effect.
16. Statistics of Radioactive Counting
17. Determination of plateau and revolving time of a G.M. counter and its application in estimating the shelf-ratio and activity of a beta sources. 19. Calibration of gamma ray spectrometer and identification of unknown sources.

SEMESTER 2

Paper 5. Anatomy and Physiology

Unit 1. Cell Biology – Structures of the cell. Types of cells and tissue, their structures and functions - Organic constituents of cells – Carbohydrates, fats, proteins and nucleic acids – Enzymes and their functions – Functions of mitochondria, ribosomes, golgi bodies and lysosomes. Cell metabolism. DNA as concepts of gene and gene action. Mitotic and meiotic cell division. Semi conservative DNA synthesis, Genetic variation Crossing over, mutation, chromosome segregation. Heredity and its mechanisms.

Unit 2. Physiology – Structure & function of organs and systems & their common diseases: Skin, Lymphatic system, Bone and muscle, Nervous, Endocrine, Cardiovascular, Respiratory, Digestive (Gastro-Intestinal), Urinary Reproductive, Eye and ear. Digestive and Respiratory and Excretory systems.

Unit 3. Radiographic Anatomy of human body - Anatomical planes, diagnostic imaging techniques nomenclature and surface anatomy. Cross sectional anatomy, identify the different organs/structures on plain x-rays, CT scans and other available imaging modalities. Normal anatomy and deviation for abnormalities. Anatomy and physiology as applied to radio-diagnosis and radiotherapy – X-ray anatomy –CT/MRI anatomy-surface anatomy applied to RD and RT – introduction to the nature of diseases and trauma-inflammation and infection. Anatomy and Physiology as applied to radio-diagnosis and radiotherapy – Structure and function of organs and systems and their common diseases: Skin, Lymphatic System, Bone and muscle, nervous, endocrine, cardiovascular, Respiratory, Digestive (Gastro-Intestinal) Urinary, Reproductive, Eye and ear.

Unit 4. Clinical Aspects of Medical Imaging & Radiation Oncology: Tumor pathology and carcinogenesis, common pathological features of cancers and interpretation of clinico-pathological data. Radiation therapy, Surgery, Chemotherapy, Hormone Therapy, Immunotherapy & Radionuclide therapy, Benign and malignant disease, Methods of spread of malignant disease, Staging and grading systems, Treatment intent – Curative & Palliative, Cancer prevention and public education and Early detection & Screening. Site specific signs, symptoms, diagnosis and management: Head and Neck, Breast, Gynecological, Gastro-Intestinal tract, Genito-Urinary, Lung & Thorax, Lymphomas & Leukemias & Other cancers including AIDS related cancers. Patient management on treatment – side effects related to radiation and dose – Acute & Late – Monitoring and common management of side effects – Information and communication.

Unit 5: Professional aspects and role of medical physicists General patient care - Principles of professional practice – Medical terminology – Research & professional writing – patient privacy – Ethical & cultural issues. Legal aspects – Confidentiality, informed consent, Health and safety.

References Books:

1. Guyton and Hall: Text Book of Medical Physiology, 11th ed. (Elsevier).
2. Tortora and Derrickson: Principles of Anatomy and Physiology, 11th ed. (Wiley).
3. Inderbir Singh: Text Book of Human Histology with Color Atlas, 4th ed. (Jaypee).
4. Lubert Stryer: Biochemistry, 4th ed. (WH freeman and company).
5. De Robertis: Cell and Molecular Biology, 8th ed. (BI Publication)
6. R.L. Drake, Vogel & Mitchell: Gray's Anatomy for students (Elsevier).

Paper 6. Radiation Biology

Unit 1. Interaction of Radiation with Cells - Action of radiation on living cells – Radiolytic products of water and their interaction with biomolecule – Nucleic acids, proteins, enzymes, fats – Influence of oxygen, temperature – Cellular effects of radiation – Mitotic delay, chromosome aberrations, mutations and recombination – Giant cell formation, cell death Recovery from radiation damage – Potentially lethal damage and sublethal damage recovery - Pathways for repair of radiation damage. Law of Bergonie and Tribondeau. Survival curve parameters – Model for radiation action – Target theory – Multihit, Multitarget – Repair misrepair hypothesis – Dual action hypothesis – Modification of radiation damage – LET,RBE, dose rate, dose fractionation – Oxygen and other chemical sensitizers – Anoxic, hypoxic, base analogs, folic acid, and energy metabolism inhibitors – Hyperthermic sensitization – Radio-protective agents.

Unit 2. Biological Effects of Radiation - Biological effects of Radiation, induction of Radiation injury, Somatic effects of radiation – Physical factors influencing somatic effects – Dependence on dose, dose rate, type and energy of radiation, temperature, anoxia, - Acute radiation sickness – LD 50 dose – Effects of radiation on skin and blood forming organs, digestive track – Sterility and cataract formation – Effects of chronic exposure to radiation – Induction of leukemia – effects of radiation on embryo normal and abnormal human exposure to radiation and maximum permissible levels.

Unit 3. Radiation Carcinogenesis – Risk of carcinogenesis – Animal and human data – Shortening of life span – In-utero exposure – Genetic effects of radiation – Factors affecting frequency of radiation induced mutations – Dose-effects relationship – first generation effects – Effects due to mutation of recessive characteristics – Genetic burden – Prevalence of hereditary diseases and defects – Spontaneous mutation rate – Concept of doubling dose and genetic risk estimate.

Unit 4. Quality assurance in radiation biology - Administrative and technical means of procuring radionuclides – Diagnosis, evaluation and treatment of radiation overexposure –ICRP recommendations – Management of radiation accidents – Radiation protection in different Nuclear isotope therapy procedures – protection of workers, patient relatives – Radiation effect on pregnancy and fertility.

Unit 5. Radiation safety - Basic concepts of protection standards. System of Radiological Protection and International Commission on Radiological Protection and its recommendations. Principles of Monitoring and Protection. Evaluation of external radiation hazards, Effects of distance, time and shielding, shielding calculations, Personnel and area monitoring and internal radiation hazards.

Books:

1. C.H. Best and N.B. Taylor, A Test in Applied Physiology, Williams and Wilkins Company, Baltimore, 1986.
2. C.K. Warrick, Anatomy and Physiology for Radiographers, Oxford. University Press, 1988.
3. J.R. Brobek, Physiological Basis of Medical Practice, Williams and Wilkins, London, 1995

Paper 7. Radiation Dosimetry and Standardization

Unit. 1. Radiation Quantities and Units – Radiation quantities and units – Radiometry – Particle flux and fluence – Energy flux and fluence – Cross section – Linear and mass attenuation coefficients – Mass energy transfer and mass energy absorption coefficients – Stopping power – LET - Radiation chemical yield – W value – Dosimetry – Energy imparted – Absorbed dose – Kerma – Exposure – Air kerma rate constant – Charged particle equilibrium (CPE) – Relationship between kerma, absorbed dose and exposure under CPE – Dose equivalent – Ambient and directional dose equivalents $[H^*(d)$ and $H'(d)]$ – individual dose equivalent penetrating $H_p(d)$ – Individual dose equivalent superficial $H_s(d)$.

Unit 2. Radiation Sources - Radiation sources – Natural and artificial radioactive sources – Large scale production of isotopes – Reactor produced isotopes – Cyclotron produced isotopes – Fission products – industrial uses – Telecobalt and Brachy Caesium sources – Gold seeds – Tantalum wire – ^{125}I Sources – Beta ray applicators – Thermal and fast neutron sources – Preparation of tracers and labelled compounds – Preparation of ratio colloids.

Unit 3. Dosimetry & Standardization of X and Gamma Rays Beams - Standards – Primary and Secondary Standards, Traceability, Uncertainty in measurement. Charged Particle Equilibrium (CPE), Free Air Ion Chamber (FAIC), Design of parallel plate FAIC, Measurement of Air Kerma/ Exposure. Limitations of FAIC. Bragg-Gray theory, Mathematical expression describing Bragg-Gray principle and its derivation. Burlin and Spencer Attix Cavity theories. Transient Charged particle Equilibrium (TCPE), Concept of D_{gas} , Cavity ion chambers, Derivation of an expression for sensitivity of a cavity ion chamber. General definition of calibration factor – N_x , N_k , N_D , air, N_D , w. IAEA TRS277: Various steps to arrive at the expression for D_w starting from N_x . TRS398: N_D , w, Q : N_D , W : K_Q, Q_0 : K_Q , Derivation of an expression for K_Q, Q_0 . Calorimetric standards – Intercomparison of standard.

Unit 4. Measurement of D_w for External beams from ^{60}Co teletherapy machines: Reference conditions for measurement, Type of ion chambers, phantom, Waterproof sleeve, Derivation of an expression for Machine Timing error, Procedure for evolution of Temperature and pressure correction : Thermometers and pressure gauges. Measurement of temperature and pressure. Saturation correction: derivation of expression for charge collection efficiency of an ion chamber based on Mie theory. Parallel plate, cylindrical and spherical ion chambers, K_{sat} , Two voltage method for continuous and pulsed beams Polarity correction. Measurement of D_w for high-energy Electrons beams from Linear accelerators: Beam quality, beam quality index, beam quality correction coefficient, Cross calibration using intermediate beam quality. Quality Audit Programs in Reference and Non-Reference conditions.

Unit 5. Neutron Standards & Dosimetry - Neutron classification, neutron sources, Neutron standards – primary standards, secondary standards, Neutron yield and fluence rate

measurements, Manganese sulfate bath system, precision long counter, Activation method. Neutron spectrometry, threshold detectors, scintillation detectors & multispheres, Neutron dosimetry, Neutron survey meters, calibration, neutron field around medical accelerators.

Paper 8. Radiation Detectors and Instrumentation

Unit 1. Principles of Radiation Detection - Interaction of charged particle with matter: Absorption process, scattering ionization and excitation, Bethe's equation, radiation energy loss (bremstrahlung), range of beta particles, backscatter and self-absorption, Cerenkov radiation. Interaction of alpha particles, heavy nuclei and fission fragments with matter: Energy loss by collision, range-energy relation and Bragg curve, specific ionization, stopping power. Gas filled detectors, Basic Principles of radiation detection– Statistical nature of radiation emission, errors, accuracy and precision of measurements, types of errors- Gas Filled detectors – Ionization chambers – Theory and design – Construction of condenser type chambers and thimble chambers – Gas multiplication – Proportional and GM Counters, Characteristics of organic and inorganic counters – Dead time and recovery time – quenching. Spe

Unit 2: Dosimetry Instruments and parameters - Central axis dosimetry parameters: percentage depth doses (PDD), tissue air ratio (TAR), back scatter factor/Peak scatter factor (BSF/PSF) - tissue phantom ratio (TPR) - tissue maximum ratio (TMR)- collimator scatter factor, phantom scatter factor and total scatter factors -relationship between TAR and PDD and its applications - relationship between TMR and PDD and its applications – scatter air ratio(SAR) – scatter maximum ratio (SMR)- off axis ratio field factors- surface dose and buildup region- Tissue equivalent phantoms- Radiation Field Analyzer (RFA)- Description and measurement of isodose curves/ charts- Dosimetry data resources

Unit 3. Radiation Protection instruments - Instruments for personnel monitoring – TLD badge readers – PM film densitometers – Glass dosimeters readers - Digital pocket dosimeters using solid state devices and GM counters – Teledetector – industrial gamma radiography survey meter – Gamma area (Zone) alarm monitors - Contamination monitors for alpha, beta and gamma radiation – Hand and Foot monitors. Laundry and Portal Monitors - Scintillation monitors for X and gamma radiations - Neutron Monitors, Tissue equivalent survey meters – Flux meter and dose equivalent monitors – Pocket neutron monitors - Teledose systems. Instruments for counting, gamma ray spectrometry. PM tubes, preamplifiers, amplifiers, pulse height analyzers, coincidence & anti coincidence circuits, TPHC, MCA, scalers and timers, high voltage supply, gamma ray spectrometry.

Unit 4. Scintillation detectors: Scintillation detectors-Organic and Inorganic scintillation detectors. Scintillation detector principles- light collection and mounting, scintillation characteristics- light output, decay time, photo peaks, Compton valley, edge and plateau, backscatter peak, iodine escape peak, annihilation peak. Pulse height selector and resolution of energies, FWHM an energy calibration, geometric efficiency, intrinsic efficiency, Bismuth germanate detector, barium Fluoride detector, technetium orthosilicate detectors, yttrium orthosilicate detector, semiconductor detectors. Ge(Li) detector, Si(Li) detector, Cadmium zinc-telluride detector. Liquid scintillation counters. Composition of liquid scintillator (scintillation

cocktail): primary solute, secondary, solute and organic solvent (toluene, 1, 4 dioxane, anthracene) and solubilizing agents for tissues, coincidence circuits and display. Quenching and quench correction methods: Internal standard method, external standard method and channel ratio. Semiconductor detectors - Semiconductors junction and surface barrier detectors, high purity germanium detectors, their response and, characteristics.

Unit 5. General systems for operation and detection - Neutron detectors: Basic principles and applications. Well counter – Geometry factor, dual radionuclide counting. Radiation calorimetry, photographic dosimetry. Chemical dosimetry: salient feature of chemical dosimeters. Spectrophotometry: Beer-Lambert's Law, definition of transmittance and absorbance (optical density), molar absorption and coefficient, Fricke dosimeter, FBX dosimeter, ceric, sulphate dosimeter, Low dose level dosimeters (aqueous benzoic acid, terephthalic acid, aqueous trimesic acid); High dose level dosimeters (red Perspex HX, polyvinyl chloride, radio chromic dye and cellulose triacetate films). Thermo-luminescent Dosimeters & Autoradiography. Physics of TLD, characteristics TLD phosphors, glow curves, dose and energy response, sensitivity and application in-dosimetry and personnel monitoring devices. Use of photographic emulsions stripping film technique, dipping method, grain density counting and track counting, X-ray films, intensifying screens, fluoroscopy.

References Books:

1. Radiation Detection and Measurement, 3rd Ed (English) 3rd Edition. Glenn Knoll.
2. Measurement and Detection of Radiation, Third Edition. Nicholas Tsoulfanidis.
3. Fundamentals of Nuclear Pharmacy. Gopal B Saha.
4. Stepanor B.J. Theory of Luminescence
5. Glenn F Knoll. Radiation detection and Measurement
6. Albert Paul Malvino. Electronics principles
7. Robert L. Boylestad. Electronics devices and circuit theory
8. Paul – Horowitz. Art of Electronics
9. Greiner R.A. Semiconductor devices and Application
10. Crawford R.H. MOSFET in circuit design

ELECTIVE 2. Applied Medical Imaging

Unit 1. Principles of x-ray Diagnosis & Conventional Imaging - Physical principles of diagnostic radiology: Interactions X-rays with human body, differential transmission of x-ray beam, spatial image formation, visualization of spatial image, limitations, of projection imaging technique Viz. superimposition of overlying structures and scatter, application of contrast media and projections at different angles to overcome superimposition of overlying structures. Radiography techniques: prime factors (kVp, mAs and SID/SFD), influence of prime factors on image quality, selection criteria of prime factors for different types of imaging, different type of projection and slices selected for imaging, objectives of radio-diagnosis, patient dose Vs image quality.

Unit 2. Filters: inherent and added filters, purpose of added filters, beryllium filter, filters used for shaping X-ray spectrum (K-edge filters: holmium, gadolinium, molybdenum). Scatter reduction: Factors influencing scatter radiation, objectives of scatter reduction, contrast reduction factor, scatter reduction methods: beam restrictors (diaphragms, cones/cylinders & collimators), grids (grid function, different types of stationary grids, grid performance evaluation parameters, moving grids, artifacts caused by grids, grid selection criteria), air gap technique. Intensifying screens: Function of intensifying screens, function evaluation parameters, emission spectra and screen film matching, conventional screens Vs rare-earth screens

Unit 3. Production of X-ray Bremsstrahlung and characteristic radiation The X-ray spectrum. The intensity of X-ray Beams. X-ray tubes. X-ray generators. Transformers, X-ray Generator types. Effect of waveform on Radiation output. Exposure switches and Timing. Interactions between X-rays and Matter. Attenuation. Interaction process. Relative importance of different types of interactions. Scatter radiation. Contrast media. Filtration: - Grids and Air gap technique. Luminescent screens- General Principles, Absorption of quantum detection efficiency (QDE). Conversion efficiency. Physical characteristics of X-ray film and film processing. Structure of X-ray film.

Unit 4. Radiographic Film: Components of radiographic film, physical principles of image formation on film, double and single emulsion film, sensitometric parameters of film (density, speed, latitude etc.,) QA of film developer. Image quality: Image parameters; source of un-sharpness, reduction of un-sharpness, factors influencing radiographic contrast, resolution, factors influencing resolution evaluation of resolution (point spread function (PSF), line spread function (LSF), edge spread function (ESF), modulation transfer function (MTF), focal spot size evaluation

Unit 5. Image quality in Radiology. Radiographic (or) image contrast Radiographic Mottle (noise), Blur. Modulation transfer function. Geometry of the Radiographic Image. Mammography - an introduction and description.

References Books:

1. Handbook of Medical Imaging: Processing and Analysis. Issac Bankman. Academic Press.
2. Applied Radiological Anatomy, 2nd Edition. Paul Butler, Adam Mitchell and Jeremiah C Healy (2012) ISBN 9780521766661.

Practical's for II Semester and Semester III

1. Measurement of absorbed dose to water under reference conditions for high energy photon beams (TRS 398)
2. Measurement of absorbed dose to water under reference conditions for electron beams (TRS 398)
3. Determination of percentage depth dose of high energy photon beams and electron beams using Radiation field analyzer (RFA)
4. Measurement of symmetry, flatness and penumbra of therapy beam using Radiation field analyzer (RFA)
5. Quality assurance test procedures of teletherapy machines
6. Quality assurance test procedures of brachytherapy machine
7. Radiation protection survey of teletherapy installations
8. Radiation protection survey of brachytherapy installations
9. Radiation protection survey of diagnostic radiology installations (DRP 13) (RD)
10. Radiation protection survey of a radioisotope laboratory and study of surface and air contamination (NM)]
11. Layout preparation and building Planning procedures of radiotherapy installations
12. Brachytherapy treatment planning procedures using a computerized radiotherapy treatment planning system
13. Teletherapy treatment planning procedures using a computerized radiotherapy treatment planning system
14. Calibration of Radiation monitoring instruments (Gadgets) (DRP 14)
15. Treatment plan 3DCRT, IMRT, Brachy
16. Patient specific QA – IMRT
17. QA MLC, EPID, film
18. Dose, dose rate – draw a graph
19. Demo (Radiochromic, EDR) calibration curve

SEMESTER III

Paper 9. External Photon Beam Radiotherapy

Unit 1. Beam Generators - Kilo voltage therapy X-ray Units: principle and application of Grenz ray therapy - contact therapy, superficial therapy, orthovoltage, deep therapy. Telecobalt units: Construction and working, source design, beam shutter mechanisms, mercury shutter pneumatic pressure system, rotating wheel shutter system, beam collimation, penumbra and it's types, trimmers and breast cones, isocentric gantry.

Unit 2. Beam modifiers and treatment planning - Beam modifying and shaping devices. Block Cutting machines- wedge filters – universal, motorized and dynamic wedges - treatment planning with wedges– shielding blocks - field shaping, custom blocking - tissue compensation – design of compensators, 2D compensators, 3D compensators-special considerations in treatment planning - skin dose, field matching, integral dose, DVHs – differential, integral.

Treatment planning in teletherapy – target volume definition and dose prescription criteria – Gross tumor volume (GTV), Clinical target volume (CTV), Internal target volume (ITV), Internal margin, Planning target volume (PTV), Organ At Risk (OAR), Treated volume, Irradiated volume, Maximum target dose, Median target dose, Modal target dose and hot spot. ICRU 50, ICRU 62 and ICRU 83- SSD and SAD set ups – two and three dimensional localization techniques, dose specification and normalization- Positioning/immobilization. Fusion techniques - virtual simulation – digitally reconstructed radiographs (DRR). Field arrangements – single, parallel opposed and multiple fields – corrections for tissue inhomogeneity, contour shapes and beam obliquity – integral dose. Arc/rotation therapy and Clarkson technique for irregular fields – mantle and inverted Y Fields. Conventional and conformal radiotherapy. Treatment time and Monitor unit calculations- SSD and SAD/isocentric technique, Co-60 and accelerator calculations.

Unit 3. Physics of electron and particulate beam therapy: Clinical electron beams – energy specification – electron energy selection for patient treatment – depth dose characteristic (Ds, Dx, R100, R50, Rp etc.) – beam flatness and symmetry – penumbra – isodose plots – monitor unit calculations – output factor formalisms – effect of air gap on beam dosimetry – effective SSD. Relative merits of electrons, neutron, x-ray and gamma ray beams and heavily charged particles – Neutron capture therapy and Heavy ion (proton and carbon ion) therapy- physical principle and equipment only. Quality assurance in radiation therapy: Quality assurance in radiation therapy – precision and accuracy in clinical dosimetry - quality assurance protocols for telecobalt, medical linear accelerator and radiotherapy simulators– IEC requirements – acceptance, commissioning and quality control of tele-cobalt, medical linear accelerator and radiotherapy simulators. Portal and in-vivo dosimetry. Electronic portal imaging devices.

Unit 4. Radiation Beam Quality and Dose - Monoenergetic and Heteroenergetic bremsstrahlung beams: Energy spectra for bremsstrahlung beams; Effects of electron energy, filtration, beam geometry; Homogeneity coefficient; Effective energy; Clinical indices for megavoltage beams (e.g., PDD at reference depth). Radiation quantities and units. Kerma, Exposure; Absorbed dose; Dose equivalent; RBE dose; Calculation of absorbed dose from Bragg-Gray cavity theory. Radiation Sources both Natural and Artificial - generation through

reactors and Cyclotrons. Chemical Dosimetry - Definition of free radicals and G-value –Kinetics of radiation chemical transformations – LET and dose-rate effects –

Unit 5. Radiation Chemistry – Radiation chemistry of water and aqueous solutions, peroxy radicals, pH effects – Radiation chemistry of gases and reactions of dosimetry interest – Radiation polymerization, effects of radiation on polymers and their applications in dosimetry – Formation of free radicals in solids and their applications in dosimetry – Description of irradiators from dosimetric view point – Dosimetry principles – Definitions of optical density, molar absorption co-efficient, Beer-Lambert's law, Spectrophotometry – Dose calculations – Laboratory techniques – Reagents and procedures – Requirements for an ideal chemical dosimeter – Fricke dosimeter – FBX dosimeter – Free radical dosimeter – Ceric sulphate dosimeter – Other high and low level dosimeters – Applications of chemical dosimeters in Radiotherapy

Paper 10. Brachytherapy: Physical and Clinical Aspects

Unit 1. Brachytherapy: Definitions and Types- Intracavitary and Interstitial. Various implant techniques and treatment planning dosimetry as per AAPM -TG 43U1 and other dosimetry formalism. Brachytherapy Requirements and techniques Low dose rate (LDR), medium dose rate (MDR), high dose rate (HDR) and pulsed dose rate (PDR). Surface mould, intracavitary, interstitial, intraluminal and intraoperative techniques. –Requirement for brachytherapy sources- Dose rate considerations and ICRU 38 and 58 protocols. Specification and calibration of brachytherapy sources - RAKR and AKS – IAEA TECDOC 1274 and ICRU 72 recommendations.

Unit 2. Brachytherapy Equipment: Radium needle, tubes, Preloaded and after loading Manual Cs needle/tubes LDR. Remote after loading LDR machine – Construction and working principles. Micro-Selectron HDR –Construction and working principles, Micro Selectron PDR – Construction and working principles. Temporary Implant sources – eye applicator, Permanent Implant sources, Endovascular Brachytherapy in cardiology.

Unit 3. Brachytherapy Remote after Loading Techniques: After loading techniques – Advantages and disadvantages of manual and remote after loading techniques. AAPM and IEC requirements for remote after loading brachytherapy. Equipment, acceptance, commissioning and quality assurance of remote after loading brachytherapy equipment. ISO requirements and QA and Standardization of Brachytherapy sources – Apparent activity – Reference Air Kerma Rate – Air Kerma Strength – Standards for HDR 192Ir and 60 CO sources – Standardization of 125I and beta sources – IAEA TECDOC 1274 – room scatter correction. Calibration of protection level instruments and monitors- Integrated brachytherapy unit. Manual pre loading systems: Manual after loading systems - remote after loading systems -source trains (fixed and programmable) - stepping source - different types of applicators (gynecological, esophageal, nasopharyngeal, bronchial) and templates.

Unit 4. Advances in Brachytherapy: Brachytherapy treatment for prostate cancer. Ocular brachytherapy using photon and beta sources. Intravascular brachytherapy – classification – sources – dosimetry procedures - AAPM TG 60 protocol. Electronic brachytherapy (Axxent, Mammosite).

Unit 5. Commissioning of Brachytherapy Computer Treatments Planning Systems: Scope of computers in radiation treatment planning – Review of algorithms used for treatment planning computations – pencil beam, double pencil beam, Clarkson method, convolution superposition, lung interface algorithm, fast Fourier transform, Inverse planning algorithm, Monte Carlo based algorithms. Treatment planning calculations for photon beam, electron beam, and brachytherapy – Factors to be incorporated in computational algorithms. Plan optimization – direct aperture optimization – beam let optimization – simulated annealing – dose volume histograms – Indices used for plan comparisons – Hardware and software requirements – beam & source library generation- Networking, DICOM and PACS.

Books:

1. Faiz M. Khan. The Physics of Radiation Therapy, 4th edition.
2. H.E. Johns and Cunningham, The Physics of Radiology.
3. Faiz M.Khan, Roger A. Potish, treatment planning in Radiation Oncology.
4. Walter and Miller's Textbook of Radiotherapy by C.K. Bomford, I.H.Kunkler.

Paper 11. Physics of Nuclear Medicine

Unit 1. Introduction to Nuclear Medicine: Unsealed Sources, Production of Radionuclide used in Nuclear Medicine, Reactor based Radionuclides; Accelerator based Radionuclides, Photonuclear activation, equations for Radionuclide production, Radionuclide Generators and their operation principles. Various usages of Radiopharmaceuticals. Radioisotopes in medical diagnosis; scintillation counters, properties of radioisotopes; units of dosage, specific activity; effective half-life; diagnostic use of radioisotope in vivo and in vitro procedures. Rectilinear Scanners and Gamma Cameras: Single head scanners, design criteria, resolution, sensitivity measurements, linearity, Multiple Window spatial resolution, Uniformity, Energy resolution, choice of collimators, Dual head scanners; Gamma cameras: Anger type camera, Single and Dual Head Camera, resolution sensitivity measurements, collimators, comparison between Gamma cameras and scanners, quality control in instrumentation.

Unit 2. Dynamic Studies using Radioisotopes: Saturation; analysis; dynamic methods, activation analysis, models of body compartments, deconvolution techniques, the occupancy principle etc. Use of I-131 for diagnosis of hypo and hyperthyroidism, blood volume studies using RIHSA and Cr-51; Red cell survival studies using Cr-51; studies of iron metabolism, diagnostic test using Vitamin B-12 labeled with radio cobalt; circulation studies with Na-24, cardio vascular studies, tumor localization. Preparation of tracers and labeled compounds, Preparation of radio colloids; Bone scanning, principle, agents for bone scanning, Mo99, Tc99m, 18F, indications for bone scanning, various agents for one scanning, interpretation, pitfalls in bone scanning, limitations, radiopharmaceuticals used for brain scanning, technique with technetium pertechnetate, the normal clinical applications, radiopharmaceuticals in liver scanning comparison, technique with 99mTc, Sulphur scans, pitfalls, clinical applications; Ga in Clinical Studies: Energy spectrum of 67Ga optimization of parameters for 67Ga scanning, Clinical applications.

Unit 3. Components of radionuclide imaging: – computer interface – gating system –Principles of radiation detection – detectors – Scintillation Cameras –Scanners –Nuclear Reactors –

Cyclotron – Radionuclide Generators – Isotope Calibrators – Well Counters – liquid scintillation counters – Whole body counters – Quality control of Nuclear Medicine Equipment’s Collimation of detectors – Newer Computer applications in Nuclear Medicine – DICOM Technology – Medical Data Communications and Computer Networks. Techniques of all kinds of radionuclide scan procedures including in-vitro procedures Radionuclide Imaging: Other techniques and Instruments; The Rectilinear Scanner and its operational principles, Basic Principles and Design of the Anger Camera / Scintillation Camera; System components, Detector System and Electronics, Different types of Collimators, Design and performance Characteristic of the Converging, Diverging and Pin hole collimator, Image Display and Recording Systems, Digital Image processing Systems, Scanning Camera, Limitation of the Detector System and Electronics.

Unit 4. Biological Basis of Radiotherapy: Physical and biological factors affecting cell survival, tumor regrowth and normal tissue response – Non-conventional fractionation scheme and their effect of reoxygenation, repair, redistribution in the cell cycle – High LET radiation therapy. Time dose fractionation – Basis for dose fractionation in beam therapy – Concepts for Nominal Standard Dose (NSD), Roentgen equivalent therapy (RET) – Time dose fractionation (TDF) factors and cumulative radiation effects (CRE) – Gap correction, Linear and Linear Quadratic models, TCP and NTCP evaluation- problem of hypoxic compartment and quiescent cells- radiobiology of malignant neoplasm- solution of hypoxic cell sensitizers, hyperthermia, combination of chemotherapy and radiotherapy- Chrono-radiobiology and its applications to get better cure- problem of tumor regression.

Unit 5. Internal Radiation Dosimetry: Difference Compartmental Model; Single Compartmental Model, Two Compartmental Models with Back Transference, Two Compartmental Models without Back Transference. Classical Methods of Dose Evaluation; Beta particle Dosimetry; Equilibrium Dose Rate Equation, Beta Dose calculation, Specific Gamma Ray constant, Gamma Ray Dosimetry, Geometrical Factor calculation, Dosimetry of Low Energy Electromagnetic Radiation. MIRD Technique for Dose calculations; Basic procedure and some practical problems, Cumulative Activity, Equilibrium Dose Constant, Absorbed Fraction, Specific Absorbed Fraction, Dose Reciprocity Theorem, Mean Dose per unit cumulative Activity and Problems related to the Dose Calculations. Limitation of MIRD technique.

Books:

1. Joseph Magill and Jean Galy, Radioactivity Radionuclides Radiation, European commission Joint research Centre, Institute for Transuranium Elements. Karlsruhe, Germany.
2. IAEA TRS 374, Calibration of dosimeters used in Radiation Therapy.
3. F.H. Attix. Introduction to Radiological Physics and Radiation dosimetry, Wiley-VCH, Verilog, 2004.

Paper 12. Radiation Protection, Safety and Standards

Unit 1. Radiation Protection Standards - Radiation dose to individuals from natural radioactivity in the environment and man-made sources. Basic concepts of radiation protection standards – Historical background – International Commission on Radiological Protection and its recommendations. The system of Radiological Protection – Justification of Practice, Optimization of protection and individual dose limits – Radiation and tissue weighting factors, equivalent dose, effective dose, committed equivalent dose, committed effective dose – concepts of collective dose – Potential exposures, dose and dose constraints – system of protection for intervention – categories of exposures – occupational, public and medical exposures – permissible levels for neutron flux – factors governing internal exposure – Radionuclide concentrations in air and water – ALI, DAC and contamination levels.

Unit 2. Principles of Radiation Monitoring: Evaluation of external radiation hazards – Effects of distance, time and shielding – shielding calculations – Personnel and area monitoring – Internal radiation hazards – Radio toxicity of different radionuclides and the classification of laboratories – control of contamination – Bioassay and air monitoring – Chemical protection – Radiation accidents – disaster monitoring. Radiation dose to individuals from natural radioactivity in the environment and man-made sources. Basic concepts of radiation protection standards – Historical background – International Commission on Radiological protection and its recommendations – The system of Radiological protection – Justification of practice, Optimization of protection and individual dose limits– potential exposures, dose and constraints – System of protection for intervention – Categories of exposures – Occupational, Public and Medical Exposures – risk factor- permissible levels for neutron flux –Factors governing internal exposure – Radionuclide concentrations in air and water – ALI, DAC and contamination levels- international/national radiation protection standards-ICRP, BSS and AERB, overview of UNSCEAR recommendations.

Unit 3. Safety in the Medical uses of Radiation - Planning of medical radiation installations – General considerations – Design of diagnostic, deep therapy, telegamma and accelerator installations, brachytherapy facilities and medical radioisotope laboratories. Evaluation of radiation hazards in medical diagnostic, therapeutic installations – Radiation monitoring procedures – Protective measures to reduce radiation exposure to staff and patients – Radiation hazards in brachytherapy departments and teletherapy departments and radioisotope laboratories – Particle accelerators Protective equipment – Handling of patients – Waste disposal facilities – Radiation safety during source transfer operations Special safety features in accelerators, reactors.

Unit 4. Management of Radioactive Disposal and Transport of Radioisotopes: Radioactive Waste – sources of radioactive waste – Classification of waste – Treatment techniques for solid, liquid and gaseous effluents – Concept of Delay Tank and Various Waste Disposal Methods used in Nuclear Medicine. Permissible limits for disposal of waste – sampling techniques for air, water and solids – Geological, hydrological and meteorological parameters – Ecological considerations. Disposal of radioactive wastes – General methods of disposal. Transportation of radioactive substances – Historical background – General packing requirements – Transports documents – Labeling and marking of packages – Regulations applicable for different modes of transport – Transports by post –Transport emergencies.

Unit 5. Legislation and Radiation Emergencies and their Medical Management: Physical protection of sources – Safety and security of sources during storage, use, transport and disposal – Security provisions: administrative and technical – Security threat and graded approach in security provisions. National legislation – Regulatory framework – Atomic Energy Act – Atomic Energy (Radiation Protection) Rules – Applicable safety codes, standards, Guides and Manuals – Regulatory Control – Licensing, inspection and Enforcement – Responsibilities of Employers, Licensees, Radiological Safety Officers and Radiation workers – National Inventories of radiation sources – Import, Export procedures. Radiation accidents and emergencies in the use of radiation sources and equipment industry and medicine - Radiographic cameras and teletherapy units – Loading and unloading of sources – Loss of Radiation sources and their tracing – Typical accidents cases, Radiation injuries, their treatment and medical management – Case histories.

Books for Reference:

1. International basic safety standards for protection against ionizing radiation and for the safety of radiation sources. Safety series 115. International Atomic Agency, Vienna.
2. Radiation Protection Manual – DRDO.

ELECTIVE 3. Recent Advances in Radiotherapy

Unit 1: Conformal and Intensity modulated radiotherapy - Introduction to CRT with MLC- Modern developments in MLC – Different categories of MLC – Leaf position detection – commercially available MLC systems– MLC acceptance, commissioning and safety assessment – clinical application- Quality assurance. Introduction to IMRT – physical optimization – Biological models for evaluation and optimization of IMRT – Target and critical structure definitions for IMRT – Static MLC IMRT, Dynamic MLC IMRT and compensator based IMRT –potential problems with IMRT – Commissioning and QA for IMRT treatment planning –patient specific quality assurance– IMRT delivery system quality assurance.

Unit 2: Stereotactic radio surgery/radiotherapy (SRS/SRT) - Stereotactic radiosurgery/ radiotherapy (SRS/SRT) – cone and mMLC based X-Knife – Gamma Knife – immobilization devices for SRS/SRT – dosimetry and planning procedures – Evaluation of SRS/SRT treatment plans – QA protocols and procedure for X- and Gamma Knife units – Patient specific QA. Physical, planning clinical aspects and quality assurance of stereotactic body radiotherapy (SBRT) and Cyber Knife based therapy.

Unit 3: Image Guided Radiation Therapy (IGRT) - Concept, imaging modality, kVCBCT and MVCBCT. Mechanics of breathing – Methods to manage respiratory motion in radiation treatment – x-ray imaging techniques for guidance in the Radiation therapy setting – clinical procedures in employing x-ray imaging technologies. – Effect of motion on the total dose distribution – 4D computed tomography imaging and treatment planning. Delivery - QA protocol and procedures.

Unit 4: Volumetric modulated arc therapy - Introduction- Machine Commissioning and Quality Assurance- Dosimetry Aspects- Treatment Planning- Comparison of VMAT treatment plans with conventional IMRT planning- Patient Specific Quality Assurance- Electronic Portal Imaging device– its clinical applications including QA tool in machine and patient specific quality assurance and gamma index analysis.

Unit 5: Special techniques in radiation therapy - Total Body Irradiation, hemi body irradiation, Total Skin Electron Therapy, electron arc treatment, intraoperative radiotherapy- principle, equipment, treatment planning, dosimetry, quality assurance and commissioning. Neutron capture therapy- Heavy ion therapy (proton and carbon ion) - dosimetry (AAPM Report No 16), treatment planning, quality assurance and commissioning.

SEMESTER IV

Summer Project and Thesis, Viva Voce

Question Paper Pattern

Time: 3 Hours		Maximum Marks: 75	
PART A: (3 X 15 = 45 Marks) Answer any THREE questions All questions carry equal marks		Long Answer 1. Unit I 2. Unit II 3. Unit III 4. Unit IV 5. Unit V	
PART B: (5 X 4 = 20 marks) Answer ALL questions choosing either a or b All questions carry equal mark		Short answers 6. a or b Unit I 7. a or b Unit II 8. a or b Unit III 9. a or b Unit IV 10. a or b Unit V	
PART C: (5 X 2 = 10 marks) Answer ALL questions All questions carry equal marks		Brief note 11. Unit I 12. Unit II 13. Unit III 14. Unit IV 15. Unit V	

PRACTICALS MEDICAL PHYSICS LAB

Suggested New Practical's:

- (1) Attenuation of Gamma rays through various materials and evaluation of HVL
- (2) Study of Voltage-Current Characteristics of a Ion Chamber
- (3) Measurement and Verification of PDD, TAR and TMR values
- (4) Determination of output of a telecobalt unit - Using TRS 398
- (5) Wedge and Tray factor determination
- (6) Manual monitor unit calculations of simple and complex treatment plans
- (7) Quality Assurance of a Telecobalt unit
- (8) Quality Assurance of a Treatment Planning System
- (9) Quality Assurance of a Linear Accelerator
- (10) Autoradiography test for Brachytherapy source in Remote Afterloader unit
- (11) Quality Assurance of a Radiography or CT.
- (12) Cross Calibration of Ion Chambers
- (13) Absolute Calibration of Photon and Electron beams using TRS 398 3
- (14) Evaluation of profile parameters using radiation field analyzer
- (15) Manual Treatment Planning of Single and Parallel Opposed fields
- (16) Quality Assurance of Multileaf Collimator.
- (17) Quality Assurance of a Brachytherapy unit
- (18) Calibration of Film Scanner
- (19) Pretreatment IMRT Quality Assurance
- (20) Radiation Protection survey of Teletherapy and Brachytherapy installations

Demonstrations: (1) Nuclear Medicine uptake studies (2) Gamma Camera demonstration (3) Demonstration of Linear Detector Array (4) Treatment Planning for External Beam with TPS (5) Treatment Planning for Brachytherapy with TPS (6) Demonstration of In-air Scanner.

M.Sc. MOLECULAR BIOLOGY

Course Overview

This course will be a broad overview of current research and methods in the field of Molecular Biology. The course will start with a basic overview of organization of the body and functional organization of cell from molecular mechanism perspective.

This course deals with the knowledge sharing, instruments and practical aspects, which might be very useful to carryout, various studies in biotechnology including molecular biology, microbiology, and fermentation process, Proteomics etc.

This course deals how the biotechnology is useful in day-to-day life especially for the production of vary important components that can be obtained both from plant and animal sources and its importance in industries. It will expose the students in current knowledge about the role of bioprocess technology in day to day life process as well in the production of most useful secondary metabolites both from plant and animal sources in large quantities. This course would help the students to get placement in Biotech industry, Pharmaceutical Industries and in further research during the invention of the newer bio-molecules, more specifically Biosimilar products or Biologics which will help the man kind to greater extend.

This course has been designed to provide the knowledge to the students in invaluable areas of biotechnology, which plays a crucial role in determining its future use and applications in medicine. Students will get an idea about the usage of biotechnological application and their uses in different challenging disease. This also will provide to study the genomic arrangement, its manipulation to useful products and to correct the accidental manipulation to prevent the occurrence and the treatment of disease related to genetic. Students will get an idea about how the nature has given the protection to the body against various infectious agents and to overcome the same either from external source or from internal source itself.

This course is to study about the defense activity that is present in the body against the entry of foreign substances which in turn produce disease in the humans and how this activity can be enhanced in those who are not having sufficient protection / defense power by using different biotechnologically produced products.

An emphasis is also laid on the nano science technology relevant to drug mechanism of action and its relation to molecular bioscience. The course work also focuses on the Biochemical mechanism components of living body, cell-signal modeling etc. The students are required to submit a dissertation thesis in the last semester on any of the topics related to molecular biology area. The aim is to provide students experience in research design, data analysis and interpretation.

Eligibility:

A graduate in Science (B.Sc.) from an UGC recognized University with biology as a major subject.

Career Opportunities:

1. Biotechnology industry
2. Pharmaceutical industry
3. Contract Research Organization
4. Higher Education leading to PhD and Post-doctoral research in the area of Molecular Biotechnology, Genetic Engineering, Tissue culture engineering, DNA technology etc.

M. Sc. MOLECULAR BIOLOGY

	Semester I	Credits
Paper 1	Fundamentals of Molecular Biology	4
Paper 2	Fundamentals of Nanotechnology	4
Paper 3	Fundamentals of Biochemistry and Biomolecules	4
Paper 4	Biochemical Techniques	4
Elective 1	Statistical Methods for Biology	4
Practical 1	Biochemical Techniques (Practical 1)	6
		26
	Semester II	
Paper 5	Cell and Tissue Culture Technology	4
Paper 6	Genetics	4
Paper 7	Nano biology and Nano systems	4
Paper 8	Immunology	4
Elective 2	Cancer Biology	4
Practical 2	Instrumentations in Molecular Biology (Practical 2)	6
		26
	Semester III	
Paper 9	Molecular Cell Signaling	4
Paper 10	Genetic Engineering	4
Paper 11	Applied Microbiology	4
Paper 12	Vaccine Development	4
Elective 3	Proteomics	4
Practical 3	Molecular Biology Techniques (Practical 3)	6
		26
	Semester IV	
	Summer Project	2
	Thesis and viva voce examination	12
		14
	Total Credits	92

SEMESTER I

PAPER 1: FUNDAMENTALS OF MOLECULAR BIOLOGY

4 CREDITS

Unit I:

Bio-molecules and Cells- Introduction, The Molecules of Life, Genomes, Cell Architecture, and Cell Function, Cells into Tissues: Unicellular and Metazoan Organisms Used for Molecular Cell Biology Investigations.

Unit II:

DNA as Chemical and Genetic Material- Covalent Bonds and Non-covalent Interactions, Chemical Building Blocks of Cells, Chemical Reactions and Chemical Equilibrium, instances of Binding Reactions Reflect the Affinity of Interacting Molecules.

Unit III:

RNA Synthesis and Properties- Structure of Nucleic Acids, Transcription of Protein-Coding Genes and Formation of Functional mRNA, The Decoding of mRNA by tRNAs.

Unit IV:

Protein Synthesis and Properties- Chemical Building Blocks of Cells

Basic Molecular Genetic Mechanisms: Introduction, Structure of Nucleic Acids, The Decoding of mRNA by tRNAs, Stepwise Synthesis of Proteins on Ribosomes. Overview of prokaryotic and eukaryotic gene regulations.

Unit V:

Bio-molecule Structure and Function: Protein Structure and Function, Introduction, Hierarchical Structure of Proteins, Protein Folding, Chemical Reactions and Chemical Equilibrium, Membrane Proteins: Structure and Basic Functions. **Protein Binding and Enzyme Catalysis-** Purifying, Detecting, and Characterizing Proteins.

Reference:

1. Bray A. D., Lewis J., Raff M., Roberts K. and Watson J.D. Molecular Biology of the Cell. B. Garland Publishing, New York and London.
2. De Robertis E.D.P., De Robertis E.M.F. 2001. Cell and Molecular biology. Lippincott Williams & Wilkins. Bombay.
3. Freifelder D. 1990. Molecular biology. Narosa Publishing House, New Delhi

4. Gardner E J & D P Snustad 1996. Principles of genetics. John Willey, New York.
 5. Alberts, B., Bray, D., Lewis, J., Raff, M, Roberts, K, and Watson, J. D. 5th Edition. 2007 Molecular biology of cell. Garland Publishing Inc., New York.
 6. Lodish, H., Berk A., Zipursky, S.L. Matsudaria, P. Baltimore, D. and Darnell, J. 2003. Molecular Cell Biology, Media connected, W.H. Freeman and Company.
 7. Celis J E (Ed). Cell biology. 1998. A laboratory handbook. Academic Press.
 8. Darnell J, Lodish H, Baltimore D 1990 Molecular Cell Biology. 2nd ed. New York, Scientific American Books.
 9. Cooper G M. The Cell: A Molecular Approach 2000 Sinauer Associates, Inc. Sunderland, Massachusetts.
-

PAPER 2: FUNDAMENTALS OF NANOTECHNOLOGY

4 CREDITS

Unit I:

Fundamentals and overview of Nanoscience and Technology, History of Nanoscience, properties at nanoscale – theory and definition, electronics, optical and magnetic properties at the nanoscale.

Unit II:

Types of nanomaterials, inorganic - metal and metal oxides, organic – self assembly structures, liposomes, micelles, nanoemulsions and polymeric nanoparticles, carbon based systems –carbon nanotubes (CNTs), bucky balls and graphene.

Unit III:

Synthesis of nanomaterials. Top-down method – lithography, ball milling and etching, Bottom-up method – colloidal method of synthesis, wet-chemistry synthesis and self-assembly.

Unit IV:

Materials used in the synthesis of nanoparticles, organic-based synthetic polymers, phospholipids, surfactants, inorganic salts, natural biopolymers.

Unit V:

Characterization of nanomaterials, electronic microscopy techniques, SEM and TEM, optical spectroscopy techniques, UV-vis absorption and fluorescence spectroscopy, dynamic light scattering, Scanning Probe Microscopy, Atomic force microscopy and scanning tunneling microscopy.

Reference:

1. *Nanoscale Science and Technology*, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005, ISSN: 978-0-470-85086-2.
 2. *Introduction to Nanotechnology*, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, New Jersey, 2003, ISSN: 978-0-471-07935-9.
 3. *Bio-Inspired Nanomaterials and Nanotechnology*, Edited by Yong Zhou, Nova Science, 2005, ISSN: 978-1608761050.
 4. *Nano:The Essentials: Understanding Nanoscience and Nanotechnology*, T. Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008, ISSN: 978-0071548298.
 5. *Nanocrystals: Synthesis, Properties and Applications*, C. N. R. Rao, P. J. Thomas and G. U. Kulkarni, Springer, New York, 2007, ISSN: 978-3-54068751-1.
 6. *Nanochemistry: A Chemical Approach to Nanomaterials*, Geoffrey A. Ozin, Royal Society of Chemistry, Cambridge, UK, 2005, ISSN: 978-1847558954.
-

PAPER 3: FUNDAMENTALS OF BIOCHEMISTRY AND BIOMOLECULES

4 CREDITS

Unit I:

Carbohydrates- Structure and classification of carbohydrates. **Chemistry of monosaccharides-** Pentoses, hexoses, deoxyglucose, amino sugars, muramic acid, neuraminic acid. Linkages in sucrose, lactose and maltose, trehalose and glycosides. **Isolation of polysaccharides-** Homopolysaccharides and heteropolysaccharides, starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell wall polysaccharides, blood group polysaccharides, pectin and pectic polysaccharides. **Structural elucidation of carbohydrates-** graded acid hydrolysis, periodate oxidation, methylation, acetylation, GC-MS, IR and NMR. **Glycobiology-** Glycoproteins; N- and O-glycosylation, lectins, carbohydrates in tissue engineering. Proteoglycans; aggrecan, syndecan, and decorin.

Unit II:

Aminoacids- Nomenclature, classification and buffering properties of amino acids, zwitterionic structure, reaction of amino acids, unusual amino acids, non protein amino acids. **Peptide bond-** Features of the peptide bond, naturally occurring peptides; glutathione, enkephalins and endorphins. Chemical synthesis of peptides; Khorana's solution phase synthesis, Merrifield's solid phase synthesis. **Determination of amino acid compositions-** Acid and base catalyzed hydrolysis, separation, quantification, determination of N and C terminal residues, determination of site of glycosylation and type of linkage (o-glycosyl and n-glycosyl). **Elucidation of structure of proteins-** Isolation of proteins; overview of purification and criteria of purity.

Determination of primary structure- Sequencing strategies; N-terminal and C-terminal, sequencing methods. Automated sequencers. Determination of disulfide bond position. Secondary structure of protein; α , β sheet, β -bend, β -turn and super secondary structures. Secondary structure prediction methods; Ramachandran plot, Chou and Fasman algorithm. Tertiary and quaternary structures. **Factors responsible for protein folding and confirmation-** Anfinsen's experiment. Weak forces of interaction; hydrogen bonding, Vander Waal's forces, London force, ionic interactions, hydrophobic interactions, S-S bridges, peptide bond, glycosidic bond, phosphodiester bond, and allolysine. Denaturation and renaturation of proteins, molten globule. 3D Structure of myoglobin, hemoglobin, immunoglobulin, collagen, chymotrypsin and keratin. Chaperons and Levinthal paradox.

Unit III:

Lipids- Classification of lipids; oils, fats, and waxes. Occurrence and physico-chemical properties of fatty acids, esters of fatty acids, cholesterol, phospholipids, glycolipids, sphingolipids, cerebrosides and gangliosides.

Lipid mediators- Eicosanoids, prostaglandins, leukotrienes, prostacyclins, thromboxanes, DAG and ceramide.

Unit IV:

Nucleic Acids- Nitrogenous bases, nucleosides, nucleotides, physicochemical properties. Isolation of DNA and RNA from biological sources (microbes, plants and animals). Purification of nucleic acids, physicochemical properties of nucleic acids, melting of DNA, T_m ; factors affecting T_m , Cot curve, classification of DNA based on cot curve. Chemical reactions of DNA and RNA; Nucleotides as regulatory molecules, enzyme cofactors and mediators of chemical energy in cells. **Sequencing of DNA-** Maxam Gilbert method, dideoxy method. Chargaff's rule, secondary structure of DNA. Watson and Crick model; B and Z DNA, other models of DNA structure. Types of RNA, secondary structure of tRNA and cloverleaf model; Other secondary structural features in DNA, stem loop structure, palindromic sequences, cruciforms. DNA protein interaction; zinc finger leucine zipper, helix-turn-helix, other motifs, DNA bending and kinks.

Unit V:

Porphyrins- Structure and properties of porphyrins – Heme, chlorophyll and cytochromes. Reactive oxygen species and detoxification mechanisms.

Vitamins- Water soluble and insoluble vitamins, structure and function, deficiency symptoms.

Reference:

- 1) Lehninger PRINCIPLES OF BIOCHEMISTRY - 5th Edition David L Nelson and Michael M. Cox
- 2) BIOCHEMISTRY – 5th Edition Jeremy M. Berg; John L. Tymoczko and Lubert Stryer
- 3) BIOCHEMISTRY – 4th Edition Donald Voet and Judith G. Voet
- 4) OUTLINES OF BIOCHEMISTRY – 5th Edition Erice Conn and Paul Stumpf
- 5) TEXT BOOK OF BIOCHEMISTRY – 4th Edition Edward Staunton West; Wilbert R. Todd; Howard S. Mason and John T. Van Bruggen

PAPER 4: BIOCHEMICAL TECHNIQUES

4 CREDITS

Unit I:

Separation techniques- Principles, methods and applications of chromatography – Paper, thin layer, ion exchange, gel filtration and affinity chromatography, GLC, HPLC, UPLC and chromatofocussing. **Spectroscopic techniques-** Principles of colorimeter, spectrophotometer, fluorimeter. Beer-Lambert's Law and its limitations. Extinction coefficient, fluorescent probes and their applications

Unit II:

Cell fractionation techniques- Cell lysis, preparation of lysis buffers, pH, ionic strength, ionic and non-ionic detergents, composition of general lysis buffers such as RIPA, homogenization, extraction, salting in, salting out, dialysis and ultra filtration. **Centrifugation-** Svedberg's constant, sedimentation velocity and sedimentation equilibrium. **Ultra centrifugation-** Differential and density gradient centrifugation, centrifugal elutriation, construction of preparative and analytical ultracentrifuge, Schlieren optics.

Unit III:

Electrophoretic techniques- Polyacrylamide gel electrophoresis, SDS-PAGE, 2D-electrophoresis, agarose gel electrophoresis, isoelectric focusing, pulsed field electrophoresis, high voltage electrophoresis, capillary electrophoresis, isotachopheresis. Separation of proteins, lipoproteins and nucleic acids. Visualizing separated components; staining, fluorescence, PAS staining, zymogram and reverse zymogram.

Unit IV:

Isotopic tracers- Heavy isotopes and radio-isotopes, theory and construction of mass spectrometer. Ionization, fragmentation, m/e, time of flight, MALDI and ESI. **Radioisotopes in Biology-** ^3H , ^{14}C , ^{32}P , ^{131}I , ^{35}S , concept of half-life, decay constant, detection and quantitation - GM counter and solid and liquid scintillation counter. Specific activity, autoradiography and their applications. **Labeling-** Using plant system (monosaccharides and polysaccharides), animal system, chemical (Glucose- ^{14}C) and enzymatic methods (disaccharides). Labeling of acetate ($1\text{-}^{14}\text{C}$ and $2\text{-}^{14}\text{C}$), ATP ($\alpha\text{-}^{32}\text{P}$ and $\gamma\text{-}^{32}\text{P}$), proteins and nucleic acids. **Applications of radioactivity-** Dilution techniques, pulse chase method, carbon dating, substrate product relationship (cholesterol biosynthesis) and bond cleavage specificity.

Unit V:

Animal models, choice of animals, types of studies, xenografts, allografts, mutant organisms (auxotroph), cultured animal and plant cells as representative models.

Reference:

- 1) PRINCIPLES AND TECHNIQUEST OF BIOCHEMISTRY AND MOLECULAR BIOLOGY – 7th Edition Keith Wilson and John Walker
 - 2) BIOCHEMICAL TECHNIQUES THEORY AND PRACTICE
John F. Robyt and Bernard J. White
 - 3) BIOCHEMICAL METHODS – A CONCISE GUIDE FOR STUDENTS AND RESEARCHERS Pingoud; C. Urbanke; J. Hoggett and A. Jeltsch
 - 4) BASIC METHODS FOR THE BIOCHEMICAL LAB
Holtzhauer Martin
-

ELECTIVE 1: STATISTICAL METHODS FOR BIOLOGY

4 CREDITS

Unit 1:

Numerical Methods to Represent Variation-Importance and Scope of Statistics, Data Types, frequency distribution, Graphical Representation Methods (Histogram, Bar Charts, Pie Charts), Measures of Center Tendency (Mean, Median, Mode,) and Dispersion (Standard Deviation, Variance) Advantages and Disadvantages, Co-Efficient of Variance.

Unit 2:

Probability- Basic Terminology, Definition of Probability, Basic Laws of Probability, Types of Probability, Additional Rule of Probability and Multiplication Rule of Probability, Probability Distribution-Bernoulli Distribution, Binomial Distribution, Poisson distribution and Normal Distribution-Simple Problems.

Unit 3:

Sampling Methods- Collection of Data, Census Method, Concept of Population, Sample, Sampling, Sample Size, Sampling Error, Advantages and Disadvantages of Sampling Method, Necessity of Sampling, Types of Sampling Methods, Types of Random Sampling Methods – SRS, Stratified Random Sampling, Systematic Random Sampling And Cluster Sampling.

Unit 4:

Testing of Hypotheses- Statistical Hypotheses-Null and Alternative, Level of Significance, Type I and Type II Error, Critical Region, Power of the Test, P Value, Degrees Of Freedom, Chi-Square Test for Independence of Attributes and Goodness of Fit, Student's t Test: One Sample t Test and Paired t Test, F Test.

Unit 5:

Regression and Analysis Of Variance- Simple Linear Regression, Multiple Linear Regression (Definition, Assumptions, Applications, and Examples), Analysis of Variance –Introduction Definition of ANOVA, Assumption , Test Of ANOVA, Types Of ANOVA, Construction of One Way Analysis of Variance.

References:

1. Fundamentals of Biostatistics: Veer Bala Rastogi
 2. Fundamentals of Mathematical Statistics: S.C. Gupta and V. K. Kapoor
 3. Fundamentals of Statistics: S.C. Gupta
 4. Biostatistics, Snedger and Gohrran.
 5. Introductory Statistics for Biology 2nd Edition, R. E. Parker
-

PRACTICAL 1: BIOCHEMICAL TECHNIQUES**6 CREDITS**

1. Paper chromatography – ascending and descending – separation of amino acids and sugars.
2. Qualitative tests for the identification of amino acids and carbohydrates.
3. Thin – layer chromatography of amino acids and lipids.
4. Column (GPC) chromatographic separation of proteins (albumin and trypsin).
5. Polyacrylamide Gel Electrophoresis and agarose gel electrophoresis of serum proteins.
6. Ion exchange chromatography of amino acids.
7. Absorption spectrum of chlorophyll extracted from green leaves.

8. Absorption spectrum of aromatic amino acids, purines and pyrimidines. Determination of Molar absorption coefficient of tyrosine.
9. Optical rotation of sugars using polarimeter.
10. Molecular weight determination of proteins by SDS-PAGE
11. Western blotting
12. Quantitative estimation of proteins by spectrophotometric method.

Reference:

- 1) PRINCIPLES AND TECHNIQUES OF BIOCHEMISTRY AND MOLECULAR BIOLOGY – 7th Edition Keith Wilson and John Walker
- 2) BIOCHEMICAL TECHNIQUES THEORY AND PRACTICE. John F. Robyt and Bernard J. White
- 3) BIOCHEMICAL METHODS – A CONCISE GUIDE FOR STUDENTS AND RESEARCHERS. A. Pingoud; C. Urbanke; J. Hoggett and A. Jeltsch
- 4) BASIC METHODS FOR THE BIOCHEMICAL LAB Holtzhauser Martin.

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SEMESTER II

PAPER 5: CELL AND TISSUE CULTURE TECHNOLOGY

4 CREDITS

Unit I:

Tissue culture media- (composition and preparations), genetic methods and application of superior culture, protoplast, anther, pollen, ovary and embryo culture; organogenesis, somatic embryogenesis: hardening and green house technology, synthetic seeds, germ plasm conservation, somoclonal variations, protoplast fusion and somatic hybridization.

Unit II:

Gene transfer in plants- gene transfer through vectors- biology of vectors used Ti and Ri plasmids, binary vectors, viral vectors cloning strategy and method of gene transfer, vector less gene transfer- electrophoresis and gene gun method.

Unit III:

Transgenic animal- methods used in gene identification, localization and sequencing of genes.

Unit IV:

Types of cell culture- primary and established culture, organ culture, tissue culture, three dimensional culture and tissue engineering, feeder layers, disaggregation of tissue and primary cell culture, Cell separation, cell synchronization, cryopreservation, Culture media, cell culture in continuous, hollow fiber reactor, mass transfer in mammalian cell culture.

Unit V:

Isolation of cells from various sources- maintenance of the cell- conclusion of stem cell research. Introduction to Bio artificial organs- Historical background- Liver, Kidney- skin, pancreas- Urinary Bladder- bone- challenging and advantages

Reference:

1. Plant cell and tissue c culture by Jeffrey W. Pollard and John M Walker.
2. Plant tissue culture by Dixon, Oxford Washington DC, 1985.
3. Plant tissue c culture by Street.
4. Medical Molecular Biology – P.C. Trivedi (2008).
5. Principles of cell and Tissue engineering- Robert Lanza (2005).
6. Microbial genetics- Friedfelder.
7. Animal tissue culture by Ian Freshney.

PAPER 6: GENETICS

4 CREDITS

Unit I:

Introduction to Genetics- Introduction, Scope and significance of genetics. Principle of Genetic Transmission: Mendel's' Experiments, Symbols and terminology, Principle of dominance and segregation, Principle of independent assortment, Mendelian inheritance and probability (Multiplication and Addition rules).

Unit II:

Extension of Mendelism- Allelic variation and gene function, Incomplete dominance, co (dominance, multiple allele, Gene action (from genotype to phenotype), Gene interaction, penetrance, expressivity, epistasis, pleiotropy, interaction with environment. **The chromosomal basis of Mendelism-** Chromosomes – chromosome number, Chromosome theory of inheritance, Experimental evidence, non disjunction as proof of chromosome theory, chromosomal basis of Mendel's principles of segregation and independent assortment, Sex linked genes in humans. **Genetic disorder-** Color blindness, Cystic fibrosis, Down syndrome, Duchenne muscular dystrophy, Hemophilia, Klinefelter syndrome, Sickle-cell disease, Turner syndrome

Unit III:

Mutations- Spontaneous, Induced mutation, Conditional lethal mutations –Base substitution mutation, Missense, Nonsense and Silent mutations; Chemical, Physical and Biological mutagenesis and Detection of mutations.

Concept of gene- Fine structure of gene, Split gene, Jumping gene, Overlapping gene & multiple genes.

Unit IV:

Sex Determination- Sex chromosomes, Chromosomal basis of sex determination in *C.elegans*, *Drosophila*, Man and Plant Example: Lichnis (Melandrium). Molecular basis of sex determination in *C.elegans*, *Drosophila* and Man. **Dosage compensation-** Genic balance, Gene dose, Molecular basis of dosage compensation in *Drosophila* and man.

Unit V:

Molecular anatomy of eukaryotic chromosome – Centromere, Telomere, Nucleosome, Nucleomere, Kinetochore, Chromosome banding.

References:

1. Genetics – Principle and Analysis – Hart and Jones.
 2. Principles of Genetics – Snustad and Simmons.
 3. Genetics – A Continuity of Life– Daniel J. Fairbanks, W. Ralph Anderson.
 4. Atherly A G, Girton, J R and Mc Donald J F, 1999. The Science of Genetics, Saunders College Publishing, Harcourt Brace College Publishers.
 5. Brooker R.J. 1999. Genetics. Analysis and Principles. Ed. Benjamin Cummings. California, Gardner E J, Simmons M J, Snustad D P 1991. Principles of Genetics. John Wiley & Sons, Inc.
 6. Griffith A J F, Miller J H, Suzuki D T, Lewontin R C, Gelbert W M.1996. An introduction to Genetic Analysis. W.H. Freeman and Co. New York
 7. Strickberger, M. W. 1976. Genetics. Macmillan New York
 8. Watson, J. D., Baker T. A., Bell S. P., Gann A., Levine M., Losick R. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Delhi, India.
 9. Klug, W S, and Cummings M. R. 1998. Essentials of Genetics, 3rd Ed. Prentice Hall, Upper Saddle River, NJ.
 10. Hartl, D L & Jones E W 2006. Essential genetics: a genomics perspective (4th Ed), Jones and Bartlett Publishers, Boston.
 11. Tamarin R. H. 2002. Principles of Genetics. Tata-McGraw Hill, Seventh Edition.
 12. Lewin B., Gene IV, V, VI. Oxford University press, Oxford.
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PAPER 7: NANOBIOLOGY AND NANOSYSTEMS

4 CREDITS

Unit I:

Introduction to Nanobiology - Bio-inspired nanomaterials, interaction between biomolecules and nanoparticle surfaces, synthesis of hybrid Nano-bio assemblies.

Unit II:

Biological Membranes: Lipid membranes, structure and properties, Protein–lipid assembly, applications of biomimetic membranes, interaction of nanoparticles with membranes.

Unit III:

Protein and DNA based nanostructures: Protein based nanostructures building blocks and templates, nanobioelectronic devices and polymer nanocontainers, topographic and electrostatic properties of DNA and proteins, Nanoparticle-based carrier for genetic material. Nanofabrication via DNA origami. Protein therapeutics and protein based nanoparticles. Smart hydrogels and cell penetrating peptides.

Unit IV:

Stem cell nanotechnology: Basics, properties, classification and types of stem cells, three-dimensional scaffolds, stem cell differentiation and proliferation, nanochemistry, nanoshapes and nanomechanics. Nanotechnology for regenerative medicine.

Unit V:

Microbial Nanotechnology: Interaction of microbes with nanoparticles, surface properties, antimicrobial properties of metallic nanoparticles, mechanism of action.

Reference:

1. *Nanoscience : Nanobiotechnology and Nanobiology*, P. Boisseau, P. Houdy and M. Lahmani, Springer, New York, 2010, ISSN: 978-3-540-88632-7.
 2. *Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology*, Hari Singh Nalwa, American Scientific Publishers, USA, 2005, ISSN: 1588830349.
 3. *Nanobiotechnology*, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, 2004, ISSN: 3-527-30658-7.
 4. *Nanocomposite Science & Technology*, Ajayan, Schadler & Braun, Wiley VCH, 2006, ISSN: 3527605177.
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PAPER 8: IMMUNOLOGY

4 CREDITS

Unit I:

Introduction: Historical development and milestones in immunology – Contributions of Edward Jenner, Louis Pasteur, Emil von Behring & Kitasato, Metchnikoff, Primary and secondary lymphoid organs – Lymphatic system, Reticulo-endothelial system, Types of immunity, Innate & Acquired.

Unit II:

Non-specific defenses: Barriers to infection – skin, mucous membrane, inflammation, phagocytosis. Complement system: Classical, alternate and lectin binding pathway, Generation of membrane attack complex. Anaphylotoxins & Opsonins. Antigens: Chemical nature & properties, Epitopes, Antigenicity, Immunogenicity, Valency of antigens, Haptens. Antibodies: Structure, Classes and subclasses, Paratopes, Immunoglobulin variants – Isotypes, Allotypes & Idiotypes, Valency of antibody, antibody diversity.

Unit III:

Immune responses: Primary and secondary, class switching. Structure & functions-MHC antigens in man, Vaccines: Vaccines and their preparations (traditional and recombinant vaccines) BCG, Polio, DPT, HBV, Adjuvants.

Unit IV:

Cellular basis of immunity: Hematopoiesis, Biology of T-cells and B-Cells. T-cell subsets. T-cell and B-Cell receptors. Antigen presenting cells and accessory cells (macrophages & dendritic cells), T-cell and B-Cell co-operation, Antigen processing & presentation, Clonal selection, Cytokines – role in immunity. Transplantation: Tissue typing-Autograft, Isograft, Allograft & Xenograft. Graft versus host reactions (GVHD). Immunosuppression. Hypersensitivity: Types of Hypersensitivity reactions. Types I, II, III & IV Anaphylaxis.

Unit V:

Monoclonal antibodies – preparations & applications, Immunological techniques: Preparations, agglutinations, Complement fixation, Immunodiffusion, Immunoelectrophoresis, Immunofluorescence, RIA & ELISA, Western blotting. Disorders of immunity: Immunological tolerance, Autoimmunity. Immunodeficiency disorders, SCID, AIDS, Tumor immunology: Tumor associated antigens & Tumor specific antigens. Immune surveillance, TNF & α , β , immunotherapy.

References:

1. Roitt I M, Brostoff J and Male D K. Immunology.3rd edn. 1993. Mosby – Yearbook Europe Ltd., London.
 2. Roitt I M Delves P J. Essential Immunology 10th ed 2001 Blackwell Scientific Publications.
 3. Boyd W C Fundamentals of Immunology 1964 Toppan Co. Ltd., Tokyo.
 4. Kimball J W Introduction to Immunology. 1983. Macmillan Publishing Co., Inc.New. York.
 5. Otto S. View and others. Fundamentals of Immunology.
 6. Wier D M. Experimental Immunology 1978 Blackwell Scientific Publications Oxford.
 7. Kubay J. Immunology. 2001. Second Edition. W H Frecman & Company NewYork.
 8. Abbas A K Lichtman A H Cellular and molecular immunology 3rd edition 2007. Oxford University Press, Oxford.
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ELECTIVE 2: CANCER BIOLOGY

4 CREDITS

Unit I:

Cell organelles and molecular organization of cell- Structural and functional organization of eukaryotic cells -cytoskeleton, plasma membrane, ribosome, endoplasmic reticulum, golgi complex, lysosome, mitochondria, peroxisome, nucleus elements of cells, biomolecules - nucleic acids, carbohydrates, lipids, proteins (structural and functional proteins), assembly of macromolecules.

Unit II:

Cellular reproduction and differentiation- The cell cycle, interphase, M-phase - mitosis and cytokinesis, meiosis; methods to study cell cycle changes, cell differentiation – general characteristics, nucleocytoplasmic interactions, molecular mechanisms of cell differentiation.

Unit III:

Cancer- Definition, benign tumors vs. malignant tumors, types of cancer, common symptoms, hallmarks of cancer – growth signal autonomy, evasion of growth inhibitory signals, evasion of apoptosis, unlimited replicative potential, angiogenesis, invasion and metastasis, molecular basis of cancer - cancer genes - oncogenes and tumor suppressor genes, carcinogenesis – a multistep process, evidences for multistage models of carcinogenesis, animal models of cancer – carcinogen induced models, xenografts, genetically modified models.

Unit IV:

Genetic instability and epigenetics- Basic defense, barriers to genomic instability, genetic variations in cancer, mechanisms of genome destabilization in tumors, chromosome instability, whole chromosome aneuploidy and cancer, perspectives and implication for cancer therapeutics, genetic mutations and drug resistance mechanisms, epigenetic process, epigenomic changes in cancer (DNA methylation, histone acetylation), epigenetic biomarkers and therapies

Unit V:

Signal transduction system- Sensory machinery, ligands and receptors, regulation of protein kinases, small-molecular second messengers, efficiency and specificity, formation of multiprotein signaling complexes, signaling networks influencing cell proliferation, survival and metastasis.

Reference:

- 1) MOLECULAR BIOLOGY OF THE CELL – 5th Edition By Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter
 - 2) TEXT BOOK OF BIOCHEMISTRY FOR MEDICAL STUDENTS – 7th Edition D.M. Vasudevan, S. Sreekumari, Kannan Vaidyanathan
 - 3) GENES IX. By Benzamin Lewin.
-

PRACTICAL 2: INSTRUMENTATIONS IN MOLECULAR BIOLOGY**6 CREDITS**

1. PCR techniques
2. Electrophoresis
3. Southern blotting
4. RNA isolation, analysis, Reverse transcription
5. Electrophoretic separation on denaturing gel
6. Western blot
7. Down loading and studying genome maps and genome annotations.
8. Protein sequence from Uniprot database.
9. Analyzing the protein sequence in EMBOSS,
10. Analyzing the protein sequence Fasta, Blast, Clustal W. 10) Analysing the sequence against Prosite and Prodom database 11) Predicting secondary structure of protein sequence.
11. Down loading structure from Pdb database.
12. MDL ISIS DRAW Software.
13. Autodock

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SEMESTER III

PAPER 9: MOLECULAR CELL SIGNALING

4 CREDITS

Unit I:

Introduction to molecular cell signaling- Introduction, significance of cell signaling. Concept of cell signaling: Endocrine, paracrine, merocrine, juxtacrine and autocrine signaling. Hormone receptors - structure of Insulin receptor, cytokine receptor, EGF receptor, receptor up regulation, down regulation, desensitization.

Unit II:

Signaling in Bacteria- Quorum sensing in Bacteria, mechanism of chemokine signaling. Molecules and mechanisms. Signaling in yeast, Signaling in plant - Signaling by stress and light. Phytochrome system.

Unit III:

Signaling in animal systems- Signaling by hydrophilic molecules - Receptors, & 7 TM helical segments, Tyrosine kinase receptors, cytokine receptors, e.g. TNF alpha G proteins, G protein cycle, SH and PH motifs, PI3K, PLC, SMase, Second messengers-cAMP, discovery, function and regulation by Cholera toxin and Pertusis toxin. Lipid second messengers - DAG and ceramide.

Unit IV:

Signaling Pathway- MAPK pathway, stress pathway, cytokine pathway, Growth factor pathway, Transcription factors - NF KB-regulation. Other transcription factors.

Unit V:

Signalling by hydrophobic molecules- Steroid hormone signaling, cytoplasmic receptors, signaling cross talk, Glucocorticoid and estrogen receptors and their mechanism of action, antihormones (Eg. RU 486) Hormone replacement therapy.

References:

1. Cooper G. M. 1996. The Cell A Molecular Approach, Sinauer Associates, Inc.,
2. Waterman. Introduction to Computational Biology: Maps, Sequences and Genomes, CRC Press.
3. Molecular Biology of the Cell. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D.Watson. Garland Publishing, New York and London.
4. Watson, J. D., Hopkins N. H., Roberts J. W., Steitz J. A., Weiner A. M. 1987. Molecular Biology of the Gene. Benjamin/Cummings.

5. Lodish H. F. (Editor) Berk A., Matsudaira P., Kaiser C. A., Krieger M., Scott M. P., Zipursky S. L., Darnell J. Molecular Cell Biology. W. H. Freeman and Co., Publishers.
 6. Devline and Witham, 1986. Plant Physiology. CBS Publs. and Distributors, New Delhi.
 7. Hopkins, W.G. 1995. Introduction to Plant Physiology, John Wiley & Sons. Inc., New York, USA.
 8. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones. Springer Verlag, New York, USA.
 9. Singhal et al. 1999. Concepts in Photobiology, Photosynthesis and Phytomorphogenesis, Narosa Pub. House, New Delhi.
 10. Taiz and Zeiger, 1998. Plant Physiology. Sinauer Associates Inc., Publishers, Sunderland
-

PAPER 10: GENETIC ENGINEERING

4 CREDITS

Unit I:

Genetic Engineering - extraction and purification of nucleic acids (DNA and RNA) from biological sources. Gene cloning - genomic cloning, C-DNA cloning. Vectors - plasmids, phage, cosmids and phagemid, yeast cloning vectors, plant vectors, bacterial artificial chromosome (BAC), SV40, shuttle vectors, phagemids construction of expression vectors. Restriction endonucleases - blunt end and staggered cut. Isochizomers. Preparation of end labeled DNA, other labeling methods, fluorescent labeling. Recombinant DNA techniques, Gene cloning in E.coli, cloning in gram Positive Bacillus.

Unit II:

Techniques - Blotting techniques - dot blot, southern, northern, western blot, DNA footprint assay, DNA fingerprint assay, gel retardation assay, nuclease protection assay. RFLP, RAPD, PCR Ligation - blunt end ligation, use of linkers, colony hybridization, plaque hybridization. Gene transfer techniques, Transgenic plants and animals, gene knockout. PCR Concept, methodology, types and applications.

Unit III:

Gene construction methods- Reporter gene, Marker gene and their conformation. Heterologous expression, recombinant protein and expression. RNAi, Antisense constructs, Micro RNA and Their application in transgenic and functional genomics.

Unit IV:

Biosafety: Laboratory methodologies, Handling of GMO"s, Testing, Evaluation, Toxicity, Allergenic & Animal ethical issues, Disposal methodologies, Natural guidelines, role of IBSC, RCGM, GEAC.

Unit V:

Application: Gene therapy. Applications in agriculture medicine, industry. GM foods, terminator gene negative impact of genetic engineering.

References:

1. Sambrook J, Frisch E and Maniatis T Molecular Cloning: A Laboratory manual. 2000. Old Spring Harbor Laboratory Press New York,
 2. Glover D M and Hames BD. DNA Cloning: a Practical Approach, IRL Press
 3. Kaufman P B, Kim W. Wu. D and Cseke L J. Molecular and Cellular methods in Biology and Medicine, CRC Press, Boca Raton Florida.
 4. Berger S L and Kimmel A P. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques. 1998. Academic Press, Inc San Diego,
 5. Methods in Enzymology Vol. 185, Gene Expression Technology, D V Goeddel, Academic Press, Inc. San Diego, 1990
 6. Mickloss D A and Freyer G A. DNA Science: A first Course in Recombinant Technology. 1990. Cold Spring Harbor Laboratory Press, New York
 7. Primrose S B. Molecular Molecular Biology . 2nd Edn. 1994. Blackwell Scientific Pub. Oxford.
 8. Davies J A and Reznikoff W S. Milestones in Molecular Biology : Classic papers on Genetic Engineering. 1992. Butterworth-Heinemann, Boston,
 9. Walker M R and Rapley R. Route Maps in Gene Technology. 1997. Blackwell Science Ltd, Oxford.
 10. Bernard R. Glick, Jack J. Pasternak Molecular Molecular Biology : Principles and Applications of Recombinant DNA (3rd edition). 2003. Amer Society for Microbiology
 11. Balasubramanian Et Al. Concepts in Molecular Biology . 1996. Orient Longman Publisher.
 12. Primrose S B Richard M. Principles of Gene Manipulation Blackwell Publishing.
 13. Brown T.A. Gene Cloning and DNA Analysis. (4th ed.). 2001. Blackwell Publishing.
-

PAPER 11: APPLIED MICROBIOLOGY

4 CREDITS

Unit I:

History of Microbiology. Principles of classification of microbes; morphological, metabolic and molecular criteria for the classification, A brief introduction to major group of bacteria. Ultra structure of bacteria.

Unit II:

Microbial Cultivation: Nutritional types requirements of bacteria. Cultivation of bacteria: Pure culture techniques different media. Culture media and preparation: Preservation of cultures, aerobic and anaerobic culture techniques. Batch and synchronous cultures. Growth curve and factors influencing growth.

Unit III:

Control of Microbial growth: Principles and techniques, Physical and Chemical methods. Disinfection, Method of action of disinfectants. Methods of testing disinfectants.

Unit IV:

Microbial physiology: Staining characteristics, Gram staining, AFB staining, florescent staining, serological characteristics:-surface antigen, capsular antigen & flagellar antigen, Cultural characteristics, Photosynthetic microorganisms, cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Bacterial aerobic respiration, Bacterial anaerobic respiration: introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria. Mechanism of oxygen toxicity. Bacterial transport system-ABC, Sec pathway, PTS, role of permeases in transport, different permeases in E. coli, Microbial drug resistance.

Unit V:

Microbial Diversity: Human microbial flora in application, General properties of fungi, fungal classification, economic importance of fungi, Mycoplasma, Actinomycetes, Archeobacteria (extremophiles) and microbial algae. General properties of virus, lifecycle.

References:

1. Microbial Physiology and Metabolism by Caldwell D.R. 1995 Brown Publishers.
2. Microbial Physiology by Moat A.G. and Foster J. W. 1999.. Wiley.
3. Prokaryotic Development by Brun. Y.V. and Shimkets L.J. 2000. ASM Press.
4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York.

5. Applied Microbial Physiology by Rhodes.
 6. Principles of bacteriology, virology and immunology Vol I Topley and Wilson Zinser, Microbiology
 7. Microbiology , Prescottt, Harley and Klien
 8. Foundations in Microbiology Talaro and Talaro
 9. Text book of Microbiology, R Ananthanarayanan C K J Panicker
 10. Microbiology, Pelczar, Chan and Kreig
-

PAPER 12: VACCINE DEVELOPMENT

4 CREDITS

Unit I:

Introduction to vaccinology, vaccines and vaccination in historical perspective, the tradition vaccines: an overview, progress and challenges in modern vaccinology, an immunologist's perspective.

Unit II:

Molecular immunology as applied to vaccine development: recent advances in immunology, impact on vaccine development, identification of B and T cell epitopes through structural characterisation and peptide technology.

Unit III:

Immuno potentiation, adjuvants, nonliving antigen delivery systems and "naked DNA" vaccine: adjuvants for future, antigen cochleate preparations for oral and systemic vaccination, immunopotential reconstituted influenza virosomal vaccine delivery system, oral vaccine production in the edible tissue of transgenic plants, DNA based vaccines: extending the technology.

Unit IV:

Live antigen delivery system, attenuated virus as a live vector for expression of immunogens, attenuated poliovirus as live vector, BCG as a recombinant vaccine vector. New and improved vaccines against diseases for which there already exist licensed vaccines, new and improved vaccines against diphtheria and tetanus, new vaccines against hepatitis A, improved vaccines against Rabies. Experimental vaccines, HIV-1 vaccines, vaccines against malaria.

Unit V:

Commercial and regulatory aspects of vaccine production and distribution, vaccines development: the long road from initial idea to product licensure, the role of the food and drug administration in vaccine testing and licensure.

Reference:

1. New Generation Vaccine, second edition, Myron M. Levine, Graeme C. Woodrow, James B. Kaper, Gary S. Cobon
-

ELECTIVE 3: PROTEOMICS**4 CREDITS****Unit I:**

Introduction to proteomics, Analytical methods of protein and peptide separations, protein digestion techniques, Mass Spectrometers for protein and peptide analysis. Protein identification by peptide mass fingerprints, peptide sequence analysis by tandem mass spectrometry.

Unit II:

Protein sequence analysis using softwares :- Emboss, Data mining proteomes, Motif mapping using Prosite , Prodom, protein expression profiling, protein - protein interactions, protein complexes. Mapping protein modifications. Protein secondary structure analysis, Molecular visualization protein 3D structure using Rasmol, pdb file format.

Unit III:

Molecular modeling, Concepts of Molecular Modeling, Molecular structure and internal energy, Energy minimization of small molecules, Ab initio, DFT and semi-empirical methods, Construction of initial model, Refining the Model, Manipulating the model, Rotamer libraries, Three- Dimensional structure prediction, comparative modeling, Homology modeling, Threading, Energy based prediction of protein structures, Modeling softwares SPDBV. SWISS - Model.

Unit IV:

Introduction to basic concepts, Molecular recognition by receptor and ligand design, Generation of Rational Approaches in Drug design, Introduction to drug designing, Discovering a drug, Target identification and validation, Identifying the lead compound, Optimization of lead compound.

Unit V:

Docking methods introduction, three dimensional descriptions of binding site environment and Energy calculation, Automatic Docking Method, Three Dimensional database search Approaches, Design of ligands, Drug-receptor interactions automated structure Construction methods, AUTODOCK.

References:

1. Cohen N. C. 1996. Guidebook on Molecular Modeling in Drug. Design. Academic Press.
 2. Brandon C., Tooze J. 1998. Introduction to Protein Structure. Garland Science Publishing.
 3. Creighton T E. Proteins. 1983 Structures and Molecular Properties. Freeman, New York
-

PRACTICAL 3: MOLECULAR BIOLOGY TECHNIQUES**6 CREDITS**

1. Cytotoxicity Assay using EAT cells
 2. Demonstration of apoptosis of DNA laddering
 3. DNA isolation – genomic & plasmid DNA.
 4. Restriction digestion
 5. DNA Ligation
 6. E.coli transformation, GUS expression
 7. Downloading DNA sequence from NCBI database and interpretation.
 8. Analyzing the DNA sequence in EMBOSS/GENE TOOL/DSGENE, Analyzing the DNA sequence Fasta, Blast, Clustal W.
 9. Analyzing the sequence against EST and genome database
 10. Analyzing the DNA sequence for GENE and translation into protein sequence.
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SEMESTER IV

Summer project work – 2 Credits

Thesis and viva-voce examination – 12 Credits

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JSS University, Mysore
Introduces an Innovative Career oriented
Program
M.Sc. Nutrition and Dietetics
(2 years Program-4semesters)



This program utilizes expert faculty from various Food Science and Nutrition, Clinical Nutrition, Nutrition and Dietetics, Research Institutes and Food industry.

Nutrition science is the study of nutrients that are essential for growth, development and maintenance of good health throughout life. In the present scenario, society needs the awareness regarding their diet and also, people are becoming more nutrition conscious. The common man is gradually switching towards nutrition scientists and dietitians for scientifically proved information on Nutrition and Dietetics. This interest in the society to gain knowledge on diet planning can lead to have a healthy life and especially in preventing the development degenerative diseases.

Criteria for designing the balanced diet were to fulfill the nutritional requirement and to overcome the nutritional deficiencies. Currently the barrier is extended towards designing the diet for therapeutic nutrition (Neutraceuticals) which is the need of the hour.

Food industry is now focusing more on nutrient composition and information of food products on label. In market many types of foods are available for all age groups and try to fulfill the requirements of people with different physiological status. Print and electronic media pour out nutrition messages to the public.

Hence it is essential that Nutrition and Dietetics is offered at various levels of education in general and in masters in particular. Here the student learns both the rudimentary and application aspects, which includes the investigation and analysis of the requirement along with the skills. Candidates pursuing the course can practice as nutritionists and dieticians in different hospitals, fitness centers, food industry, R and D institutes etc.

Career opportunities:

Opportunities in Academia: A candidate with M.Sc. in Nutrition and Dietetics can continue the studies for higher degrees such as M.Phil and Ph.D. In addition, the candidate can also join a teaching institution as lecturer

Opportunities in Industry: M.Sc. Nutrition and Dietetics students can also register in Indian Dietetics Association to serve as registered dietitians in various hospitals, fitness centers etc

Opportunities abroad: Students with M.Sc. in Nutrition and Dietetics can also join various academic and research institutes abroad.

Eligibility Criteria

1. B.Sc., Cognate subjects: Home Science/any one of the following subjects as one option at B.Sc - Food Science and Nutrition/Human Nutrition and Dietetics/Clinical Nutrition and Dietetics/Food Science & Quality Control and from Medical and Para-medical courses (MBBS, B.Sc - Nursing, B.Sc - Yoga & Naturopathy) are eligible to apply.
2. Candidates from Non-cognate subjects viz., Biochemistry, Biotechnology, Microbiology as major are also eligible to apply.
3. Preference at every stage of seat allocation will be given to students who have studied COGNATE subjects. If seats fall vacant applicants from Non-cognate subjects shall be considered.

M.Sc. Nutrition and Dietetics

	Semester I	Credits
Paper 1	Fundamentals of Food Science	4
Paper 2	Nutritional Biochemistry	4
Paper 3	Human Physiology	4
Paper 4	Biochemical Techniques	4
Elective 1	Statistical Methods for Biology	4
Practical 1	Biochemical Techniques (Practical 1)	6
		26
	Semester II	
Paper 5	Advanced Nutrition-1	4
Paper 6	Community Nutrition	4
Paper 7	Human Nutrition	4
Paper 8	Diet Therapy – 1	4
Elective 2	Nutraceuticals and Functional Foods	4
Practical 2	Food Analysis	6
		26
	Semester III	
Paper 9	Life cycle Nutrition	4
Paper 10	Medical Nutrition and Management	4
Paper 11	Diet Therapy – 2	4
Paper 12	Advanced Nutrition 2	4
Elective 3	Food Safety and Food Service Management	4
Practical 3	Clinical Nutrition	6
		26
	Semester IV	
	Summer Project	2
	Thesis and viva voce examination	12
		14
	Total Credits	92

Rules and Instructions

- 75% of attendance is compulsory
- 3 Internal exams will be conducted for each semester and attending all the three internals is compulsory.
- Average marks of all the three tests will be considered.
- Assignments and seminars will be given for each paper in each semester.
- After II semester one month summer project work - 2credits.
- 4th semester dissertation or project work, thesis submission and viva-voce examination – 12 Credits
- Total internal assessment marks -25 (attendance, internals, assignments and seminars).
- Total marks for theory – 75.
- Total practical marks- 75

NUTRITION AND DIETETICS- M. Sc. SYLLABUS

Paper 1- Fundamentals of Food Science-(Semester I)

Unit I: 8h

- Concept of food and classification of food.1h
- **Cereals** Rice and Wheat, Millets (Ragi, Maize, Barley & Oats) – Cultivation to improve the nutritional quality, structure, composition and nutritive value -2h
- **Starch** - Chemistry, cooking quality of cereal and root starches - gelatinization, starch gel and factors affecting of gelatinization and starch gel – 2h
- **Flour** – Types, properties, role of ingredients and preparation of bread, rheological properties of dough. Functional properties of flour-
- **Sugar cookery** – Principles and stages of sugar cookery, preparation of crystalline and non-crystalline candies.- 3h

Unit II:5h

- **Pulses and legumes**- Composition, nutritive value, toxic constituents physical & chemical properties of proteins, pulses cookery-2h
- **Nuts and oil seeds** – composition, nutritive value, role of nuts and oil seeds in cookery-1h
- **Fats and oils** - Physical and chemical properties of fats and oil, rancidity and prevention and its uses – 2h

Unit III:5h

- **Fruits and vegetables** – Composition, classification, nutritive value, structure, Texture, pigments and flavor component, changes during cooking and processing and browning reaction 3h
- **Spices and condiments** – Composition, flavoring extract, and medicinal value.2h

Unit IV:5h

- **Meat** - Structure, composition, selection, cuts of meat, post mortem changes, methods of cooking, tenderness of meat.2h
- **Poultry and fish** – Composition, market forms, selection factors and methods of cooking. 2h
- **Milk based beverages** -1h

Unit V:6h

- **Egg** – Structure, composition, selection, coagulation, foam formation and its role in cookery.2h
- **Milk** – Composition, types, nutritive value, physical and chemical properties, coagulation of milk protein.2h
- **Beverages** – Classification and nutritive value, Preparation of milk based beverages. 2h

REFERENCES

1. Potter, N.N. (1998) Food Science, AVI publishing company INC West Port Connecticut.
2. Tressler. D.K. and Joslyn. M.A. (1971) Fruit and vegetable juice processing technology, AVI publishing company.
3. Desrosier N.W, (1998) Elements of Food Technology, AVI publishing company, Connecticut.
4. Srilakshmi (1998) Food Science, AVI publishing company, Connecticut.
5. Swaminathan, M. (1998) Food Science and Experimental Foods, BAPCO Bangalore.
6. Marion and Banion (1998) Food Science, Mac Millon Company, London.

Paper 2-Nutritional Biochemistry

Unit I:4h

- **Cell Structure and Function:** Components, cell membrane composition, fluid mosaic model, membrane lipids, proteins and carbohydrates, membrane receptors, functional role of sub cellular organelles and membrane systems. 4h

Unit II:6h

- **Amino acids and Proteins-Amino acids-** Classification and structure, properties, reactions and identification techniques. Formation of peptide linkages, amide plane and biologic activity. 3h
- **Proteins-** Structure and organization, physico-chemical properties, classification and functional diversity of proteins, techniques of protein purification. Estimation of protein – Kjeldhal method.3h

Unit III: 5h

- **Carbohydrates:** Classification, structural features, stereoisomerism and optical activity, chemical properties. 2h
- Monosaccharide and related compounds, disaccharides, polysaccharides. 1h
- Inter conversion of hexoses, sugar derivatives of biomedical importance, hetero-glycans. Methods to estimate sugars and starch. 2h

Unit IV: 6h

- **Lipids:** Classification, chemical structure and properties of fatty acids 1h
- Triglycerides, phospholipids and derivatives, cholesterol and derivatives 2h
- Dietary fats, biological functions of lipids, glycolipids.1h
- Methods to determine crude fat and fatty acids. 1h
- **Lipoproteins:** Types, Structure and physicochemical properties.1h

Unit V: 10h

- **Nucleic acids:** Components, structure and level of organization, Physico chemical properties, biological importance 3h
- DNA replication and enzymes in DNA replication. 1h
- **Enzymes:** Classification, nomenclature, general properties- stereo and reaction specificity, kinetics and mechanisms of enzyme action, regulation of enzyme activity. 3h
- Coenzymes and cofactors, their structure and functions. Enzyme inhibition, isoenzymes, immobilized. 3h

Paper 3- Human Physiology

Unit I: 8h

- **Cellular basis of Physiology** - Body fluid compartment, membrane potential, Intercellular communication - Homeostasis. 3h
- **Biochemical aspects of muscle tissue** - structure, chemical composition, mechanism and energetics of muscle contraction, muscle fatigue. 3h
- **Biochemical aspects of nerve tissue** - structure, composition & functions of nerve tissue 1h
- Special senses - only physiology of sense organs 2h

Unit II: 7h

- **Endocrinology and Reproduction** - Anatomy of endocrine glands and Reproductive organs. 3h
- **Hormones** - Mode of action, functions of hormones of the endocrine glands - Pituitary, Adrenal, Thyroid, Gonadal hormones, Pancreas, Pineal body and Parathyroid. 3h
- Hypo- and Hyper- functions of the glands. 1h

Unit III: 9h

- **Respiration:** Oxygen requirement for nutrients, composition of inspired and expired gas, partial pressure of gas, diffusion gradient and gas flow, transport of oxygen and CO₂, Hemoglobin affinity for O₂ and dissociation. 4h
- **Gastro – Intestinal Tract:** Anatomy and function of Gastrointestinal Tract, movement of intestine. 2h
- Mechanism of secretion of gastric juice 1h
- **Hunger, Appetite, Satiety** - physiological and psychological factors affecting food intake, circadian rhythm in GI tract secretions 2h

UNIT IV:8h

- **Circulation:** Blood - composition, functions of formed elements of blood and plasma proteins, origin and conduction heartbeat, ECG-interpretation 3h
- Latest development in cardiac condition, cardio vascular mechanism and homeostasis 2h
- **Excretion:** Formation of urine, characteristics of urine, normal and abnormal constituents of urine, acid - base balance.3h

Unit V:4h

- **Immunity** - Properties, natural and acquired Immunity, features of immune responses, antigen - antibodies - types, properties, antigen - antibody interaction, Auto immune disorder and allergy.4h

REFERENCES

1. Biochemical Aspects of Nutrition - Ed by Kurio yogi, Japan Scientific suppliers Univ.press.
2. Health Promotion - Cavol Jeans, Westsniter and Forbes Crowley, J.B.Lippin Cott & Co.
3. Human physiology by CC Chatterjee, Vol I & II.
4. Bacteriology, Virology and Immunity for Students of medicine by Steward FS & Besnic TSI.
5. Biochemistry - A case oriented approach by Montgomery. R, Conway, T.W &Spector A.A.
6. Medical Physiology by Anil Baran Singha & Mahapatra, Current Books International Kolkatta.
7. Living body by Best & Taylor.

Paper 4: Biochemical Techniques

Unit I:

- **Separation techniques:** Principles, methods and applications of chromatography – Paper, thin layer, ion exchange, gel filtration and affinity chromatography, GLC, HPLC, UPLC and chromatofocussing.
- **Spectroscopic techniques:** Principles of colorimeter, spectrophotometer, fluorimeter. Beer-Lambert's Law and its limitations. Extinction coefficient, fluorescent probes and their applications

Unit II:

- **Cell fractionation techniques:** Cell lysis, preparation of lysis buffers, pH, ionic strength, ionic and non-ionic detergents, composition of general lysis buffers such as RIPA,

homogenization, extraction, salting in, salting out, dialysis and ultra filtration.

- **Centrifugation:** Svedberg's constant, sedimentation velocity and sedimentation equilibrium.
- **Ultra centrifugation:** Differential and density gradient centrifugation, centrifugal elutriation, construction of preparative and analytical ultracentrifuge, Schlieren optics

Unit III:

- **Electrophoretic techniques:** Polyacrylamide gel electrophoresis, SDS-PAGE, 2D-electrophoresis, agarose gel electrophoresis, isoelectric focusing, pulsed field electrophoresis, high voltage electrophoresis, capillary electrophoresis, isotachopheresis.
- Separation of proteins, lipoproteins and nucleic acids. Visualizing separated components; staining, fluorescence, PAS staining, zymogram and reverse zymogram

Unit IV:

- **Isotopic tracers:** Heavy isotopes and radio-isotopes, theory and construction of mass spectrometer. Ionization, fragmentation, m/e, time of flight, MALDI and ESI.
- **Radioisotopes in Biology:** ^3H , ^{14}C , ^{32}P , ^{131}I , ^{35}S , concept of half-life, decay constant, detection and quantitation - GM counter and solid and liquid scintillation counter. Specific activity, autoradiography and their applications
- **Labeling:** Using plant system (monosaccharides and polysaccharides), animal system, chemical (Glucose- ^{14}C) and enzymatic methods (disaccharides). Labeling of acetate ($1\text{-}^{14}\text{C}$ and $2\text{-}^{14}\text{C}$), ATP ($\alpha\text{-}^{32}\text{P}$ and $\gamma\text{-}^{32}\text{P}$), proteins and nucleic acids.
- **Applications of radioactivity:** Dilution techniques, pulse chase method, carbon dating, substrate product relationship (cholesterol biosynthesis) and bond cleavage specificity

Unit V:

- Animal models, choice of animals, types of studies, xenografts, allografts, mutant organisms (auxotroph), cultured animal and plant cells as representative models.

Textbooks:

1) Principles And Techniques Of Biochemistry And Molecular Biology – 7th Edition
Keith Wilson And John Walker

2) Biochemical Techniques Theory and Practice
John F. Robyt And Bernard J. White

3) Biochemical Methods – A Concise Guide For Students and Researchers
A. Pingoud; C. Urbanke; J. Hoggett And A. Jeltsch

4) Basic Methods for the Biochemical Lab, Holtzhauser Martin

Elective 1: Statistical Methods for Biology (4 Credits)

Unit 1: Numerical Methods to Represent Variation

Importance and Scope of Statistics, Data Types, frequency distribution, Graphical Representation Methods (Histogram, Bar Charts, Pie Charts), Measures of Center Tendency (Mean, Median, Mode,) and Dispersion (Standard Deviation, Variance) Advantages and Disadvantages, Co-Efficient of Variance.

Unit 2: Probability

Basic Terminology, Definition of Probability, Basic Laws of Probability, Types of Probability, Additional Rule of Probability and Multiplication Rule of Probability, Probability Distribution- Bernoulli Distribution, Binomial Distribution, Poisson distribution and Normal Distribution- Simple Problems.

Unit 3: Sampling Methods

Collection of Data, Census Method, Concept of Population, Sample, Sampling, Sample Size, Sampling Error, Advantages and Disadvantages of Sampling Method, Necessity of Sampling, Types of Sampling Methods, Types of Random Sampling Methods – SRS, Stratified Random Sampling, Systematic Random Sampling And Cluster Sampling.

Unit 4: Testing of Hypotheses

Statistical Hypotheses-Null and Alternative, Level of Significance, Type I and Type II Error, Critical Region, Power of the Test, P Value, Degrees Of Freedom, Chi-Square Test for Independence of Attributes and Goodness of Fit, Student's t Test: One Sample t Test and Paired t Test, F Test.

Unit 5: Regression and Analysis Of Variance

Simple Linear Regression, Multiple Linear Regression (Definition, Assumptions, Applications, and Examples) ,Analysis of Variance –Introduction ,Definition of ANOVA, Assumption , Test Of ANOVA, Types Of ANOVA, Construction of One Way Analysis of Variance.

References:

1. Fundamentals of Biostatistics: Veer Bala Rastogi
2. Fundamentals of Mathematical Statistics: S.C. Gupta and V. K. Kapoor
3. Fundamentals of Statistics: S.C. Gupta
4. Biostatistics, Snedger and Gohrran.
5. Introductory Statistics for Biology 2nd Edition, R. E. Parker

Practical 1: Biochemical Techniques

1. Paper chromatography – ascending and descending – separation of amino acids and sugars.
2. Qualitative tests for the identification of amino acids and carbohydrates.
3. Thin – layer chromatography of amino acids and lipids.
4. Column (GPC) chromatographic separation of proteins (albumin and trypsin).

5. Polyacrylamide Gel Electrophoresis and agarose gel electrophoresis of serum proteins.
6. Ion exchange chromatography of amino acids.
7. Absorption spectrum of chlorophyll extracted from green leaves.
8. Absorption spectrum of aromatic amino acids, purines and pyrimidines. Determination of polar absorption coefficient of tyrosine.
9. Optical rotation of sugars using polarimeter
10. Molecular weight determination of proteins by SDS-PAGE
11. Western blotting
12. Quantitative estimation of proteins by spectrophotometric method.

REFERENCES

- 1) Principles and Techniques of Biochemistry and Molecular Biology – 7th Edition
Keith Wilson and John Walker
- 2) Biochemical Techniques Theory and Practice; John F. Robyt and Bernard J. White
- 3) Biochemical Methods – A Concise Guide for Students and Researchers
A. Pingoud; C. Urbanke; J. Hoggett and A. Jeltsch
- 4) Basic Methods For The Biochemical Lab; Holtzhauer Martin
- 5) Practical Clinical Biochemistry; Harold Varley
- 6) Hawk's Physiological Chemistry – 14th Edition; By Philip Bovier Hawk, Etd.by Bernard L. Oser

Paper 5- Advanced Nutrition-1

Unit I:5h

- **Calcium** - Skeleton and other tissue measurement, bone mass, effect of diet and immobilization, calcium absorption and utilization, calcium balance, requirement, sources, deficiency and excess (toxicity).3h
- **Phosphorous** - Concentration in the body, calcium -phosphorous ratio, absorption and utilization, deficiency and toxicity and interrelationship of calcium, phosphorus, vitamin D and protein 2h

Unit II:8h

- **Trace Elements** - Concepts, mode of action, trace element interactions. 2h
- **Iron** - Intake, utilization, storage, iron balance, functions, deficiency and toxicity. Role of Iron in prevention of anemia, sources and RDA. 2h
- **Iodine and Zinc** - Physiology, functions, sources recommended intake, deficiency and toxicity.3h
- **Flourine** -Physiology, sources, RDA, the prevention of dental carries and toxic effects.1h

Unit III:8h

- **Electrolyte** - Concept, balance and acid base balance **1h**
- Distribution, absorption utilization, role in human nutrition, deficiency and toxicity- Sodium, potassium , magnesium and sulphur **-3h**
- Physiology, sources, recommended intake, deficiency and toxicity - copper, molybdenum, cobalt, nickel, manganese, selenium, chromium and cadmium. **4h**

Unit IV:5h

- Bioavailability and interrelationship of micronutrients **1h**
- **Vitamin like molecules:** Choline, carnitine, inositol, taurine, flavonoid, pangamate, laetrile, PABA - chemistry, metabolism, deficiency, excess and source. **4h**

Unit V:4h

- Assessment of nutriture and methods of estimation in food materials –Ca, K, P, Fe, Zn etc.,. **3h**
- RDA of Minerals-**1h**

Paper 6 Community Nutrition

Unit I:8h

- **Relationship of nutrition to development** -In terms of socio economic, industrial and agricultural development. **2h**
- **Consequences of malnutrition and prevalence of common nutritional problems** - PEM, vitamin A deficiency disease, anemia, iodine deficiency disorders and fluorosis. **3h**
- Etiological factors leading to malnutrition. **1h**
- Synergism between malnutrition and infection. Measures to overcome malnutrition. **2h**

Unit II:9h

- **Nutrition Education:** Its importance to the community. Qualities of training workers in nutrition education programs, integration of nutrition with education and extension work. **2h**
- Methods of education, when to teach, whom to teach. **1h**
- Principles of planning, executing and evaluating nutrition education programs, problems of nutrition education **2h**

- **Epidemiology of communicable disease:** Factors responsible for the spread of communicable diseases, mode of transmission - chicken pox, typhoid fever, malaria, leprosy, filariasis 4h

Unit III:7h

Assessment of nutritional status:

- **Direct method** - Anthropometry, biochemical, biophysical and clinical assessment. 4h
- **Indirect method** – Dietary Survey, Vital statistics 3h

Unit IV:10h

- **Nutrition Intervention programs in India:** Genesis objectives and operation of National Anemia Control Prophylaxis Program, National Goiter Control Program, Vitamin A Prophylaxis Program, School Lunch Program, 4h
- CMNMP, ICDS, TINP, 1h
- **National Nutrition policy** - thrust areas and implementation at national level Impact of national policy on food security. 2h
- **Primary health center (PHC)** - Concept, organization, current status in India and delivery of service, Taluk level hospital, and employees state insurance (ESI) and immunization. 3h

Unit V:6h

- **National organization concerned with food and nutrition** - ICMR, CHEB, CSWB, SSWB, NIN, NNMB, CFTRI, DFRL, NIPCCD, ICAR. 3h
- **International organization concerned with food and nutrition** - FAO, WHO, UNICEF, World Bank, FFHC, UNESCO, DANIDA. 3h

REFERENCES

1. Vinodini Reddy ., pralhad raj., Gowrinath sastry, J find Kashinath, K.C. (1993), Nutrition Trends in India, NIN, Hyderabad.
2. Park and park (1995), Text book of preventive and social medicine, Banarsidas published by Jabalpu.
3. Jellifee, D.D and Pathes (1989), Assessment of Nutritional status of community, WHO, Geneva.
4. Proceeding of the Nutrition society of India (1999), Vol (35,42,43,44,46 and 47), NIN, Hyderabad.
5. Sarah Gopalam (1996), Towards better Nutrition for women and children problems and programs, Development of women and child development Government of India.
6. Bagehi, K (1987), Evaluation of nutrition education nutrition monitoring and assessment, Editors - Gopaldas, T and Seshadris, Oxford University press.

Paper 7: Human Nutrition

Unit I:- 8h

- **Body fluids and water balance-** Body water compartments. Regulation of water balance, disorders of water balance. 2h
- **Body composition-** Methods of study, compositional changes during life cycle, nutritional disorders and their effect body composition. 3h
- **Energy metabolism** – Basal and resting metabolism- influencing factors. 1h
- Methods to determine energy requirements & expenditure. 1h
- Thermo genesis, adaptation to altered energy intake, latest concepts in energy requirements and recommendations for different age groups 2h

Unit II -8h

- **Bioenergetics and oxidative metabolism** – Concept of energy and its conversion, energy producing and utilizing systems, thermo dynamic relationships and energy-rich components. 3h
- Sources of and fates of acetyl co A, The Krebs's cycle, structure and role of mitochondria, Electron transport chain, oxidative phosphorylation. 3h
- **Hormone and Nutrient interaction;** interaction over carbohydrates protein and fat metabolism. 3h

Unit III 13h

- **Carbohydrates** - Occurrence and physiological functions, Digestion and Absorption of dietary carbohydrates. 2h
- **Metabo lism of carbohydrates-** Glycolysis, TCA cycle, Pentose Phosphate pathway 2h
- Dental caries, Lactose intolerance, Artificial sweeteners. 3h
- Factors influencing metabolism. Disorders related to carbohydrate metabolism. 2h
- Glycemic index of foods and its uses. 1h
- **Dietary Fiber** - Definition, types of fiber in plan food, sources, composition, digestion, Role of dietary fiber in health, disease and therapeutic nutrition. 2h
- Effect of fiber in the absorption of different nutrients, effects of over consumption of fiber. 1h

Unit IV – 8h

- **Proteins** - Concepts of essential and non-essential amino acids- their role in growth and development, Physiological functions of proteins 2h
- **Metabolism of protein**- Synthesis, function, digestion, absorption, utilization, factors affecting protein utilization 2h
- Protein Requirement, nitrogen balance concept. Methods for evaluating protein quality 2h
- **Protein energy malnutrition**-Clinical features and biochemical changes, prevalence, causes and treatment, role of animal protein and vegetable protein mixture in compacting malnutrition requirement 2h

Unit V 8h

- **Fats and lipids**- Digestion and absorption of fats, lipid transformation in the liver, lipotropic factors, deposition of fat in the body, 2h
- **Lipids** - Concepts of visible and invisible fats. EFA, SFA, MUFA, PUFA- sources and physiological functions. 2h
- Role of lipoproteins and cholesterol, triglycerides in health and disease.2h
- Role of essential fatty acid, effect of deficiency and toxicity, role of fat in the etiology of atherosclerosis. 3h

Paper 8 Diet Therapy-I

Unit I: 80h

- **Basic concepts of diet therapy** – Therapeutic adaptations of normal diet, principles and classification of therapeutic diets, nutrition support techniques, Principles of Nutritional care 3h
- **Parenteral feeding** - Nutritional Support, Formula feeds and Complications in TPN – 2h
- **Enteral indications**, types - Nasogastric, Gastrostomy, Jejunostomy and Rectal feeding - requirements and advantages 3h

Unit II: 10h

- **Team approach of health care**
- **Dietitian** – types, qualities, qualifications and role of dietitian in management of hospital diet. 3h
- **Routine Hospital diets** – Regular, light, soft, fluid, Types of hospital diets -3h
- **Fitness** - Definition, basic components of physically active life style in preventing obesity, osteoporosis, heart disease, and diabetes. 3h
- **Physical fitness tests** - for flexibility, muscle endurance (any 3 tests for each) and cardio vascular endurance. 1h

Unit III: 9h

- **Nutrition and exercise** - energy requirement for aerobic and anaerobic exercises, carbohydrate loading, water and dehydration, special foods. 2h
- **Importance of exercise in preventing life style diseases** - Diabetes, CVD, hypertension, obesity and osteoporosis, 2h
- **Sports nutrition** - special foods - Nutrition and performance of athletes and players, dietary modifications and diet plan, sports supplementation. 3h
- **Diet in Energy Imbalance** - Underweight and obesity, Etiology and dietary management 2h

Unit IV: 11h

- **Dietary management in metabolic stress**: Sepsis, trauma, burns, surgery; Nutrition for oral and dental health 2h
- **Diet in Febrile condition** Short duration - Typhoid, Influenza, Malaria, Long duration - Tuberculosis. 2h
- **Diet in deficiency diseases** - PEM, Vitamin A, Anemia. 1h
- **Surgery** - Physiological response, Metabolic Consequences, Stage of Convalescence, pre- and post-operative diets. 3h

- **Burns** - Metabolic changes in protein and electrolytes and Nutritional support. 1h
- **Diet in allergy** - Common food allergens, test for allergy - Skin test and Elimination diet and Treatment for allergy. 2h

Unit V: 5h

- **Nutritional therapy for neurologic diseases:** Classification of neurologic diseases; Neurological diseases arising from nutritional deficiencies or excesses; Neurologic diseases of non-nutritional etiologies 3h
- **Special diets for metabolic disorders:** Phenylketonuria (PKU); Maple Syrup Urine Disease (MSUD); Lactose intolerance; Galactosemia; disorders of fatty acid oxidation. 2h

REFERENCES:

1. Anderson, L., Dibble, M.V. Turl-ki, P.R., Mitchall, H.S., and Ryntceruili, H.J. (1982) Nutrition in Health and Disease, 17th Ed., J.B. Lippincott Co. Philadelphia.
2. Antic, F.P. (1973): Clinical Dietetics and Nutrition, Second Edition, Oxford University press, Delhi.
3. Mahan, L.K., Arlin, M.T., (1992): Krause's Food, Nutrition and Diet Therapy, 8th Ed. W.B. Saunders Company, London.
4. Robinson, C.H., Lawler, M.R., Chenoweth, W.L., and GarMck, A.E. (1986) Normal and Therapeutic Nutrition. 17th Ed., MacMillan Publishing Co.
5. Williams, S.R. (1989); Nutrition and Diet Therapy, 6th Ed. Times Mirror/Mosby college publishing St. Louis.
6. Raheena, Begum (1989): A Textbook of foods, nutrition and dietetics. Sterling publishers, New Delhi.
7. Joshi, S.A. (1992): Nutrition and Dietetics, Tata McGraw Hi 11 Publications, New Delhi.

PRACTICAL 2: FOOD ANALYSIS 3h/week

- 1) Determination of moisture, Ash - total, acid soluble and insoluble.
- 2) Determination of Protein in foods by micro-Kjeldahl method.
- 3) Determination of Fat – Crude fat.
- 4) Carbohydrates
Starch – Digestible and Resistant Starches, Dietary fiber – Soluble and insoluble.
- 5) Mineral estimation – Dry and wet ashing, calcium, iron, phosphorous.
- 6) Vitamin estimation – Ascorbic acid, thiamine, riboflavin and β carotene.
- 7) Enzyme activity assays – Amylase, lipase and protease
- 8) Biological value- calculations
- 9) Protein Efficiency Ratio (PER)

- 10) Estimation of Fat Soluble vitamins
- 10) Cereals and millets cookery

Textbooks:

1. Food Analysis Laboratory Manual, 2nd Edition, 2010 by Nielsen S. Suzanne. Publishers: Springer
2. The Food Chemistry Laboratory: A Manual for Experimental Foods, Dietetics and Food Scientists. 2nd Edition, 2005, by Connie M. Weaver and James R. Daniel. Publishers: CRC Press.

Elective 2: Nutraceuticals And Functional Foods

Unit I:4h

- **Functional foods and nutraceutical** – Introduction – Defining, the concept – Review of the history of functional foods – teleology of nutraceuticals. 1h
- **Primary and secondary metabolites in plants general teleology** – a) Carotenoids b) Conjugated linolenic acid c) Flavonoids d) Nitrogen and Sulphur containing Amino acid e) Omega – 3 PUFA g) Terpenoids. 3h

Unit II:5h

- **Classifying nutraceuticals** 1h
- **Organizational models for nutraceuticals-** a) Food source – Plant: Soya, olive oil, plant steroid, tea, grape vine, garlic, capsicum, dietary fibre and other fruits. b) Animal: Milk and products, meat, fish. Microbial probiotics. c) Mechanism of action – Anticancer, positive influence on blood lipid profile, anti oxidation, anti inflammatory, osteogenetic d) Chemical nature – Isoprenoid derivatives, phenolic substances, fatty acids and structural lipids, carbohydrates and derivatives, amino acid base substances, microbes, minerals. 4h

Unit III:8h

- **Physico-chemical properties of foods-** Organic food components, colloids, osmotic pressure, food dispersions (sols, gels, emulsion, foam), Hydrogen ion concentration etc. 2h
- **Role of water-** in foods, free water and bound water, functional properties, water activity and intermediate moisture foods. 3h

- **Functional properties** - proteins, modified proteins, application in product formulation
1h
- **Carbohydrates:** Starch, cellulose, hemicelluloses, hydrocolloids and gums: occurrence, functions in food systems, properties, gelatinization, retrogradation and modified starches
2h

Unit IV: 5h

- Measurement of functional component and their bioavailability 2h
- **Need for measurement, safety quality assurance and cost** — bioavailability: definition, factor affecting, chemical measurement and physical testing and micro-biological testing- functional foods and in vitro studies. 3h

Unit V: 6h

- **Pharmacology and nutraceuticals** — pharmacology of chemical components derived from plant source and the therapeutic derived from plant source and the therapeutic efficiency of functional food ingredients 3h
- **Nutrigenomics** — Relationship between nutritional supplementation and gene expression and disease prevention. 3h

Paper 9: Nutrition During Life Cycle or Life Cycle Nutrition

Unit I:5h

- Basis for computing nutrient requirements, latest concepts in dietary recommendations. 2h
- RDA- ICMR and WHO: their uses and limitations; 2h
- Balanced Diets. 1h

Unit II: 6h

- General concepts about growth and development through different stages of life. 2h
- **Nutrition in Pregnancy** - Stages of gestation, maternal physiological adjustments, nutritional problems and dietary management. 2h
- Importance of nutrition during and prior to pregnancy - nutritional problems and dietary management, planning a menu. 2h

Unit III:6h

- **Nutrition during Lactation** - Physiology of lactation, hormonal control and reflex action, efficiency of milk production, problems of breast feeding. 3h
- Nutritional composition of breast milk, nutritional concerns during lactation, special foods during lactation, dietary modification, planning a menu. 3h

Unit IV:7h

- **Nutrition in Infancy** - Infant feeding, nutritional needs, premature infant and their feeding, weaning foods. Feeding problems, infant formulae, lactose intolerance, planning menu. 3h
- **Nutrition in preschool:** Feeding and factors to be considered. Planning a menu, packed lunch. 2h
- **Nutrition in school children** - Feeding school children and factors to be considered. Planning a menu, feeding problems, packed lunch. 2h

Unit V:8h

- **Nutrition during Adolescence** - Changes in growth and development, hormonal influences 1h.
- **Age at menarche** - factors affecting age at menarche, psychological problems, body image, disordered eating behavior, nutritional problems, planning a menu. 2h
- **Nutrition in Adult and Elderly** - Nutrition and work efficiency, Menopausal and post-menopausal women, hormonal changes, nutritional requirement, planning a menu. 2h

- **Physiological changes in aging** - Psycho-social and economic factors affecting eating behavior, social situation, knowledge and belief, institutionalization, common health problems, nutritional requirement, modification in diet, feeding old people. 3h

Paper 10: Medical Nutrition and Management

Unit I: 4h

- **Nutritional and dietary care process in health and in disease** - Nutritional screening/ assessment and identification of nutritional problem. 1h
- **Nutritional Intervention and Diet Modification** - based on interpretation of - Patient data- clinical, biochemical and other relevant data. 2h
- **Nutrition Education and Counseling** -Evaluation of Nutritional care 1h

Unit II: 14h

- **Nutrition for weight management:** Disorders of energy balance 1h
- **Obesity Components of body weight**- Types of obesity, Assessment of obesity, Health risks, Regulation of body weight. 2h
- **Adipose tissue**- structure, regional distribution and storage. 1h
- **Causes of obesity**- neural, hormonal, and psychological 1h
- **Management of obesity** - Dietary Modification: past and present approach 1h
- **Psychology of weight reduction:** psychotherapy and behavior modification
Physical activity and exercise 2h
- **Eating disorders:** Anorexia Nervosa and Bulimia Nervosa, Pharmacological treatment, Surgical treatment effect on satiety and other factors, maintenance of reduced weight. 3h
- **Underweight / Excessive Leanness** - Causes and assessment - Health risks - Dietary Management – Psychotherapy 2h
- **Eating disorders:** Anorexia Nervosa and Bulimia Nervosa 1h

Unit III: 5h

- Nutrition in Fever and Infectious Diseases 1h
- Patho-physiology of fever and infection 1h
- Effect of fever and infection on nutritional status 1h
- Nutritional management: typhoid, tuberculosis and malaria, AIDS. 2h

Unit IV: 15h

- **Medical nutrition therapy for Upper Gastrointestinal tract Diseases / Disorders.** 1h
- Diagnostic Tests for the G.I. diseases 1h
- Pathophysiology and Nutritional care and diet therapy in diseases of oesophagus; oesophagitis, Hiatus hernia 2h
- **Disorders of stomach:** Indigestion, Gastritis, Gastric and duodenal ulcers 1h
- Management: associated with H. pylori infection, NSAIDS Dietary management: traditional approach and liberal approach 2h
- **Gastric Surgery:** Nutritional care, dumping syndrome 1h
- Medical nutrition therapy for Lower gastrointestinal tract Diseases/Disorders Common Symptoms of Intestinal dysfunction - Flatulence, constipation, haemorrhoids, diarrhoea, steatorrhoea 3h
- **Diseases of the large intestine:** Diverticular disease, Irritable bowel syndrome, inflammatory bowel disease 1h
-
- **Mal-absorption Syndrome / Diseases of Small intestine** - Celiac (Gluten –induced) sprue, tropical sprue, intestinal brush border enzyme deficiencies, Lactose intolerance, protein- losing enteropathy 2h
- **Principles of dietary care:** Dietary fiber, Modified fiber diets 1h
- **Intestinal surgery:** Short bowel syndrome, Ileostomy, Colostomy, Rectal surgery 1h

Unit V: 8h

Diseases of the Hepato - Biliary Tract-

Nutritional care in liver disease in context with results of specific liver function tests Dietary care and management in viral hepatitis (different types) 2h

- Cirrhosis of liver 1h
- Hepatic encephalopathy 1h
- Wilson's disease. 1h
- **Dietary care and management in diseases of the gall bladder and pancreas**-biliary dyskinesia, cholelithiasis, cholecystitis, cholecystectomy, pancreatitis, Zollinger- Ellison syndrome 3h
- **Delivery of nutritional Support** – Meeting nutritional needs, Feeding, Aspects of nutrition, Enteral feeding, Enteral tube.
- **Nutrition in alcoholism**- effect of alcohol on digestion and absorption of nutrients alteration of nutrient metabolism and organ damage.

REFERENCES

1. Anderson,L.,Dibble,M.V.,Turkki,P.R.,Mitchall,H.S.,and Rynbergin , H.J.(1982) Nutrition in Health and Disease , 17thEd.,J.B.Lippincott Co.Philadelphia.
2. Aititia,F.P.(1973):Clinical Dietetics and Nutrition 'Second Edition, Oxford University press, Delhi.
3. Mahan,L.K.,Arlin,M.T., (1992): Krause's Food, Nutrition mid Diet Therapy, 8thEd. W.B.Saunders Cotnpany,London.
4. Robinson, C. H., Lawler, M. R., Chenoweth,W. L., and (Iiiwick,A.E.(1986) Normal and Therapeutic N i i I rition, 17thEd., MacMillan Publishing Co.
5. Williams,S.R.(1989):Nutrition and Diet Therapy, 6th Ed Times Mirror/Mosby college publishing,
6. Raheena,Begum(1989):A Textbook of foods, nutrition and dietetics. Sterling publishers, NewDelhi.
7. Joshi, S.A. (1 992):Nutrition and Dietetics, Tata McGr Hill Publications, New Delhi

Paper 11: Diet Therapy – 2

Unit I:7h

- **Diabetes Mellitus** - Classification, symptom diagnosis, management of diabetes mellitus-insulin therapy oral hypoglycemic agent, dietary care and nutrition therapy, meal plan (with and without insulin), specific dietetic foods, sweeteners and sugar substitutes, diabetes in pregnancy, elderly, surgery, illness, diabetic coma, insulin reaction, juvenile diabetes 4h
- **Dietary treatment of hypoglycemia.** Dietary management of diabetes – The role of soluble and insoluble fibers, artificial sweeteners, dietary recommendations for pre-diabetic, diabetic and severely effected diabetics 3h

Unit II: 6h

- **Diseases of the cardiovascular system:** Atherosclerosis - Etiology and risk factors 1h
- **Hyperlipidemia** - Brief Review of lipoproteins and their metabolism, classification of hyperlipidemia Clinical nutritional aspects of hyperlipidemia. Dietary care. 2h
- **Ischemic heart disease**- Nutritional management. Congestive heart disease and nutritional management. 2h
- **Hypertension** Etiology, prevalence, nutritional management and prevention.1h

Unit III: 8h

- **Renal diseases** - Review of physiology and function of a normal kidney 1h

- **Diseases of kidney** - Classification, etiology, characteristic symptoms 1h
- **Dietary management:** Glomerulonephritis- acute and chronic, Nephrotic syndrome Renal failure and uremia, acute and chronic renal failure. 3h
- **Dietary management:** renal dialysis and renal transplant. Chronic renal failure in patients with diabetes mellitus and children. Use of sodium and potassium, exchange lists, Nephrolithiasis.3h

Unit IV:14h

- **Nutrition in cancer:** Epidemiological studies, reproduction of the normal cells, classification of neoplasms, principles of cancer pathogenesis, causes of cancer cell development, metabolic and nutritional alterations in malignancy. Bodies defense 24 system, cancer therapy and nutrition, eating problems in cancer. Cancer blends preparation. HIV infection and AIDS: Epidemiology, transmission of HIV, defense pathophysiology, clinical manifestations, HIV infection and other disease, immunity and AIDS virus, dietary management prevention and control.5h
- **Nutrition for treating cancers:** Dietary components as anti-cancer agents. Role of Selenium, Vitamin-E, Vitamin-C, Vitamin-D, Vitamin-B12, Folic acid, Carotenes for preventing and treating cancers; 3h
- Isothiocyanates and selenocyanates containing diets as anti-cancer diets 2h
- Nutritional prevention of cancer – clinical trials. 4h

Unit V: 6h

- **Allergies** - Definition, symptoms, diagnosis and dietary management. Food selection. Food allergy in infancy. 2h
- **Diseases of Musculoskeletal system** - Dietary, management of rheumatoid arthritis, osteoarthritis, osteoporosis, Gout 2h
- Nutritional care in trauma. 1h
- Nutritional management of burns in patients 1h

PAPER 12: Advanced Nutrition- II

Unit I:4h

- **Energy** - Energy content of foods, Energy measurement - direct and indirect calorimetry
Energy utilization in cell, basal metabolism, physical activity, regulator. Thermogenesis,
energy requirement, variables, which influence the energy requirement, energy balance
and control of body weight, the share of three main energy nutrients - carbohydrate,
protein and fat. 4h

Unit II: 8h

- **Water soluble Vitamins:** Thiamine, riboflavin, niacin, vitamin B 12, pyridoxine,
pantothenic acid, biotin and ascorbic acid - history chemistry, sources, physiological
action, biochemical utilization, storage, transport, biosynthesis of vitamins, losses in
preparation and handling, recommended intake, deficiency diagnosis and toxicity,
methods of assay. 8h

Unit III: 8h

- Vitamins - Numbering and naming of vitamins, units and measurement of vitamins,
factors influencing the utilization of vitamins. 2h
- Fat soluble vitamins: A,D,E,K - History, chemistry, physiological action, transport,
utilization and storage, methods of assay, dietary sources, dietary losses in preparation
and handling, conversion of carotene in to vitamin A 6h

Unit IV: 8h

- Assessment of nutriture and methods of estimation in food materials 1h
- Fat soluble – A,D,E,K, 3h
- Water soluble – Thiamine, riboflavin, niacin, vitamin B 12, pyridoxine and ascorbic acid.
in human beings, RDA, deficiency and toxicity. 4h

Unit V:4h

- Interaction of vitamins and minerals with other nutrients 2h
- Minerals and vitamins as co enzymes and co factors in carbohydrate, protein and lipids
metabolic pathways 2h

REFERENCES

1. Vinodini Reddy ., Prajlad Raj., Gowrinath Sastry, J , Kashinath, K.C. (1993),
Nutrition Trends in India, NIN, Hyderabad.
2. Mahan, L.K., Arlin, M.T., (1992): Krause's Food, Nutrition and Diet Therapy, 8th Ed.
W.B. Saunders Company, London .

3. Joshi, S.A. (1992): Nutrition and Dietetics, Tata McGraw Hi 11 Publications, New Delhi.

Elective 3 Food Safety and Food Service Management

Unit I:4h

- **Food service industries in India** - acts and responsibilities. Fables, foibles, fraud and fact - note on eating preference and misinformation, reliable information, source of reliable information, government information and regulations on healthful food program. 4h

Unit II 4h

- Projecting and preserving nutrients during production, purchase, storage, cooking and serving. Types and function of menu, planning a menu according to food service type, recipes and special menu for food service. 4h

Unit III 4h

- Kitchen management Principles of layout, determination of equipment - factors affecting the selection, criteria for selection, types of equipment, basic materials used in manufacture of equipment, installation and care of equipments, fuel saving techniques, physical planning - architectural features, floor, walls, lighting, plumbing and ventilation. 4h

Unit IV: 6h

- **Food service** - Service areas, methods and styles, table winding up, setting, presentation techniques, clearing and customer relations. 3h
- **Laws governing food service institutions** -food laws, labor laws, laws concerning hygiene and safety 3h

Unit V 6h

- **Environmental hygiene and sanitation:** Hygiene in food, plant hygiene, safety handling, Personal hygiene, to prevent procedure followed in food service establishment to prevent accidents, facilities and benefits to workers in each establishment. 3h

- Indices of food and water field of catering establishment biological criteria of foods, testing and control measures. 2h
- Management of food waste and waste-water. 1h

REFERENCES:

1. Sethi, M. and Matha, S. Catering Management – An integrated approach, Wiley Eastern Ltd., New Delhi, II Edition 1993.
2. Branson, J.C. and Lennon, M. Hostel and Hospital Housekeeping, EILBS (Publication) V Edition 1992.
3. Palacio J.P. Harger . V., Shugart G. and thesis, M. West introduction to food service, Mac Millan publication Co., New York XVII Edition 1994.
4. Kotscheva, r. and. Teerell, M.E., Food service planning; layout and equipment, MacMillan Publication Co., New York, III Edition, 1985.
5. Splaver, B.R
6. .Successful catering, Van Norstrand Reinhold, New York, II Edition.
7. Kinton, R. and Cesarani, V., The Theory of catering ELBS, VII Edition, 1992.
8. Lillicap, D.R. and Cousins, J.A. Food and Beverage Service, ELBS, IV Edition, 1994.
9. Marris, M. McCreery, C and Brighton, R. Introduction to Catering, Blackwell Scientific Publication, London, 1993.
10. Delfakis, H, Scanion, W.C. and Van Burch, J.B. Food service Management, South Western Publication Co., Cincinnati, Ohio, 1992.
11. Cracknell, H.C. and Nobis, G. Mastering Restaurant Service, Macmillan Master Service, Macmillan Education Ltd., (pub) London, 1989.

PRACTICAL 3: CLINICAL NUTRITION

1. Analysis of blood for
 - a) Glucose
 - b) Hemoglobin - Cyanmethhaemoglobin method
 - c) Iron and Calcium - Wong's method
 - d) Total cholesterol, HDL, LDL and Triglycerides
 - e) Pyruvic acid
 - f) Serum A/G ratio and total protein
 - g) Serum phospholipid
 - h) Serum Vitamin A, C and E
 - i) Serum alkaline phosphatase
 - j) Serum creatinine
 - k) Serum Urea
 - l) SGOT and SGPT
2. Analysis of Urine for
 - a) Creatinine
 - b) Urea , c) Albumin , 3) Legumes and Vegetables cookery

REFERENCES:

1. Reghuramulu N., Naire, K.M & Kalyanasundaram, S.A. (1983), Manual of Laboratory Techniques, National Institute of Nutrition, ICMR, Silver Prints, Hyderabad.
2. Varley, H., Gowenlock, A.H and Hell, M. (1980), Practical clinical
3. Biochemistry, William Itinmaon Medical I looks, London.
4. Jayaraman, J.(1996), Laboratory manual in Biochemistry, New Age International Ltd, Publishers, New Delhi, Fifth Reprint.
5. Sadasivam, S and Manickam, A (1996), Biochemistry methods, New Age International Ltd. Publishers, New Delhi, Second edition.

M.Sc. Medical Statistics

Overview

JSS UNIVERSITY, Department of Faculty of Life Sciences Introduces an Innovative Career Oriented Program **M.Sc. Medical Statistics** with CBCS scheme, Which allows for greater flexibility for the students to enhance their learning experience, The MSc in Medical Statistics is a flexible degree programme blending theoretical and applied statistical disciplines ideal for training in medical statistics, This course aims to train students from a variety of academic backgrounds to work as statisticians in various sectors.

Medical Statistics is a fundamental scientific component of health research, deals with Applications of statistics to medicine and the health sciences, including epidemiology, public health, demography and clinical research. Medical Statistics is a sub discipline of statistics. "It is the science of summarizing, collecting, presenting and interpreting data in medical practice and using them to estimate the magnitude of associations and test hypotheses". It has a central role in medical investigations.

The course is designed to cover modern statistical theory and methods providing a good foundation for research in Medical Statistics. The emphasis throughout is on applying and adapting it to real-life circumstances. The course provides opportunity to develop skills for data analysis and the individual project work provides field experience and hands-on training.

The course also aim at providing students scope for professional development in understanding and use of statistical software packages including SPSS, R, MATLAB and Excel.

THE CURRICULUM INCLUDES

- Problem based learning.
- Introducing concepts through real examples.
- Discussion oriented teaching.

Eligibility: Any Undergraduate Science degree recognized by UGC with Mathematics as one of the subject in second PUC or 10+2 or its equivalence.

Job Opportunities

Medical Statisticians Typically Work In Collaboration With Scientists And Physicians. They May Work in Hospitals, In The Pharmaceutical And Biotech Industries, Market Research Organizations, Public Health And Utility Providers, Government Departments, Universities And Technical Institution.

The Key Tasks A Medical Statistician Is Likely To Undertake Include:

- Meeting With Medical Researchers To Identify And Understand Their Needs
- Selecting An Appropriate Study Design To Address The Medical Questions Being Researched
- Selecting And Applying Appropriate Statistical Techniques For Analyzing Medical Data
- Analyzing And Managing Statistical Data Using A Range Of Software Packages
- Interpreting Results
- Keeping Up-To-Date With New Developments In Medical Statistics

.

Medical statisticians, also called biostatisticians, work in a variety of medical and public health fields. They conduct statistical research to advance medical knowledge, track or prevent diseases and improve medications and treatments. There Are Several Opportunities For A Student Of Medical Statistics With Good Computing Techniques.

Job Opportunities Are Varied. A Statistician May:

- Consult In The Design And Analysis Of Clinical Studies, Evaluating New Pharmaceutical Agents
- Design Experiments For Agricultural, Ecological, Environmental, Or Energy-Related Studies
- Determine Mortality, Morbidity, And Accident Rates For An Insurance Company
- Develop Theories Of Learning And Behavior In Conjunction With Psychologists
- Determine Optimal Combinations And Evaluate Performance Of Various Chemicals In Industrial Setups
- Conduct Reliability And Quality Control Studies In Various Industries
- Develop Econometrics, Time Series, And Forecasting Models For Determining The Cause And Effects Of Various Socio-Economic Variables On The Society

M.Sc. Medical Statistics

	Semester I	Remarks
Paper 1	Basic Medical Statistics	4
Paper 2	Statistical Epidemiology	4
Paper 3	Fundamentals of Mathematics	4
Paper 4	Population and Health Data Management	4
Elective 1	Statistical Computing Using Excel and SPSS	4
Practical 1	Practical –I	6
		26
	Semester II	
Paper 5	Basics of Clinical Trial	4
Paper 6	Linear Regression and Robustness	4
Paper 7	Documentation and Research Methodology	4
Paper 8	Time Series and Spatial Statistics	4
Elective 2	Statistical Model Using `R`	4
Practical 2	Practical –II	6
		26
	Semester III	
Paper 9	Generalized Linear Models	4
Paper 10	Multivariate Analysis	4
Paper 11	Survival Data Analysis	4
Paper 12	Advanced Epidemiology	4
Elective 3	Data analysis Using MATLAB	4
Practical 3	Practical –III	6
		26
	Semester IV	
	Summer Project	2
	Thesis and viva voce examination	12
	Total Credits	92

Paper1: Basic Medical Statistics (4 Credits)

Unit: The Scope of Medical Statistics

Definition and Scope of Medical Statistics, Types of Measurement : Nominal , Metric And Ordinal Scales ,Discrete And Continuous Variables, Construction of Statistical Table And Frequency Distribution, Graphical Representation of Data, Measures Of Central Tendency : Mean, Median, Mode, Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation, Variance, Coefficient Of Variation, Skewness And Kurtosis.

Unit2: Quantitative Aspects of Medical Decisions: Probability

Random Experiment, Sample Space ,Event ,Trial , Outcomes ,Mutually Exclusive And Exhaustive ,Events, Independent Events, Types Of Probability, Axiomatic Approach to Probability ,Application Of Principles Of Probability To Biological Problems ,Additional Rule Of Probability, Conditional Probability, Generalization Of Multiplicative Law Of Probability, Probability Distribution: Binomial, Poisson and Normal Distribution-Properties and simple problems

Unit 3: Architecture of Medical Statistics: Sample Survey Methods

Population And Sample, Need For Sampling, Census And Sample Surveys, Sampling And Non Sampling Errors, advantages and disadvantages of sampling method, types of sampling method random sampling: SRSWR, SRSWOR, Systematic Sampling, Stratified Sampling, Cluster Sampling, non probability sampling .

Unit4: Test of Significance

Hypothesis ,Errors, Level Of Signification ,P Value ,One And Two Tailed Tests ,Critical Region Degrees Of Freedom , Fisher Z Transformation And Its Application ,Student t Test ,Chi-Square Test, F Test ,Relation Between t , Chi-Square F And Z Test.

Unit5: Methods based on rank order

Non Parametric Test, Kolmogorov - Smirnov One Sample And Two Sample Test , Runs Test, Wilcoxon Signed Rank Test, Mann-Whitney U Test, Median Test For Three Or More Samples, Kruskal-Wallis Test and One Way And Two Way ANOVA.

References:

1. Martin Bland: An Introduction to Medical Statistics
2. Abhaya Indrayan Sanjeev B.Sarmukaddam: Medical Biostatistics.
3. P. Armitage and G. Berry: Statistical Methods in Medical Research, Third Edition.
4. Gurumani N. An Introduction to Biostatistics.
5. Cochran,W.G. Sampling Technigues. Wiley.
6. Murthy.M.N.Sampling Thorey and Methods.
7. S C Gupta and V K Kapoor: Fundamental of Mathematical Statistics.

Paper2: Statistical Epidemiology (4 Credits)

Unit 1: Introduction and Tools of Epidemiology

Historical aspects of Epidemiology and evolution, Definition and understanding - Natural history of disease, Tools of Epidemiology: measuring disease Frequency (Prevalence, incidence, morbidity rates and attack rates).

Unit 2: The Role of Probability in Observational Studies

- Probability and the incidence proportion
- Inference based on an estimated probability
- Conditional probabilities
- Independence of two events
- Example of conditional probabilities—Berkson's bias

Unit 3: Measures of Disease-Exposure Association

- Relative risk
- Odds ratio
- The odds ratio as an approximation to the relative risk
- Symmetry of roles of disease and exposure in the odds ratio
- Relative hazard
- Excess risk
- Attributable risk

Unit 4: Principles of Measurements

- Types of measures
- Reliability
- Validity
- Accuracy
- Questionnaire construction
- Diagnostic tests
- Measurement issues

Assessing Significance in a 2x2 Table and Estimation and Inference for Measures of Association - Population-based designs, Role of hypothesis tests and interpretation of p-values

Unit 5: Infectious disease Epidemiology, Chronic disease Epidemiology

- Epidemiology of policy, public health programme, Health services etc.
- Roles of Genetic and Environmental Factors in Disease Causation.

References:

1. Gordis L, Epidemiology, 2004, Elsevier Saunders.
2. Nicholas P. Jewell, Statistics for Epidemiology, CHAPMAN & HALL/CRC A CRC Press Company

Paper 3: Fundamentals of Mathematics (4 Credits)

Unit 1: Trigonometry and Analytical Geometry

Trigonometric functions, trigonometric ratios of standard angles, allied angles, compound angles
Cartesian rectangular coordinate system, distance formula, section formula, straight lines, slopes, types of straight lines. Application in solving life science problems

Unit 2: Elementary Mathematics

Solutions of simultaneous linear equations, quadratic equations, progressions, permutations and combinations,

Unit 3: Matrices & Determinants

Introduction to Matrix, Transpose of a Matrix, Elementary row and column operations of Matrix, determinants, Properties of determinants (Without Proof) Rank of a Matrix, Minor and Co-factors Inverse of a matrix.

Unit IV: Numerical Method

Gauss Jordan, Jacobi and Gauss side methods, Newton-Raphson method. Transcendental function-
Logarithmic and exponential functions, Application in solving Biological science problems

Unit V: Vector Algebra

Definition, Types of Vectors, two and three dimensional vectors, Scalar (dot) and Vector (cross) product
. Application in solving Biological science problems

References:

1. T.B : SCHAUM Series books of calculus , vectors, statistics & matrices
2. Pharmaceutical Mathematics with Application to Pharmacy – PharmMed Press, A Unit of
BSP Books Pvt Ltd, 4-4-309/316, Giriraj Lane, Sultan Bazar, Hyderabad – 500 095 -
Panchaksharappa Gowda D.H.
3. Introduction to Mathematics for life scientist – Publisher- Springer (India) Pvt. Ltd- Edward
Batschelet

Paper 4: Population and Health Data Management (4 credits)

Unit 1: Demography and Measures of population:

Introduction to demographic data: Census, vital events, registration, survey, Application of Demography, Static Demography, Dynamic Demography, Collection of Demographic Data, Measures of population, Growth of population, Population Density, population distribution by age and Sex in India .

Unit 2: Vital Statistics:

Basic concept of Vital Statistics, Uses and Advantages of Vital Statistics, Application, Measures of Vital Statistics, Measures of fertility, Fertility rates, Reproduction rate, Measures of Marital Status, Measures Of Morbidity, Measures of Mortality, Crude Death rate, Standardized death rates, Specific Death rates, Monitoring of Family Planning Programme .

Unit 3: Life Table:

Basic Concept and Definition of a life table, construction of a life table, types of life table, Basic Assumptions for preparing a life table, Uses and Application of Life Table, Force of Mortality and Expectation of life, Population projection using logistic curve.

Unit 4: Population growth models:

Models for population growth: exponential, logistic, Gompertz models, Deterministic models, birth and death processes, logistic growth, Competition between populations, growth rate, stable population analysis, population projection by component method and using Leslie matrix.

Unit 5: National income and Development statistics:

Estimation of National Income - product approach, income approach and expenditure approach. Population growth in developing and developed countries, basic concept of National income –GNP,GDP, Uses of National income, problems in estimating National income, Methods of estimating National income, CSO,NSSO and Its activities, National accounts statistics of CSO, Measuring inequality of incomes, Gini coefficient.

Reference:

1. Mahajan B.K.: Methods in Biostatistics, 7th edition.
2. Spiegelman H : Introduction to demography, Harvard University press.
3. UNESCO: Principles of Vital Statistics Systems, Series M-12.
4. Keyfitz, N. Mathematical Demography
5. Pollard, J.H.: Mathematical Models for the growth of human population, Cambridge University press.

Eelective1: Statistical computing using Excel and SPSS

Unit1: Introduction to Excel

Workbooks and Worksheets, Cell Addresses, Entering And Editing Data, Savings Files, Importing/Accessing Data, Mathematical Operators In Excel, Creating Formulas And Functions, Data Analysis Toolpak: Installing The Analysis Toolpak, Using The Analysis Toolpak, Practice Problems.

Unit2: Creating Tables, Charts and Descriptive Statistics Using Excel Functions

Creating And Formatting Tables, Frequency Distribution Tables, Histograms And Bar Charts, Pie Chart, Scatter Diagram, Descriptive Statistics Using Excel Functions, Practice Problems.

Unit3: Statistical Functions in Excel Analysis Toolpak

Creating an XY Plot of Data, Using The Regression Function to Fit A Straight Line, Correlation, ANOVA, t-Test And F Test.

Unit4: SPSS For Windows: An Introduction

Overview And Scope Of SPSS, Starting SPSS, Typing in Data, Loading Data, Starting SPSS For Windows, Entering Data, Importing a File ,Defining The Variables, Missing Values, Saving Your Data, Help, Exiting SPSS.

Unit5: Writing / Performing Programs Using SPSS On Problems From The Following Topics:

Frequencies, Bar Chart, Pie chart, Box plot, Descriptive Statistics, One And Two Sample Parametric And Nonparametric Tests, Chi-Square Tests, Regression And Correlation Analysis, Analysis Of Variance and Kruskal-Wallis Test.

References:

1. Essentials Of Biostatistics Workbook Statistical Computing Using Excel: By Lisa M.Sullivan(Second Edition)
2. An Introduction To Statistics Using Microsoft Excel: By Dan Remenyi George Onofrei Joe English
3. Practical Statistics Using SPSS Authors Nicola Spiers, Brad Manktelow, Michael J. Hewitt
4. A Handbook Of Statistical Analyses Using SPSS By Sabine Landau And Brian S. Everitt

Paper 5: Basics of Clinical Trial (4 credits)

UNIT 1: Designing an Experiment: Clinical Trials

Selecting the participants, Measuring Baseline variables, Applying the interventions, Follow-up and adherence to the protocol, measuring the outcomes, analyzing the results, Alternatives to the randomized blinded trials

Randomization in Clinical Trials

Definition, Types of bias in randomization, Selection bias, Accidental bias

Fixed allocation randomization

- Simple randomization
- Block randomization
- Stratified randomization

Adaptive randomization

- Biased coin method
- Baseline adaptive (minimization)
- Outcome adaptive

Unit 2: Alternative Trial Designs And Implementation Issues

Factorial design, Group or Cluster Randomization, Non Randomized Between- Group designs, Within – Group designs (Time series and Cross – Over), Trial for regulatory approval of New interventions, Pilot Clinical trial, Conducting a clinical trial – Follow-up and Adherence to the Protocol, Adjudicating outcomes, Adaptive design, Analyzing the results

UNIT 3: Designing Studies of Medical Tests

Determining whether a test is useful , Studies of test reproducibility ,Studies of the accuracy of tests ,Studies of the effect of test results on clinical decisions ,Studies of feasibility, costs and risks of tests, Studies of the effect of testing on outcomes ,Pitfalls in the design or analysis of diagnostic test studies

UNIT 4: Addressing Ethical Issues

Ethical Principles, Additional Protection for Research Participants, Responsibilities of Investigators, Ethical Issues specific to certain types of research, other issues

UNIT 5: Classification of Clinical Trials: Phase-I, Phase-II, Phase-II and Phase – IV,

Sample size determination for Phase-I, Phase-II, Phase-III and Phase-IV Clinical Trials

Bioavailability and Bioequivalence Studies

References:

1. Designing Clinical Research – Third Edition – Stephen B.Hulley
Pub: Lippincott Williams and Wilkins, a Wolters Kluwer business, 530 Walnut Street, Philadelphia, PA 19106 USA, LWW.com
2. Introductory Biostatistics - CHAP T.LE - PUBLISHED BY John wiley and Sons,,Inc., Hoboken, New Jersey

Paper 6: Linear Regression and Robustness (4 credits)

Unit 1: Simple linear regression: assumptions, inference related to regression parameters, standard error of prediction, tests on intercepts and slopes, extrapolation, diagnostic checks and correction: graphical techniques, tests for normality, uncorrelatedness, homoscedasticity, lack-of-fit testing, polynomial regression, transformations on Y or X (Box-Cox, square root, log etc.), method of weighted least squares, inverse regression.

Unit 2: Multiple regression: definition, general purpose of Multiple regression, examples, multiple regression model, assumption of Multiple regression, application of Multiple regression analysis, estimation, testing linear hypothesis, confidence interval, confidence region, prediction of new observations, prediction interval, Polynomial regression in one variable, use of orthogonal polynomials, use of dummy variables, Introduction to non-linear models.

Unit 3: Logistic Regression: explanation, types of Logistic Regression, Logit transformation, ML estimation, Tests of hypotheses, Wald test, LR test, multiple logistic regression, forward, backward method, interpretation of parameters, relation with categorical data analysis, multicollinearity.

Unit 4: Non Linear Regression (NLS): main features of non linear regression, Non Linear equation, comparison of linear and Non Linear Regression. Linearization transforms, their uses & limitations, examination of non linearity, iterative procedures for NLS, Newton-Raphson, Marquardt's methods, Additive regression models, Introduction to nonparametric regression methods.

Unit 5: Robust regression: Influential observations, outliers, methods of detection of outliers and influential observations, M-estimators: Median, Trimmed and winsorized mean. Influence curve for M-estimators, Robust regression with rank residuals, Resampling procedures for regression models, methods and its properties (without proof), Jackknife techniques and least squares approach based on M-estimators.

Books for Reference

1. Lehmann, E. and Romano, J. P. (2010). Testing Statistical Hypotheses, Springer
2. Kendall, M. G. & Stewart, A. The Advanced Theory of Statistics, Vol. 2
3. Mood, A. M. & Graybill, F. A. (2009). Introduction to the theory of statistics, Tata McGrawHill
4. Rao, C. R. (2002). Linear Statistical Inference and its Applications, John Wiley & Sons, New York
5. Siegal, S. (). Nonparametric methods
6. Zacks, S. (1971). Theory of Statistical Inference (Probability & Mathematical Statistics), John Wiley & Sons.
7. Huber, P. J. and Ronchetti, E. M. (2011) Robust Statistics, Wiley, 2nd Edition.

Paper 7: Documentation and Research Methodology (4 Credits)

Unit 1: Introduction to Research: Need for Research, Designing the methodology, Protocol Writing, Report Writing and Presentation of data, Sample size determination and Power of study

Unit 2: Getting Started: The Anatomy and Physiology of Research

What it is made of, How it works, Designing the study,
Conceiving the Research Question: Origins of a research question, Characteristics of a good research question, Developing the research question and study plan,
Choosing Study Subjects: Basic terms and concepts, Selection criteria, Sampling, Recruitment of study subjects

Unit 3: Planning the Measurements: Precision and Accuracy

Measurement scales, Precision, Accuracy, Other features of measurement approaches,
Measurements on stored materials
Case Study: Types of case studies, Design and Analysis of study

Unit 4: Designing a Cohort Studies

Prospective cohort studies, Retrospective cohort studies, Nested Case-Control and Case-Cohort studies, Multiple-cohort studies and External Controls , Planning a cohort study
Designing an Observational Study: Cross sectional studies, Case control studies, Choosing among observational designs, Enhancing Causal Inference in Observational Studies: Spurious associations, Real associations other than cause effect, coping with confounders in the design phase, coping with confounders in the analysis phase.

Unit 5: Unit 5: Implementing the Study and Quality Control

Assembling Resources - Space, Research team, Leadership and Team- Building, Institutional Review Board Approval, Operational Manual and Forms Development, Database Design,
Finalizing The Protocol: Pre-test and Pilot Studies, Substantive Protocol Revision once Data Collection has begun, Quality Control During The study : Good Clinical Practice, Quality Control for Clinical Procedures, Quality Control for Laboratory Procedures, Quality Control for Data Management,

References:

1. Designing Clinical Research – Third Edition – Stephen B.Hulley
Pub: Lippincott Williams and Wilkins, a Wolters Kluwer business, 530
WWalnut street, Philadelphia, PA 19106 USA, LWW.com
2. Introductory Biostatistics - CHAP T.LE - PUBLISHED BY John wiley
and Sons, Inc., Hoboken, New Jersey

Paper8: Time Series and Spatial Statistics (4 credits)

Unit 1: components of time series, additive and multiplicative models, measurement of trend by moving averages and by least squares, Time series as discrete parameter stochastic process, auto-covariance and auto-correlation functions and , their properties, Partial autocorrelation function, Exploratory time series analysis, test for trend and seasonality.

Unit2: Detailed study of the stationary processes: Autoregressive(AR), Moving Average(MA), Autoregressive Moving Average, ACF and PACF plots of these processes, Non-stationary time Series models: ARIMA and Seasonal ARIMA Models.

Unit3: Estimation of mean, auto covariance and autocorrelation functions under large sample theory (statement only). Choice of AR and MA periods, Estimation for ARIMA model parameters

Unit4: Spectral analysis of weakly stationary process, Periodogram and correlogram Analyses, Spectral decomposition of weakly AR process and representation as a one sided MA process – necessary and sufficient conditions, Implication of spectral decomposition in prediction problems

Unit5: Basic concept and definition of spatial statistics, spatial statistics in current use and application of spatial statistics, Spatial statistical techniques: point pattern data, spatially continuous data, area data and interaction data, modeling spatial data: Basic concepts, statistical models, hypothesis testing, spatial data modeling, parameter estimation, geographically weighted regression, Software for spatial statistics

Books for Study

1. Abraham,B and Ledolter,J.C(1983). Statistical Methods for Forecasting, Wiley
2. Box, G. E. P. and Jenkins, G. M(1970). Time Series Analysis, Forecasting and Control Holden-Day.
3. Brockwell,P. J and Davis, R.A(1987). Time Series . Theory and Methods, Springer-Verlag
4. Bailey .T.C and Gatrell ,A.C.(1995) Interactive spatial data analysis. Longman, Harlow

Books for Reference

1. Anderson, T. W(1971). Statistical Analysis of Time Series, Wiley
2. Fuller, W. A(1978). Introduction to Statistical Time Series, John Wiley.
3. Kendall, M. G(1978). Time Series, Charler Graffin
4. Tanaka, K(1996). Time Series Analysis, Wiley Series

Elective 2: Statistical Model Using `R` (4 credits)

Unit1: Introduction to statistical software R:

Downloading and Installing R, Essentials, Advantages and objects, Functions and arguments, Manipulating vectors, Factors, Matrix operations: addition, subtraction, multiplication, Lists, Importing of files, Data frame, Getting Help: The functions help(), help.search() and example() .

Unit2: Descriptive statistics and Graphics in R:

Measure of central tendency and measure of dispersion (Mean, median, standard deviation, variance, quartiles, five-number summary), Measure of skewness and kurtosis, R-Graphics- Bar Graph, Pie chart, Box-plot, Stem and leaf plot and Histogram,

Unit3: Introduction to Probability and Probability Distribution using R functions:

Sample spaces, Events, Set Union, Intersection, and Difference, Basic probability problems in R, Conditional probability, Fitting of distributions to given data with R –Binomial distribution, Poisson distribution and Normal distribution, Simulation from discrete and continuous distribution.

Unit4: Using R functions for standard statistical tests and Programming in R :

One and two sample t-tests, Chi-squared tests, F- test for equality of variance and non parametric test, Kruskal-Wallis Test, Programming in R: for/while/loops.

Unit 5: R functions in Linear modeling:

Correlation, correlation coefficient, Simple linear regression, multiple linear regressions, Logistic regression, one way ANOVA and two way ANOVA.

References:

- 1) Purohit S.G., Gore,S.D. and Deshmukh,S.R.(2008) Statistics Using R, Alpha Science.
- 2) Peter Dalgaard: Introductory statistics for R ,Springer.
- 3) Statistical Methods Using R Software :V. R. Pawagi and Saroj A. Ranade
- 4) Verzani, J. (2005). Using R for Introductory Statistics, Chapman and Hall, London.
- 5) Introduction to Probability, and Statistics Using R, G. Jay Kerns, First Edition

Paper 9: Generalized linear models (4 credits)

Unit1: Basic concept and definition of generalized linear models, Assumptions of Generalized linear models, Concept of estimability, linear estimation: Gauss-Markov model, Least squares estimation, Distributional properties of least squares estimators, Gauss-Markov theorem.

Unit2: BLUE, Variances and covariance's of BLUEs, Error space, Estimation space, Tests of hypothesis in general linear models, ML estimation of parameters, Likelihood ratio tests for various hypotheses including independence, Marginal and conditional independence.

Unit3: Analysis of binary and grouped data by using logistic models, large sample tests about parameters, Goodness of fit, analysis of deviance, Variable selection, Introduction to poisson regression, Generalized Linear model: link functions such as Poisson, binomial, inverse binomial, inverse Gaussian.

Unit4: The Generalized Linear Mixed Model, including both fixed and random effects, Log linear model for two and three dimensional contingency tables, Interpretation of parameters, comparison with ANOVA and regression.

Unit5: Family of Generalized Linear Models: Exponential family of distributions, Formal structure for the class of GLMs, Likelihood equations, quasi likelihood, Link functions, important distributions for GLMs, Power class link function.

References:

1. Searle, S.R.(1971): Linear Models, John Wiley.
2. Alvin C. Rencher (2000): Linear Models in Statistics, John Wiley & Sons, New York
3. Guttman, I (1982): Linear Models - An Introduction , John Wiley
4. Dobson A J and Barnett A G, An Introduction to Generalized Linear Models, Chapman and Hall. (3rd Edition) 2008.
5. Lindsey J K, Applying Generalized Linear models, Springer, 1997.
6. McCullagh P and Nelder J A, Generalized Linear Models, Chapman and Hall, (2nd Edition), 1989.

Paper10: Multivariate Analysis (4 credits)

Unit1: Multivariate Data In Biological Sciences, Examples, Multivariate Normal Distribution, Maximum Likelihood Estimators Of Parameters, Multivariate Linear Regression Model, Estimation Of Parameters, Testing Linear Hypothesis About Regression Co-Efficients.

Unit2: Principal Component Analysis, Factor Analysis –Orthogonal Factor Model, Factor Loadings, Estimation Factor Loadings, Factor Scores, Applications, Canonical Correlations and Canonical Variable - Definition, Use, Estimation and Computation.

Unit3: Classification And Clustering, Linear Discrimination, Classification Trees, Hierarchical Clustering, K-Means Clustering, Multidimensional Scaling.

Unit4: Application in Test on Mean Vectors For Single And Several Multivariate Normal Populations, Hotelling's T² -Statistic and its Distribution, Relationship with Mahalanobis D² Statistic, Applications Of Hotelling's T²-Statistic.

Unit5: Methods and Applications of MANOVA, Structural Equation Modelling and Path Analysis.

References:

1. Anderson, T. W.(1984) Introduction to Multivariate Analysis (John Wiley)
2. Kshirsagar, A. M. (1983) Multivariate Analysis (Marcel Dekker)
3. Morrison, D.F.(1990) Multivariate Statistical Methods (McGraw Hill Co.)(3rd ed.)
4. Rao, C. R.(1995) Linear Statistical Inference and its Applications. (Wiley Eastern Ltd.)
5. Johnson R.A. & Wichern, D.W. (1988) Applied Multivariate Statistical Analysis
6. H'ardle, W. and Simar, L. (2003). Applied Multivariate Statistical Analysis. Springer.
7. Mardia, K.V., Kent, J.T. and Bibby, J.M. (1979). Multivariate Analysis. Academic Press.

Paper 11: Survival Data Analysis (4 credits)

Unit1: Introduction, Basic functions and Models. Censoring and Truncation , Parametric univariate estimation: Exponential, extreme value, gamma, Pareto, logistic, normal and log – normal, Survival function, hazard rate, cumulative hazard function, and mean residual life. Censoring mechanisms: type I, type II and random censoring.

Unit 2: Nonparametric univariate estimation: Actuarial, Kaplan-Meier and Nelson-Aalen Estimators, Tests of equality of survival functions: Gehan's and Mantel-Haenszel tests. Treatment of ties(Peto's method).

Unit 3: Semi parametric regression models: Cox proportional hazard model – estimation, tests, Diagnostics. Graphical methods: Hazard plots and Survival plots, Regression for grouped data: Life table, logistic and proportional hazards approaches.

Unit 4: Additive Models. Accelerated Models, Competing Risk and Multivariate Survival models, Frailty Models. Ageing classes - IFR, IFRA, NBU, NBUE, HNBUE .

Unit 5: understand Cox PHM, estimate coefficients from first principles on computer, test equality of coefficients using the likelihood-ratio(LR) test, fit model and do LR test on a computer.

References:

1. R.G.Miller : Survival Analysis
2. P.J.Smith : Analysis of Failure and Survival Data
3. J.D.Kalbfleisch&R.L.Prentice: The Statistical Analysis of Failure Time Data, 2nded.
4. J.P.Klein&M.L.Moeschberger: Survival Analysis : Techniques for Censored and Truncated Data
5. D.J.Kleinbaum and M.Klein: Survival Analysis – A Self-Learning Text

Elective 3: Data Analysis Using MATLAB (4 Credits)

Unit1: Introduction to MATLAB

What Is MATLAB, Advantages And Disadvantages, MATLAB Key Features, Getting Help In MATLAB, Importing And Exporting Data, Desktop Basics, Arithmetic Operations: Addition, Multiplication, Division, Powers, Log, Trigonometry, Exponential and Functions, Variables In MATLAB.

Unit2: MATLAB Graphics

2-D Plots And 3-D Plots, Formatting And Annotation ,Images ,Printing And Savings ,Line Plots :Syntax, Description ,Examples ,Plot Multiple Lines ,Create Line Plot From Matrix ,Specify Line Style ,Color And, Line Width ,Larker Size ,Marker Color ,Add Title And Axis Labels, Plot Circle, Plotting

Unit3: Descriptive Statistics and Distribution

Functions For Calculating And Plotting Descriptive Statistics: Maximum, Minimum, Mean, Median, Mode, Standard Deviation, Variance And Statistics On Plots, Basic Visualization: Bar Diagram And Histogram, MATLAB Commands For Discrete Distribution And Continuous Distribution, Introduction To Simulation Using MATLAB.

Unit4: Linear Algebra and Linear Methods.

About Matrices, Entering Matrices, Basics Matrix Operation: Matrix Addition and Scalar Multiplication, Matrix Multiplication, Matrix Algebra ,Matrix Inverses ,Powers Of A Matrix, The Transpose And Symmetric Matrices, Cross Product, Dot Product, System Of Linear Equations, Inverse And Determinants, Eigen Values.

Unit5: Modeling Data

Linear Correlation, Correlation Co-Efficient, Linear Regression: Simple Linear Regression, Fitting Data with Cure Fitting Toolbox, Multivariate Data, M-Files, Parametric and Non Parametric Test.

References:

1. Understanding MATLAB by S.N. Alam (Author), S.S. Alam
2. Statistics in MATLAB: A Primer by MoonJung Cho, Wendy L. Martinez
3. Computational Statistics Handbook with MATLAB, Second Edition, Wendy L. Martinez, Angel R. Martinez

http://in.mathworks.com/support/books/index_by_categorytitle.html?category=12&requestedDomain=www.mathworks.com

Paper 12: Advanced Epidemiology (4 Credits)

Unit 1: Experimental studies and Qualitative research

Experimental Studies -The Randomized Control trial, Allocation alternative, Maneuver, Measurement including blinding, Compliance, contamination, co intervention, adverse events, Stopping rules, Analysis, Diagnostic tests, Measurement issues, Qualitative research - Mixed designs, Ecological Studies, Space time cluster studies, Familial aggregation studies

Unit 2: Regression Models Relating Exposure to Disease

- Some introductory regression models
- The linear model
- Pros and cons of the linear model
- The log linear model
- The probit model
- The simple logistic regression model

Unit 3: Estimation of Logistic Regression Model Parameters

- The likelihood function
- The likelihood function based on a logistic regression model
- Properties of the log likelihood function and the maximum likelihood estimate
- Null hypotheses that specify more than one regression coefficient
- Logistic regression with case-control data
- Confounding and Interaction within Logistic Regression Models
- Assessment of confounding using logistic regression models
- Introducing interaction into the multiple logistic regression model
- Collinearity and centering variables

Unit 4: Matched Studies

- Frequency matching
- Pair matching
- Mantel-Haenszel techniques applied to pair-matched data
- Small sample adjustment for odds ratio estimator
- Confounding and interaction effects
- Assessing interaction effects of matching variables
- Possible confounding and interactive effects due to nonmatching variables
- The logistic regression model for matched data

Unit 5: Alternatives and Extensions to the Logistic Regression Model

- Flexible regression model
- Beyond binary outcomes and independent observations
- Introducing general risk factors into formulation of the relative hazard—the Cox model
- Fitting the Cox regression model
- When does time at risk confound an exposure-disease relationship?
- Time-dependent exposures
- Differential loss to follow-up

References:

1. Gordis L, Epidemiology, 2004, Elsevier Saunders.
- 2.Nicholas P.Jewell, Statistics for Epidemiology, CHAPMAN & HALL/CRC A CRC Press Company

Semester IV

Summer project	2 Credits
Thesis and viva vice examination	12 Credits

M. Sc. Nanoscience and Technology

General Overview of the Course

Nanotechnology is an emerging paradigm that is interdisciplinary in nature and expected to have great influence in a wide-range of products with far-reaching implications. It is an “enabling technology” wherein, using the principles of nanoscience, it is going to take the existing product and make it better. It is an interdisciplinary research area with involvement of basic sciences, medical and dental sciences and pharmaceutical sciences. In the area of life sciences, several exciting research topics are being explored such as design of nanotechnology enabled drug delivery systems with minimal side effects, scaffolds in tissue engineering for improved integration of biomedical implants, nanoparticle embedded membranes of waste water treatment, etc. The field of nanoscience and nanotechnology has already made significant in-roads in fructification into commercial products and is expected to continue to play an important role in several fields to enhance human kind.

The courses in the program are designed to provide the core principles in biochemistry, molecular biology and nanoscience along with the necessary practical skills in this interdisciplinary area to train the students in this new field. Through this training, the students not only seek employment opportunities in traditional life sciences-related industries but also better prepared to seize the emerging employment opportunities in nanotechnology-enabled industries.

Eligibility:

A graduate in Science (B.Sc.) from an UGC recognized University with biology as a major subject.

Career Opportunities:

- Ph.D. Scholar
- Research Scientist
- Formulation Designer and Product Developer
- Government agencies for regulatory monitoring
- Patent examiner

M. Sc. Nanoscience & Technology

	Semester I	Remarks
Paper 1	Fundamentals of Molecular Biology	4
Paper 2	Fundamentals of Nanotechnology	4
Paper 3	Fundamentals of Biochemistry and Biomolecules	4
Paper 4	Biochemical Techniques	4
Elective 1	Statistical Methods for Biology	4
Practical 1	Biochemical Techniques (Practical 1)	6
		26
	Semester II	
Paper 5	Cell and tissue culture technology	4
Paper 6	Properties of Nanomaterials	4
Paper 7	Nanobiology and Nanosystems	4
Paper 8	Synthesis and surface modification of nanomaterials	4
Elective 2	Cancer Biology	4
Practical 2	Synthesis and surface modification of nanomaterials (Practical 2)	6
		26
	Semester III	
Paper 9	Nanotechnology Product Development	4
Paper 10	Pharmacokinetics and drug metabolism	4
Paper 11	Nano-drug delivery systems	4
Paper 12	Biomedical Applications of nanomaterials	4
Elective 3	Environmental nanoscience	4
Practical 3	Pharmacokinetics and drug metabolism (Practical 3)	6
		26
	Semester IV	
	Summer Project	2
	Thesis and viva voce examination	12
		14
	Total Credits	92

PAPER 1: FUNDAMENTALS OF MOLECULAR BIOLOGY

4 CREDITS

Unit-I:

Biomolecules and Cells, Introduction, The Molecules of Life, Genomes, Cell Architecture, and Cell Function, Cells into Tissues: Unicellular and Metazoan Organisms Used for Molecular Cell Biology Investigations.

Unit-II:

DNA as Chemical and Genetic Material, Covalent Bonds and Noncovalent Interactions, Chemical Building Blocks of Cells, Chemical Reactions and Chemical Equilibrium, instances of Binding Reactions Reflect the Affinity of Interacting Molecules

Unit-III:

RNA Synthesis and Properties, Structure of Nucleic Acids, Transcription of Protein-Coding Genes and Formation of Functional mRNA, The Decoding of mRNA by tRNAs

Unit-IV:

Protein Synthesis and Properties, Chemical Building Blocks of Cells
Basic Molecular Genetic Mechanisms, Introduction, Structure of Nucleic Acids, The Decoding of mRNA by tRNAs, Stepwise Synthesis of Proteins on Ribosomes.
Overview of prokaryotic and eukaryotic gene regulations

Unit-V:

Biomolecule Structure and Function, Protein Structure and Function, Introduction, Hierarchical Structure of Proteins, Protein Folding, Chemical Reactions and Chemical Equilibrium, Membrane Proteins: Structure and Basic Functions

Protein Binding and Enzyme Catalysis, Purifying, Detecting, and Characterizing Proteins

Reference:

1. Bray A. D., Lewis J., Raff M., Roberts K. and Watson J.D. Molecular Biology of the Cell. B. Garland Publishing, New York and London.
 2. De Robertis E.D.P., De Robertis E.M.F. 2001. Cell and Molecular biology. Lippincott Williams & Wilkins. Bombay.
 3. Freifelder D. 1990. Molecular biology. Narosa Publishing House, New Delhi
 4. Gardner E J & D P Snustad 1996. Principles of genetics. John Wiley, New York.
 5. Alberts, B., Bray, D., Lewis, J., Raff, M, Roberts, K, and Watson, J. D. 5th Edition. 2007 Molecular biology of cell. Garland Publishing Inc., New York.
 6. Lodish, H., Berk A., Zipursky, S.L. Matsudaria, P. Baltimore, D. and Darnell, J. 2003. Molecular Cell Biology, Media connected, W.H. Freeman and Company.
 7. Celis J E (Ed). Cell biology. 1998. A laboratory handbook. Academic Press.
 8. Darnell J, Lodish H, Baltimore D 1990 Molecular Cell Biology. 2nd ed. New York, Scientific American Books.
 9. Cooper G M. The Cell: A Molecular Approach 2000 Sinauer Associates, Inc. Sunderland, Massachusetts.
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PAPER 2: FUNDAMENTALS OF NANOTECHNOLOGY

4 CREDITS

Unit I:

Fundamentals and overview of Nanoscience and Technology, History of nanoscience, properties at nanoscale – theory and definition, electronics, optical and magnetic properties at the nanoscale.

Unit II:

Types of nanomaterials, inorganic - metal and metal oxides, organic – self-assembly structures, liposomes, micelles, nanoemulsions and polymeric nanoparticles, carbon based systems – carbon nanotubes (CNTs), bucky balls and graphene.

Unit III:

Synthesis of nanomaterials. Top-down method – lithography, ball milling and etching, Bottom-up method – colloidal method of synthesis, wet-chemistry synthesis and self-assembly.

Unit IV:

Materials used in the synthesis of nanoparticles, organic-based synthetic polymers, phospholipids, surfactants, inorganic salts, natural biopolymers

Unit V:

Characterization of nanomaterials, electronic microscopy techniques, SEM and TEM, optical spectroscopy techniques, UV-vis absorption and fluorescence spectroscopy, dynamic light scattering, Scanning Probe Microscopy, Atomic force microscopy and scanning tunneling microscopy.

Textbooks:

1. *Nanoscale Science and Technology*, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, **2005**, ISSN: 978-0-470-85086-2.
2. *Introduction to Nanotechnology*, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, New Jersey, **2003**, ISSN: 978-0-471-07935-9.
3. *Bio-Inspired Nanomaterials and Nanotechnology*, Edited by Yong Zhou, Nova Science, **2005**, ISSN: 978-1608761050.
4. *Nano:The Essentials: Understanding Nanoscience and Nanotechnology*, T.Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, **2008**, ISSN: 978-0071548298.

5. *Nanocrystals: Synthesis, Properties and Applications*, C. N. R. Rao, P. J. Thomas and G. U. Kulkarni, Springer, New York, **2007**, ISSN: 978-3-54068751-1.
 6. *Nanochemistry: A Chemical Approach to Nanomaterials*, Geoffrey A. Ozin, Royal Society of Chemistry, Cambridge, UK, **2005**, ISSN: 978-1847558954.
-

PAPER 3: FUNDAMENTALS OF BIOCHEMISTRY AND BIOMOLECULES

4 CREDITS

Unit I:

Carbohydrates: Structure and classification of carbohydrates

Chemistry of monosaccharides: Pentoses, hexoses, deoxyglucose, amino sugars, muramic acid, neuraminic acid. Linkages in sucrose, lactose and maltose, trehalose and glycosides.

Isolation of polysaccharides: Homopolysaccharides and heteropolysaccharides, starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell wall polysaccharides, blood group polysaccharides, pectin and pectic polysaccharides.

Structural elucidation of carbohydrates: graded acid hydrolysis, periodate oxidation, methylation, acetylation, GC-MS, IR and NMR.

Glycobiology: Glycoproteins; N- and O-glycosylation, lectins, carbohydrates in tissue engineering. Proteoglycans; aggrecan, syndecan, and decorin.

Unit II:

Amino acids: Nomenclature, classification and buffering properties of amino acids, zwitterionic structure, reaction of amino acids, unusual amino acids, non protein amino acids.

Peptide bond: Features of the peptide bond, naturally occurring peptides; glutathione, enkephalins and endorphins. Chemical synthesis of peptides; Khorana's solution phase synthesis, Merrifield's solid phase synthesis.

Determination of amino acid compositions: Acid and base catalyzed hydrolysis, separation, quantification, determination of N and C terminal residues, determination of site of glycosylation and type of linkage (o-glycosyl and n-glycosyl).

Elucidation of structure of proteins - Isolation of proteins; overview of purification and criteria of purity.

Determination of primary structure: Sequencing strategies; N-terminal and C-terminal, sequencing methods. Automated sequencers. Determination of s-s-bond position. Secondary structure of protein; α , β sheet, β -bend, β -turn and super secondary structures. Secondary structure prediction methods; Ramachandran plot, Chou and Fasman algorithm. Tertiary and quaternary structures

Factors responsible for protein folding and confirmation: Anfinsen's experiment. Weak forces of interaction; hydrogen bonding, Vander Waal's forces, London force, ionic interactions, hydrophobic interactions, S-S bridges, peptide bond, glycosidic bond, phosphodiester bond, and allolysine. Denaturation and renaturation of proteins, molten globule. 3D Structure of myoglobin, hemoglobin, immunoglobulin, collagen,

chymotrypsin and keratin. Chaperons and Levinthal paradox.

Unit III:

Lipids: Classification of lipids; oils, fats, and waxes. Occurrence and physico-chemical properties of fatty acids, esters of fatty acids, cholesterol, phospholipids, glycolipids, sphingolipids, cerebrosides and gangliosides.

Lipid mediators: Eicosanoids, prostaglandins, leukotrienes, prostacyclins, thromboxanes, DAG and ceramide

Unit IV:

Nucleic Acids: Nitrogenous bases, nucleosides, nucleotides, physicochemical properties. Isolation of DNA and RNA from biological sources (microbes, plants and animals). Purification of nucleic acids, physicochemical properties of nucleic acids, melting of DNA, T_m ; factors affecting T_m , Cot curve, classification of DNA based on cot curve. Chemical reactions of DNA and RNA; Nucleotides as regulatory molecules, enzyme cofactors and mediators of chemical energy in cells.

Sequencing of DNA: Maxam Gilbert method, dideoxy method. Chargaff's rule, secondary structure of DNA. Watson and Crick model; B and Z DNA, other models of DNA structure. Types of RNA, secondary structure of tRNA and cloverleaf model; Other secondary structural features in DNA, stem loop structure, palindromic sequences, cruciforms. DNA protein interaction; zinc finger leucine zipper, helix-turn-helix, other motifs, DNA bending and kinks

Unit V:

Porphyrins – Structure and properties of porphyrins – Heme, chlorophyll and cytochromes. Reactive oxygen species and detoxification mechanisms.

Vitamins – Water soluble and insoluble vitamins, structure and function, deficiency symptoms.

Textbooks:

1) Lehninger PRINCIPLES OF BIOCHEMISTRY - 5th Edition
David L Nelson and Michael M. Cox

2) BIOCHEMISTRY – 5th Edition
Jeremy M. Berg; John L. Tymoczko and Lubert Stryer

3) BIOCHEMISTRY – 4th Edition
Donald Voet and Judith G. Voet

4) OUTLINES OF BIOCHEMISTRY – 5th Edition
Eric Conn and Paul Stumpf

5) TEXT BOOK OF BIOCHEMISTRY – 4th Edition

Edward Staunton West; Wilbert R. Todd; Howard S. Mason and John T. Van Bruggen

PAPER 4: BIOCHEMICAL TECHNIQUES

4 CREDITS

Unit I:

Separation techniques: Principles, methods and applications of chromatography – Paper, thin layer, ion exchange, gel filtration and affinity chromatography, GLC, HPLC, UPLC and chromatofocussing.

Spectroscopic techniques: Principles of colorimeter, spectrophotometer, fluorimeter. Beer-Lambert's Law and its limitations. Extinction coefficient, fluorescent probes and their applications

Unit II:

Cell fractionation techniques: Cell lysis, preparation of lysis buffers, pH, ionic strength, ionic and non-ionic detergents, composition of general lysis buffers such as RIPA, homogenization, extraction, salting in, salting out, dialysis and ultra filtration.

Centrifugation: Svedberg's constant, sedimentation velocity and sedimentation equilibrium.

Ultra centrifugation: Differential and density gradient centrifugation, centrifugal elutriation, construction of preparative and analytical ultracentrifuge, Schlieren optics

Unit III:

Electrophoretic techniques: Polyacrylamide gel electrophoresis, SDS-PAGE, 2D-electrophoresis, agarose gel electrophoresis, isoelectric focusing, pulsed field electrophoresis, high voltage electrophoresis, capillary electrophoresis, isotachopheresis. Separation of proteins, lipoproteins and nucleic acids. Visualizing separated components; staining, fluorescence, PAS staining, zymogram and reverse zymogram

Unit IV:

Isotopic tracers: Heavy isotopes and radio-isotopes, theory and construction of mass spectrometer. Ionization, fragmentation, m/e, time of flight, MALDI and ESI.

Radioisotopes in Biology: ^3H , ^{14}C , ^{32}P , ^{131}I , ^{35}S , concept of half-life, decay constant, detection and quantitation - GM counter and solid and liquid scintillation counter. Specific activity, autoradiography and their applications

Labeling: Using plant system (monosaccharides and polysaccharides), animal system, chemical ($\text{Glucose-}^{14}\text{C}$) and enzymatic methods (disaccharides). Labeling of acetate ($1\text{-}^{14}\text{C}$ and $2\text{-}^{14}\text{C}$), ATP ($\alpha\text{-}^{32}\text{P}$ and $\gamma\text{-}^{32}\text{P}$), proteins and nucleic acids.

Applications of radioactivity: Dilution techniques, pulse chase method, carbon dating, substrate product relationship (cholesterol biosynthesis) and bond cleavage specificity

Unit V:

Animal models, choice of animals, types of studies, xenografts, allografts, mutant organisms (auxotroph), cultured animal and plant cells as representative models.

Textbooks:

1) PRINCIPLES AND TECHNIQUEST OF BIOCHEMISTRY AND MOLECULAR BIOLOGY – 7th Edition

Keith Wilson and John Walker

2) BIOCHEMICAL TECHNIQUES THEORY AND PRACTICE

John F. Robyt and Bernard J. White

3) BIOCHEMICAL METHODS – A CONCISE GUIDE FOR STUDENTS AND RESEARCHERS

A. Pingoud; C. Urbanke; J. Hoggett and A. Jeltsch

4) BASIC METHODS FOR THE BIOCHEMICAL LAB

Holtzhauer Martin.

ELECTIVE 1: STATISTICAL METHODS FOR BIOLOGY

4 CREDITS

Unit 1:

Numerical Methods to Represent Variation-Importance and Scope of Statistics, Data Types, frequency distribution, Graphical Representation Methods (Histogram, Bar Charts, Pie Charts), Measures of Center Tendency (Mean, Median, Mode,) and Dispersion (Standard Deviation, Variance) Advantages and Disadvantages, Co-Efficient of Variance.

Unit 2:

Probability- Basic Terminology, Definition of Probability, Basic Laws of Probability, Types of Probability, Additional Rule of Probability and Multiplication Rule of Probability, Probability Distribution-Bernoulli Distribution, Binomial Distribution, Poisson distribution and Normal Distribution-Simple Problems.

Unit 3:

Sampling Methods- Collection of Data, Census Method, Concept of Population, Sample, Sampling, Sample Size, Sampling Error, Advantages and Disadvantages of Sampling Method, Necessity of Sampling, Types of Sampling Methods, Types of Random Sampling Methods – SRS, Stratified Random Sampling, Systematic Random Sampling And Cluster Sampling.

Unit 4:

Testing of Hypotheses- Statistical Hypotheses-Null and Alternative, Level of Significance, Type I and Type II Error, Critical Region, Power of the Test, P Value, Degrees Of Freedom, Chi-Square Test for Independence of Attributes and Goodness of Fit, Student's t Test: One Sample t Test and Paired t Test, F Test.

Unit 5:

Regression and Analysis Of Variance- Simple Linear Regression, Multiple Linear Regression (Definition, Assumptions, Applications, and Examples), Analysis of Variance –Introduction ,Definition of ANOVA, Assumption , Test Of ANOVA, Types Of ANOVA, Construction of One Way Analysis of Variance.

References:

1. Fundamentals of Biostatistics: Veer Bala Rastogi
2. Fundamentals of Mathematical Statistics: S.C. Gupta and V. K. Kapoor
3. Fundamentals of Statistics: S.C. Gupta
4. Biostatistics, Snedger and Gohrran.
5. Introductory Statistics for Biology 2nd Edition, R. E. Parker

PRACTICAL 1: BIOCHEMICAL TECHNIQUES

6 CREDITS

1. Paper chromatography – ascending and descending – separation of amino acids and sugars.
2. Qualitative tests for the identification of amino acids and carbohydrates.
3. Thin – layer chromatography of amino acids and lipids.
4. Column (GPC) chromatographic separation of proteins (albumin and trypsin).
5. Polyacrylamide Gel Electrophoresis and agarose gel electrophoresis of serum proteins.
6. Ion exchange chromatography of amino acids.
7. Absorption spectrum of chlorophyll extracted from green leaves.
8. Absorption spectrum of aromatic amino acids, purines and pyrimidines. Determination of Molar absorption coefficient of tyrosine.
9. Optical rotation of sugars using polarimeter
10. Molecular weight determination of proteins by SDS-PAGE
11. Western blotting
12. Quantitative estimation of proteins by spectrophotometric method.

Textbooks

- 1) PRINCIPLES AND TECHNIQUES OF BIOCHEMISTRY AND MOLECULAR BIOLOGY – 7th Edition, Keith Wilson and John Walker
- 2) BIOCHEMICAL TECHNIQUES THEORY AND PRACTICE, John F. Robyt and Bernard J. White
- 3) BIOCHEMICAL METHODS – A CONCISE GUIDE FOR STUDENTS AND RESEARCHERS, A. Pingoud; C. Urbanke; J. Hoggett and A. Jeltsch
- 4) BASIC METHODS FOR THE BIOCHEMICAL LAB
Holtzhauer Martin
- 5) PRACTICAL CLINICAL BIOCHEMISTRY
Harold Varley
- 6) HAWK'S PHYSIOLOGICAL CHEMISTRY – 14th Edition, By Philip Bovier Hawk,
Edited by Bernard L. Oser

PAPER-5: CELL AND TISSUE CULTURE TECHNOLOGY

4 CREDITS

Unit I:

Tissue culture media (composition and preparations), genetic methods and application of superior culture, protoplast, anther, pollen, ovary and embryo culture; organogenesis, somatic embryogenesis: hardening and green house technology, synthetic seeds, germ plasm conservation, somoclonal variations, protoplast fusion and somatic hybridization.

Unit II:

Gene transfer in plants- gene transfer through vectors- biology of vectors used Ti and Ri plasmids, binary vectors, viral vectors cloning strategy and method of gene transfer, vector less gene transfer- electrophoresis and gene gun method

Unit III:

Transgenic animal, methods used in gene identification, localization and sequencing of genes.

Unit IV:

Types of cell culture- primary and established culture, organ culture, tissue culture, three dimensional culture and tissue engineering, feeder layers, disaggregation of tissue and primary cell culture, Cell separation, cell synchronization, cryopreservation, Culture media, cell culture in continuous, hollow fiber reactor, mass transfer in mammalian cell culture.

Unit V:

Isolation of cells from various sources- maintenance of the cell- conclusion of stem cell research. Introduction to Bio artificial organs- Historical background- Liver, Kidney- skin, pancreas- Urinary Bladder- bone- challenging and advantages

Reference:

1. Plant cell and tissue c culture by Jeffrey W. Pollard and John M Walker.
2. Plant tissue culture by Dixon, Oxford Washington DC, 1985
3. Plant tissue c culture by Street.
4. Medical Molecular Biology – P.C. Trivedi (2008)
5. Principles of cell and Tissue engineering- Robert Lanza (2005)
6. Microbial genetics- Friedfelder
7. Animal tissue culture by Ian Freshney.

PAPER 6: PROPERTIES OF NANOMATERIALS

4 CREDITS

UNIT I:

Nanooptics: Absorption: direct and indirect bandgap transitions, Emission: photoluminescence and Raman Scattering, Chemiluminescence and Electroluminescence, Shape dependent optical properties, Quantum size effects in semiconductor quantum dots and nanowires, Optical absorption and emission, Surface plasmon resonance (SPR), Surface enhanced Raman scattering (SERS)

UNIT II:

Nanomagnetism: Introduction, fundamental concepts of magnetic materials – dia, para and ferromagnetism, magnetic phenomena in ferromagnetic materials, magnetic anisotropy, magnetic domains, hysteresis small particle magnetism, single domain particles, coercivity of single domain particles, superparamagnetism, coercivity of small particles, review of some issue in nanoscale magnetism.

Unit III:

Nanoscale Mechanics: Introduction, Mechanical properties, Density Considered as an Example Property, elasticity of nanomaterials, elasticity of bulk nanomaterials, plastic deformation of nanomaterials, physical basis of yield strength, crystals and crystal plasticity, crystal plasticity to polycrystal plasticity.

Unit IV:

Surface Properties of nanomaterials: Surface to volume ratio, scaling effects of nanoparticles, Intermolecular forces at the surface, effect of surface properties on flocculation, wetting and self-assembly in biological and synthetic systems.

Unit V:

Nanoelectronics: Electrical properties at the nanoscale, electrical properties of nanowires and CNTs, Semiconductor junctions; field-effect transistors, MOSFETs , electroactive polymers,

Textbooks:

1. *Nanomaterials : Mechanics and Mechanisms*, K. T. Ramesh, Springer London, **2009**, ISSN: 978-0-387-09782-4.
2. *Nanoscale materials in chemistry*, Kenneth J. Klabunde, John Wiley & Sons Ltd, New Jersey, **2009**, ISSN: 978-0-470-22270-6.

3. *Nanoscopic materials; Size dependent phenomena*, Emil Roduner, Royal Society of Chemistry, UK, **2006**, ISSN: 978-0-85404-857-1.
 4. Optical properties and spectroscopy of nanomaterials, Jin Zhong Zhang, World Scientific, USA, 2009, ISSN: 978-981-283-664-9.
 5. Nanoelectronics and nanosystems – K. Gosser, P. Glösekötter and J. Dienstuhl, Springer New York, 2008, ISSN: 3-540-40443-0.
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PAPER 7: NANOBIOLOGY AND NANOSYSTEMS

4 CREDITS

Unit I:

Introduction to Nanobiology, bio-inspired nanomaterials, interaction between biomolecules and nanoparticle surfaces, synthesis of hybrid nano-bio assemblies

Unit II:

Biological Membranes: Lipid membranes, structure and properties, models and methods for characterizing membranes, protein–lipid assembly, applications of biomimetic membranes, interaction of nanoparticles with membranes

Unit III:

Protein and DNA based nanostructures: Protein based nanostructures building blocks and templates, proteins as transducers and amplifiers of biomolecular recognition events, nanobioelectronic devices and polymer nanocontainers, topographic and electrostatic properties of DNA and proteins, Nanoparticles-based carrier for genetic material

Unit IV:

Stem cell nanotechnology: Basics, properties, classification and types of stem cells, three-dimensional scaffolds, stem cell differentiation and proliferation, nanotechnology-enabled cues – nanochemistry, nanoshapes and nanomechanics.

Unit V:

Microbial nanotechnology: Interaction of microbes with nanoparticles, surface properties, antimicrobial properties of metallic nanoparticles, mechanism of action.

Textbooks:

1. *Nanoscience : Nanobiotechnology and Nanobiology*, P. Boisseau, P. Houdy and M. Lahmani, Springer, New York, **2010**, ISSN: 978-3-540-88632-7.
2. *Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology*, Hari Singh Nalwa, American Scientific Publishers, USA, **2005**, ISSN: 1588830349.
3. *Nanobiotechnology*, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, **2004**, ISSN: 3-527-30658-7.
4. *Nanocomposite Science & Technology*, Ajayan, Schadler & Braun, Wiley VCH, **2006**, ISSN: 3527605177.

PAPER 8: SYNTHESIS AND SURFACE MODIFICATION OF NANOMATERIALS

4 CREDITS

Unit I:

Physical Method: Sonication methods, lithographic techniques, CVD and thermal evaporation methods, plasma and ion beam deposition, sputtering and ion-beam techniques

Unit II:

Chemical Method: Colloidal method, wet chemical method, electrodeposition, sol-gel method

Unit III:

Biological Method: Biologically synthesized nanomaterials, bacteria, fungi, actinomycetes and plant-based synthesis of nanoparticles, green-chemistry for nanoparticle synthesis.

Unit IV:

Process involved in surface modification, role of surfactants in properties, physical method for surface modification, chemical method for surface modification

Unit V:

In vitro and In vivo targeting strategies for nanoparticles, biological targeting, antibody targeting, protein targeting, aptamer binding, cell-surface receptor binding

Textbooks:

1. *Nanoscience : Nanobiotechnology and Nanobiology*, P. Boisseau, P. Houdy and M. Lahmani, Springer, New York, **2010**, ISSN: 978-3-540-88632-7.
 2. *Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology*, Hari Singh Nalwa, American Scientific Publishers, USA, **2005**, ISSN: 1588830349.
 3. *Nanobiotechnology*, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, **2004**, ISSN: 3-527-30658-7.
 4. *Nano:The Essentials: Understanding Nanoscience and Nanotechnology*, T.Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, **2008**, ISSN: 978-0071548298.
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ELECTIVE 2: CANCER BIOLOGY

4 CREDITS

Unit I:

Cell organelles and molecular organization of cell: Structural and functional organization of eukaryotic cells -cytoskeleton, plasma membrane, ribosome, endoplasmic reticulum, golgi complex, lysosome, mitochondria, peroxisome, nucleus elements of cells, biomolecules - nucleic acids, carbohydrates, lipids, proteins (structural and functional proteins), assembly of macromolecules.

Unit II:

Cellular reproduction and differentiation: The cell cycle, interphase, M-phase - mitosis and cytokinesis, meiosis; methods to study cell cycle changes, cell differentiation – general characteristics, nucleocytoplasmic interactions, molecular mechanisms of cell differentiation.

Unit III:

Cancer: Definition, benign tumors vs. malignant tumors, types of cancer, common symptoms, hallmarks of cancer – growth signal autonomy, evasion of growth inhibitory signals, evasion of apoptosis, unlimited replicative potential, angiogenesis, invasion and metastasis, molecular basis of cancer - cancer genes - oncogenes and tumor suppressor genes, carcinogenesis – a multistep process, evidences for multistage models of carcinogenesis, animal models of cancer – carcinogen induced models, xenografts, genetically modified models.

Unit IV:

Genetic instability and epigenetics: Basic defense, barriers to genomic instability, genetic variations in cancer, mechanisms of genome destabilization in tumors, chromosome instability, whole chromosome aneuploidy and cancer, perspectives and implication for cancer therapeutics, genetic mutations and drug resistance mechanisms, epigenetic process, epigenomic changes in cancer (DNA methylation, histone acetylation), epigenetic biomarkers and therapies

Unit V:

Signal transduction system: Sensory machinery, ligands and receptors, regulation of protein kinases, small-molecular second messengers, efficiency and specificity , formation of multiprotein signaling complexes, signaling networks influencing cell proliferation, survival and metastasis.

PRACTICAL 2: SYNTHESIS AND SURFACE MODIFICATION OF NANOMATERIALS

6 CREDITS

1. Synthesis of gold nanoparticles by three different methods
 - a. Sodium borate reduction method
 - b. THPC reduction method
 - c. Citrate stabilized method.
 2. Synthesis of magnetic NPs by two different methods
 - a. Co-precipitation method
 - b. Thermal decomposition method
 3. Synthesis of Quantum dots by two different methods
 - a. Microwave assisted method
 - b. Conventional hot plate method
 4. Synthesis of polymeric nanoparticles by two methods
 - a. Precipitation method
 - b. Solvent evaporation method
 5. Synthesis of lipid micelles
 6. Synthesis of liposomes
 7. Synthesis of nanoemulsions
 8. Synthesis of organic-inorganic hybrid systems
 - a. Magnetic NPs inside micelles
 - b. Magnetic NPs inside liposomes
 9. Synthesis of drug-loaded nanoparticle systems
 - a. Magnetic nanoparticles-drug loaded micelles
 - b. Drug loaded micelles
 - c. Drug loaded liposomes
 - d. Drug loaded nanoemulsion
 10. Fabrication of nanoporous titania films
 11. Fabrication of non-woven fibers by electrospinning technique.
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PAPER 9: NANOTECHNOLOGY PRODUCT DEVELOPMENT

4 CREDITS

Unit I:

Introduction, types of nano-businesses, ease of entry, intellectual property, ethics, risks/dangers, standardization, investors and commercialization centers, business applications, social aspects of nanotechnology

Unit II:

Business Development: Market landscape, tools to map, understand and segment the nanotechnology marketplace, end-users and applications, global market for products, academy-industry relationship, University and employee's inventions

Unit III:

Capital Market for product development: Types of funding, diluting vs non-diluting sources, government and foundations, angel investments, venture capital, private equity, other financing options.

Unit IV:

Intellectual Property and Regulatory Aspects: Indian and international IP perspectives, various mechanisms for protection, US PTO, Indian PTO, International IP flavors, Regulatory framework for developing nanotechnology marketplace, incentives for commercial applications, critical impact of regulation of nanotechnology – environmental, health and safety

Unit V:

Economics of product development: Comparison and projection of yield, manufacturing output, labor and equipment expenses to calculate and estimate costs, identification of equipment, facilities and overheads, specific manufacturing methods, tools to estimate the economics of process, addressing the effect of overall system costs and its benefits

Textbooks:

1. W.R. Cornish, Intellectual Property, Sweet & Maxwell, London (2000)
2. P. Narayana, Patent Law, Wadhwa Publication.
3. *Patent Law and Policy: Cases and Materials*, Robert Patrick Merges, LexisNexis Matthew Bender, **2011**, ISSN: 1422480305
4. *A Practical Guide to Patent Law*, Brian C. Reid, Sweet & Maxwell, **1998**, ISSN: 978-0421656307.

5. *Global Patent Litigation, Strategy and Practice*, Prof. Willem Hoyng, 2006, Kluwer Law International, **2006**, ISSN: 978-9041124609.
 6. *The Law of Patents – with a special Focus on Pharmaceuticals in India*, Feroz Ali Khader, LexisNexis Butterworths, Nagpur, **2007**, ISSN: 8180381501, 9788180381508.
 7. *Principles of Intellectual Property*, N.S. Gopalakrishnan and T. G. Agitha, Eastern Book Company, Lucknow, **2009**, ISSN: 8170121574, 9788170121572.
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PAPER 10: PHARMACOKINETICS AND DRUG METABOLISM

4 CREDITS

Unit I:

Nanoparticle for oral drug delivery: Physiology of GIT with reference to particulate uptake, Channels of uptake, Lymphatic uptake, Particle size and surface absorption critical factors

Unit II:

Brain delivery by nanoparticles: Bio distribution studies, Pathological study of CNS, Pharmacological activity, Mechanism of absorption

Unit III:

Ocular drug delivery: Disposition of nanoparticles in eye, Ocular drug delivery enhancement by nanoparticles, Safety and tolerability of nanoparticles

Unit IV:

Transdermal route of drug delivery: Mechanisms involved in transdermal Route of absorption, Particle size, lipophilicity effect on the absorption of drug, Metabolism of the drug, Safety and tolerability

Unit V:

Mucoadhesive route of drug delivery: Mechanism mucoadhesion, Mechanism of absorption, Factors effecting absorption, Absorption and metabolism

Textbooks:

1. *Industrial Pharmaceutical Biotechnology*, Heinrich Klefenz, Wiley-Vch Publication, Germany, **2002**, ISSN: 3527299955, 9783527299959
 2. *Pharmaceutical Biotechnology*, Daan Crommelin, Robert D Sindelar, 2002, Taylor and Francis Publications, New York, **2002**, ISSN: 415285003.
 3. *Hand book of Pharmaceutical Biotechnology*, Jay P Rho, Stan G Louie, Haworth press, New York, **2003**, ISSN: 789016354
 4. *Theory and practice of industrial pharmacy*, Lachman L Lieberman, HA, Kanig, J, 1986, 3rd edition, Varghese publishing & Co, New Delhi, **2000**, ISSN: 0812109775, 9780812109771
 5. Remington's Pharamaceutial sciences, Joseph Price Remington, 18th edition, Mack publishing & Co., Easton, 1980.
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PAPER 11: NANO-DRUG DELIVERY SYSTEMS

4 CREDITS

Unit I:

Principles of drug delivery systems: Modes of drug delivery, ADME hypothesis-controlled drug delivery, site specific drugs, barriers for drug targeting, passive and active targeting, Strategies for site specific, time and rate controlled delivery drugs, antibody -based and metabolism based targeting, Block copolymer, Polymer based nanocomposites, functional polymers, biodegradable and non-biodegradable polymers, Polymer structure and physical properties - crystalline melting point, the glass transition, factors affecting T_m and T_g.

Unit II:

Targeted Nanoparticles for drug delivery: Nanoparticle surface modification, bioconjugation, pegylation, antibodies cell- specific targeting and controlled drug release Cell recognition and signaling, signal transduction, cell surface receptors, methods in designing targeted nanoparticles for drug delivery

Unit III:

Implants and Inserts: Types of implants, Osmotic pumps, design and evaluation methods, types of inserts, design and evaluation methods, medical prosthetics and their applications

Unit IV:

Theory of controlled release drug delivery systems: Zero order kinetics, theory of diffusion, release and diffusion of drug from polymers, mechanism and kinetics, general methods of design and evaluations of controlled release products, sustained release

Unit V:

Design of nanoparticles for drug delivery applications: Liposomes, micelles, nanoemulsions, polymeric nanoparticles for drug delivery, pharmaceutical polymers, physicochemical properties of polymers and relationship with structure, properties, kinetics, mechanism and applications, hydrogels, strategies for long circulation, commercialized nanoparticles for drug delivery,

Textbooks:

1. *Nanoparticles as Drug carriers*, Vladimir P Torchilin, Imperial College Press, USA, **2006**, ISSN: 1860946305, 9781860946301.
 2. *Nanomedicine*, Parag Diwan and Ashish Bharadwaj, , Oscar Publications, India, **2006**, ISSN: 978-8182741394.
 3. *Nanobiotechnology*, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, **2004**, ISSN: 3-527-30658-7.
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PAPER 12: BIOMEDICAL APPLICATIONS OF NANOMATERIALS

4 CREDITS

Unit I:

Nanotechnology for tissue engineering: principles of tissue engineering, regenerative medicine, design of artificial scaffolds, reconstructive surgery, organ regeneration, hybrid nanomaterials

Unit II:

Nanomaterials for in vitro diagnostics: Nanosensors, principles of microfluidics, biomarkers detection, glucose monitoring, electrical, chemical and mechanical detection of biomarkers

Unit III:

Nanomaterials for in vivo imaging: Principles of molecular imaging, different imaging modalities - MRI, SPECT, PET, CT, non-invasive imaging modalities, radioisotopes

Unit IV:

Localized drug delivery: Systematic vs localized drug delivery, burst release, therapeutic dose, sustained release, platforms for localized drug delivery, drug reservoir, drug depot

Unit V:

Triggered release: Definition and need for triggered drug release, external triggers – light, ultrasound, magnetic field and electrical field, internal triggers – pH, enzymes, proteins, heat.

Textbooks:

1. *Nanoparticles as Drug carriers*, Vladimir P Torchilin, Imperial College Press, USA, **2006**, ISSN: 1860946305, 9781860946301.
 2. *Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology*, Hari Singh Nalwa, American Scientific Publishers, USA, **2005**, ISSN: 1588830349.
 3. *Nanomedicine*, Parag Diwan and Ashish Bharadwaj, Pentagon Press, India, **2006**, ISSN: 978-8182741394.
 4. *Nanotechnology in Biology and Medicine: Methods, Devices and Applications*, Tuan Vo-Dinh, CRC Press, **2014**, ISSN: 1439893780, 9781439893784.
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Elective 3: Environmental Nanoscience

Unit I:

Environmental pollution: Environmental fate and transport of Nanomaterials, physical-chemical interactions, aggregation and deposition, definition of air pollution, water pollution and ground pollution, contribution of nanoparticles in aggravating pollution. Environmental Health, Safety and Societal Concerns with nanotechnology, Safety of nanomaterials and societal implications, Green nanoscience – Approaches to safe nanotechnology

Unit II:

Toxic Impacts of Nanomaterials: Exposure and risk assessment, dose-response, mechanisms of toxicity, definition of eco-toxicity, routes of entry of nanomaterials into the environment, cytotoxicity of nanomaterials. Nanotoxicology – Methods for toxicity studies of nanoparticles, toxicology of carbon nanoparticles, toxicology of metal nanoparticles.

Unit III:

Health effects of nanoparticles: Sources of nanoparticles, epidemiological evidence, entry routes into the human body – Lung, Intestinal Tract, Skin, effect of nanoparticle size, shape and charge, effects of nanoparticles on - cardiovascular, liver and gastrointestinal and nervous system, coagulation and thrombosis, blood-brain barrier.

Unit IV:

Environmental application of nanomaterials: Environmental Remediation, nanoparticles reactivity, fate, and lifetimes in the subsurface, ground water remediation with nanoparticles, nanomaterials for water and wastewater treatment

Unit V:

Microbial interaction with nanoparticles: Applications and emerging opportunities in the area of nanoparticle interaction with microbes, detection of microbial pathogens with nanotechnology, nanozymes for biofilm removal
Ethics in Research and Development, ethics in medical applications, ethics in nanomedicine

PRACTICAL 3: PHARMACOKINETICS AND DRUG METABOLISM

6 CREDITS

1. Dissolution study of Nano drug delivery systems by Dialysis method or by using Dissolution apparatus
2. In vivo and ex vivo comparative absorption study for API and Nanocrystals.
3. Determination of Lymphatic absorption (In vivo, for lipid Nano formulations).
4. Diffusion study of Nano emulsion/suspensions using biological membrane.
5. Bio distribution of drug loaded nanoparticles.
6. Protein binding behavior of Nano suspension and API.
7. Study on blood components (Hemolysis) of Nano delivery systems.
8. Comparative metabolism study of API & Nano formulations Via GIT
9. Relative Bio availability of conventional and Nano formulations.
10. Elimination behavior of polymeric Nano formulations with reference to $t_{1/2}$, K_e , MRT.

Summer project work – 2 Credits

Thesis and viva-voce examination – 12 Credits
