GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)
(Deemed to be University, Estd. u/s 3 of UGC Act 1956)
VISAKHAPATNAM ∗HYDERABAD ∗BENGALURU
Accredited by NAAC with 'A^{+}' Grade

REGULATIONS AND SYLLABUS

of

Master of Science
in
Biochemistry

(w.e.f. 2019-20 Admitted batch)

Website: www.gitam.edu

Master of Science in Biochemistry (M.Sc. Biochemistry)
REGULATIONS
(w.e.f. 2019-20 admitted batch)

1. ADMISSION

1.1 Admission into M.Sc. Biochemistry and Molecular Biology program of GITAM (Deemed to be University) is governed by GITAM admission regulations.

2. ELIGIBILITY CRITERIA

3. A pass in B.Sc. with Life Sciences / BEM / B.Sc. Food Science / Home Science / B.Tech. Biotechnology and allied subjects / B.Pharm / B.P.T. / M.L.T/ BDS with a minimum aggregate of 50% or second division marks in group (optional) subjects in the qualifying examination or any other equivalent examination approved by GITAM (Deemed to be University)

3.1. Admission into M.Sc. Biochemistry and Molecular Biology (Master of Science in Biochemistry and Molecular Biology) will be based on an All India GITAM Science Admission Test (GSAT) conducted by GITAM (Deemed to be University) and the rule of reservation, wherever applicable.

4. CHOICE BASED CREDIT SYSTEM

Choice Based Credit System (CBCS) is introduced with effect from the admitted Batch of 2015-16 based on UGC guidelines in order to promote:

- Student Centered Learning
- Cafeteria approach
- Inter-disciplinary learning

Learning goals/ objectives and outcomes are specified leading to what a student should be able to do at the end of the program.

5. STRUCTURE OF THE PROGRAM

4.1 The Program Consists of

i) Foundation Courses (compulsory) which give general exposure to a Student in communication and subject related area.

ii) Core Courses (compulsory).

iii) Discipline centric electives which
   a) are supportive to the discipline
   b) give expanded scope of the subject
   c) give their disciplinary exposure
   d) nurture the student skills

iv) Open electives are of general nature either related or unrelated to the discipline.

v) Practical Proficiency Courses, Laboratory and Project work.

4.2 Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week.

4.3 In general, credits are assigned to the courses based on the following contact hours per week per semester.

- One credit for each Lecture / Tutorial hour per week.
- One credit for two hours of Practical per week.
- Eight credits for project.

4.4 The curriculum of the four semesters M.Sc. Biochemistry and Molecular Biology is designed to have a total of 96 credits for the award of M.Sc. Biochemistry and Molecular Biology degree.

6. MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be in english.

7. REGISTRATION

Every student has to register himself / herself for each semester individually at the time specified by the Institute / University.

8. ATTENDANCE REQUIREMENTS

8.1. A student whose attendance is less than 75% in all the courses put together in any semester will not be permitted to attend that end - semester examination and he/she will not be allowed to register for subsequent semester of study. He/she has to repeat the semester along with his / her juniors

8.2. However, the Vice Chancellor on the recommendation of the Principal / Director of the Institute/School may condone the shortage of attendance to the students whose attendance is between 66% and 74% on genuine grounds and on payment of prescribed fee.

9. EVALUATION

9.1. The assessment of the student's performance in a theory course shall be based on two components: Continuous Evaluation (40 marks) and Semester-end examination (60 marks).

9.2. A student has to secure an aggregate of 40% in the course in continuous and semester end examinations the two components put together to be declared to have passed the course, subject to the condition that the candidate must have secured a minimum of 24 marks (i.e. 40%) in the theory component at the semester-end examination.

9.3. Practical / Viva voce etc. course are completely assessed under Continuous Evaluation for a maximum of 100 marks and a student has to obtain a minimum of 40% to secure Pass Grade. Details of Assessment Procedure are furnished below in Table 1.

Table 1: Assessment Procedure

S. No.	Component of assessment	Marks allotted	Type of Assessment	Scheme of Examination
1	Theory	40	Continuous evaluation	(i) Three mid semester examinations shall be conducted for 15 marks each. The performance in best two shall be taken into consideration. (ii) 5 marks are allocated for quiz. (iii) 5 marks are allocated for assignments.
		60	Semester-end examination	The semester-end examination shall be for a maximum of 60 marks.
	Total	100		
2	Practicals	100	Continuous evaluation	60 marks for performance, regularity, record / and case study. Weightage for each component shall be announced at the beginning of the semester. 40 marks (30 marks for experiment (s) and 10 marks for practical Viva-voce) for the test conducted at the end of the Semester conducted by the concerned lab Teacher.
	Total	100		
3	Project work	200	Project evaluation	150 marks for evaluation of the project work dissertation submitted by the candidate. 50 marks are allocated for the project Viva-Voce. The project work evaluation and the Viva-Voce shall be conducted by one external examiner outside the University and the internal examiner appointed by the Head of the Department.

9. SUPPLEMENTARY EXAMINATIONS & SPECIAL EXAMINATIONS:

9.1 The odd semester supplementary examinations will be conducted on daily basis after conducting regular even semester examinations in April/May.

9.2 The even semester supplementary examinations will be conducted on daily basis after conducting regular odd semester examinations during November/December

9.3 A student who has completed his/her period of study and still has "F" grade in final semester courses is eligible to appear for Special Examination normally held during summer vacation.

10. PROMOTION TO THE NEXT YEAR OF STUDY

10.1 A student shall be promoted to the next academic year only if he/she completes the academic requirements of 60% of the credits till the previous academic year.

10.2 Whenever there is a change in syllabus or curriculum he/she has to continue the course with new regulations after detention as per the equivalency established by the BoS to continue his/her further studies

11. BETTERMENT OF GRADES

11.1 A student who has secured only a pass or second class and desires to improve his/her class can appear for betterment examinations only in 'n' (where 'n' is no.of semesters of the program) theory courses of any semester of his/her choice, conducted in summer vacation along with the Special Examinations.

11.2 Betterment of Grades is permitted 'only once', immediately after completion of the program of study.

12. REPEAT CONTINUOUS EVALUATION:

12.1 A student who has secured 'F' grade in a theory course shall have to reappear at the subsequent examination held in that course. A student who has secured 'F' grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

12.2 A student who has secured 'F' grade in a practical course shall have to attend Special Instruction classes held during summer.

12.3 A student who has secured 'F' grade in a combined (theory and practical) course shall have to reappear for theory component at the subsequent examination held in that course. A student who has secured 'F' grade can improve continuous evaluation marks upto a maximum of 50% by attending special instruction classes held during summer.

12.4 The RCE will be conducted during summer vacation for both odd and even semester students. Student can register a maximum of 4 courses. Biometric attendance of these RCE classes has to be maintained. The maximum marks in RCE be limited to 50% of Continuous Evaluation marks. The RCE marks are considered for the examination held after RCE except for final semester students.

12.5 RCE for the students who completed course work can be conducted during the academic semester. The student can register a maximum of 4 courses at a time in slot of 4 weeks. Additional 4 courses can be registered in the next slot.

12.6 A student is allowed to Special Instruction Classes (RCE) 'only once' per course.

13. GRADING SYSTEM

13.1 Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given in Table 2.

Table 2: Grades & Grade Points

Sl.No.	Grade	Grade Points	Absolute Marks
1	O (outstanding)	10	90 and above
2	A+ (Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79
4	B+ (Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C (Average)	5	45 to 49
7	P (Pass)	4	40 to 44
8	F (Fail)	0	Less than 40
9	Ab. (Absent)	0	-

13.2 A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, subject to securing an average GPA (average of all GPAs in all the semesters) of 5 at the end of the Program to declare pass in the program.

Candidates who could not secure an average GPA of 5 at the end of the program shall be permitted to reappear for a course(s) of their choice to secure the same.

14. GRADE POINT AVERAGE

14.1 A Grade Point Average (GPA) for the semester will be calculated according to the formula:

$$GPA = \frac{\Sigma [C * G]}{\Sigma C}$$

Where

C = number of credits for the course,
G = grade points obtained by the student in the course.

14.2 To arrive at Cumulative Grade Point Average (CGPA), a similar formula is used considering the student's performance in all the courses taken, in all the semesters up to the particular point of time.

14.3 CGPA required for classification of class after the successful completion of the program is shown in Table 3.

Table 3: CGPA required for award of Class

Class	CGPA Required
First Class with Distinction	≥ 8.0*
First Class	≥ 6.5
Second Class	≥ 5.5
Pass Class	≥ 5.0

*In addition to the required CGPA of 8.0 or more the student must have necessarily passed all the courses of every semester in first attempt.

15. ELIGIBILITY FOR AWARD OF THE M.Sc. Biochemistry and Molecular Biology DEGREE

15.1 Duration of the program: A student is ordinarily expected to complete M.Sc Biochemistry and Molecular Biology program in four semesters of two years. However a student may complete the program in not more than four years including study period.

15.2 However the above regulation may be relaxed by the Vice Chancellor in individual cases for cogent and sufficient reasons.

15.3 A student shall be eligible for award of the M.Sc Biochemistry and Molecular Biology Degree if he / she fulfills all the following conditions.

a) Registered and successfully completed all the courses and projects.
b) Successfully acquired the minimum required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated time.
c) Has no dues to the Institute, hostels, Libraries, NCC / NSS etc., and
d) No disciplinary action is pending against him / her.

15.4 The degree shall be awarded after approval by the Academic Council.

16. DISCRETIONARY POWER:

Not with standing anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

Scheme of Instruction

M.Sc. Biochemistry – I Semester

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction		Total	Scheme of Examination		
					Hours per Week			Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con. Eval
1	SBC 701	Biomolecules	PC	4	4	0	4	3	60	40
2	SBC 703	Cell Biology and Genetics	PC	4	4	0	4	3	60	40
3	SBC 705	Biochemical Techniques	PC	4	4	0	4	3	60	40
4	SBC 707	Basic Bioinformatics and Biostatistics	PC	4	4	0	4	3	60	40
5	SSE 701/ SSE 703	Skill enhancement course *	SEC	2	0	3	3	3	--	100
PRACTICALS										
6	SBC 721	Biochemical Techniques Lab	PP	3	0	8	8	3	--	100
7	SBC 723	Quantitative Analysis and Bioinformatics Lab	PP	3	0	8	8	3	--	100
8	SBC 791	Viva voce	--	1	--	--	--	--	50	
		Total		25	16	19	35	--	750	

*** Skill enhancement course (Choose one of the following)**

1. SSE 701: Basic Computer Tools
2. SSE 703: Information Technology Tools

M.Sc. Biochemistry- II Semester

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction		Total	Scheme of Examination		
					Hours per Week			Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con. Eval
1	SBC 702	Metabolism	PC	4	4	0	4	3	60	40
2	SBC 704	Enzymology and Enzyme Technology	PC	4	4	0	4	3	60	40
3	SBC 706	Systems Physiology	PC	4	4	0	4	3	60	40
4	SBC 708	Molecular Biology	PC	4	4	0	4	3	60	40
5	SAE 702	Professional Communication Skills	AEC	2	0	3	3	3	--	100
PRACTICALS										
6	SBC 721	Enzymology Lab	PP	3	0	8	8	3	--	100
7	SBC 723	Molecular Biology Lab	PP	3	0	8	8	3	--	100
8	SBC 792	Viva voce	--	1	--	--	--		50	
		Total		25	16	19	35	--	750	

M.Sc. Biochemistry - III Semester

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction		Total	Scheme of Examination		
					Hours per Week			Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con. Eval
1	SBC 801	Microbiology and Immunology	PC	4	4	0	4	3	60	40
2	SBC 803	Genetic Engineering	PC	4	4	0	4	3	60	40
3	SBC 805	Bioprocess Technology and Bioethics	PC	4	4	0	4	3	60	40
4	SBC 841	Genomics and Proteomics	GE	4	4	0	4	3	60	40
	SBC 843	Environmental Biochemistry and Biodiversity								
	SBC 845	Developmental Biology								
5	SOE 821	Cancer – Diagnosis, Therapy and Prevention	OE	3	3	0	3	3	60	40
	SOE 823	Fundamentals of Bioinformatics								
	PRACTICALS :									
6	SBC 821	Microbiology and Immunology Lab	PP	3	0	8	8	3	--	100
7	SBC 823	Genetic Engineering and Bioprocess Technology Lab	PP	3	0	8	8	3	--	100
8	SBC 891	Viva voce	---	1	---	---	--		**50**	
		Total		26	19	16	35	--	750	

M.Sc. Biochemistry – IV Semester

Sl. No.	Course Code	Name of the Course	Category	Credits	Scheme of Instruction		Total	Scheme of Examination		
					Hours per Week			Duration in Hrs.	Maximum Marks	
					L/T	P			Sem. End Exam	Con. Eval
1	SBC 802	Clinical Biochemistry and Cancer Biology	PC	4	4	0	4	3	60	40
2	SBC 842	Drug Designing and Nanotechnology	GE	4	4	0	4	3	60	40
	SBC 844	Nutritional Biochemistry								
	SBC 846	Stem cell Biology and Regenerative Medicine								
PRACTICALS										
3	SBC 822	Clinical Biochemistry and Cancer Biology Lab	PP	3	0	8	8	3	60	40
4	SBC 892	Viva voce	--	1	--	--	--	--	50	
5	SBC 892	Project Work	PP	8	0	0	0	3	--	200
		Total		20	8	16	24	--	550	

M.Sc. (BIOCHEMISTRY) - I SEMESTER

SBC 701: BIOMOLECULES

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

Biochemistry is a discipline, which aims at understanding the chemical properties of the biomolecules, their structural architecture, principles of stereochemistry and molecular forces responsible for the activities of biomolecules. The course includes their importance in understanding various biomolecular reactions and how they fold to their native, functional forms.

Course Objectives

- To understand the biological roles of carbohydrates (Mono, oligo, polysaccharides) and their chemical structures.
- To learn about amino acids, proteins, naturally occurring peptides and structural organization and its conformation.
- To outline the concept of lipids, their biological and chemical roles.
- To learn in detail the structures of DNA and RNA structure, sequence determination and synthesis.
- To understand the biological role of porphyrins and chemistry and physiological role of vitamins.

UNIT-I

Classification and chemical properties of carbohydrates. Chemistry and biological roles of mono, di and poly (homo and hetero) saccharides, peptdiogycans, glycosaminoglycans and glycoproteins. Structural elucidation of polysaccharides (starch).

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the classification and chemical properties of carbohydrates.
- Describe the biological roles of mono, di and polsaccharides.
- Understand the structure and biological role of peptidoglycans, glycosaminoglycans and glycoproteins.
- Elucidate the structure of starch.

UNIT-II

Amino acids- classification, structure and physicochemical properties, Peptide bond. Naturally occurring peptides. Solid phase peptide synthesis. Proteins – classification, purification and criteria of homogeneity. Structural organization, Conformation of protein structure – Ramachandran plot. Sequence determination. Denaturation of proteins.

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the classification, structure and properties of amino acids.
- Describe naturally occurring peptides, peptide synthesis.
- Understand the protein structure, its purification and criteria of homogeneity.
- Explain mitochondrial and plastid genomes.

UNIT-III

Classification of lipids, physicochemical properties of fatty acids, fats and oils. Properties and biological roles of phospholipids and sphingolipids. Properties and Biological functions of prostaglandins. Chemistry and properties of cholesterol.

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the classification and properties of fatty acids, fats and oils
- Describe the biological roles of phospholipids and sphingolipids.
- Understand the biological role of prostaglandins.
- Explain the structure and properties of cholesterol.

UNIT-IV

Nucleic acids – bases, nucleosides, nucleotides. Properties and functions of nucleic acids. Structure of DNA, Different forms of DNA. Circular DNA and DNA supercoiling. Chemical synthesis and sequencing of DNA. Types and structures of RNA. RNA double helices, triple helices, Watson Crick and Hoogsteen base pairing, mini double helices formed by ApU, GpU, turns bands in UpAH. Nucleotides as regulatory molecules and mediators of chemical energy in cells.

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the structure of bases, nucleosides, nucleotides.
- Describe the properties of nucleic acids.
- Understand the structure of DNA, RNA and its forms.
- Explain base pairing, forming helices between A, U, G.
- Learn the importance of nucleotides as regulatory molecules and mediators.

UNIT-V

Porphyrins – structure and properties of porphyrins – heme, cytochromes and chlorophyll. Chemistry and physiological role of fat soluble (A, D, E and K) and water soluble (C and B complex) vitamins.

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the structure and biological role of porphyrins.
- Describe physiological roles of fat soluble vitamins.
- Understand the physiological role of water soluble vitamins.
- Explain mitochondrial and plastid genomes.

Recommended books:

1. Principles of Biochemistry by Nelson and Cox 4th ed. Pearson
2. Biochemistry by Voet & voet 3rd ed. John Wiley and sons
3. Biochemistry by Matthews 3rd ed. PSN
4. Biochemistry by Lehninger 2nd ed. Kalyani Publishers
5. Biochemistry by Stryer 4th ed. WH Freeman and CO.

M.Sc. (BIOCHEMISTRY) - I SEMESTER

SBC 703: CELL BIOLOGY AND GENETICS

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

Our life and health depend upon the intricate relationship between the cellular and nuclear components. This course discusses about the organization of various cellular components, cytoskeletal structure and the amazing physiology of cellular interactions and communication both with the matrix and the genetic components. The course provides insights of various signalling cascades and their regulation; and provides a comprehensive understanding of various genetic aspects and impact of their mutations on cellular physiology and outcome. Completion of this course improves the understanding of the genetic basis for life and opens up new approaches for the investigation, diagnosis and treatment of disease.

Course Objectives:

- To study the structure of bacteria, plant and animal cells, plasma membrane and membrane transport mechanisms.
- To understand the mechanism of cell cycle and its regulation.
- To understand and figure out signal transduction mechanisms in health and diseases.

UNIT-I **10L**

Outline of cell architecture. Ultrastructure of plasma membrane. Structure and functions of mitochondria, chloroplast, nucleus, endoplasmic reticulum, golgi, lysosomes, ribosomes, cytoskeletal elements. Membrane transport - Membrane channels and pumps, exocytosis and endocytosis. Intracellular trafficking.

Learning outcomes
By the end of this unit, the student will be able to

- Learn about structure of bacteria, plant and animal cells, plasma membrane and membrane transport mechanisms
- Gain knowledge of structure and functions of mitochondria, chloroplast, nucleus, endoplasmic reticulum, golgi, lysosomes, ribosomes, cytoskeletal elements, Intracellular trafficking.

UNIT-II **10L**

Microscopy – Phase contrast, fluorescent, confocal and electron microscopy. Cell cycle and its regulation. Extracellular matrix, cell-cell interactions. Cell - matrix interactions. Cellular communication – exosomes, bacterial chemotaxis and quorum sensing.

Learning outcomes
By the end of this unit, the student will be able to

- Understand the mechanism of cell cycle and its regulation, cell-cell and cell - matrix interactions.
- Able to understand the mechanisms of cellular communications in prokaryotic and eukaryotic cells.

UNIT-III **10L**

Signal transduction – General features, types of signal transducers. G - proteins, secondary messengers - cAMP, cGMP, calcium, DAG, IP3, nitric oxide. Receptor tyrosine kinases, Growth factor signaling cascade. Regulation of signaling pathways.

Learning outcomes

By the end of this unit, the student will be able to

- Understand the signal transduction mechanisms and their significance
- Able to explain RTK and Growth factor signaling cascade and their regulatory mechanisms.

UNIT-IV

Mendel's laws and their limitations. Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting,multiple alleles, linkage and crossing over.Linkage maps, mapping with molecular markers, tetradanalysis. Sex-linkage-sex limited and sex influenced characters. Mutations – types, molecular mechanisms and significance.

Learning Outcomes:

By the end of this unit, the student will be able to

- Describe the basic laws of inheritance
- Explain deviations from basic laws of inheritance
- Lay down the genetic mechanisms of inheritance and variations
- Interpret and find out the various genetic crosses observed in different experiments

UNIT-V

Homologous and non-homologous recombination.Extra chromosomal inheritance - episomes, mitochondria and chloroplast.Transposons.Genetic equilibrium and Hardy-Weinberg law. Fine structure of rII locus- Benzers experiments, Complementation testing.

Learning Outcomes:

By the end of this unit, the student will be able to

- Explain the mechanism of genetic recombination
- Differentiate extra-chromosomal inheritance from chromosomal
- Illuminate, how genetic equilibrium is maintained in the population
- Lay down the experimental strategies to find out gene structure

Recommended Books:

1. Molecular Biology of the Cell by B. Alberts *et al*. Garland publications incorporation, 4th Ed.
2. Molecular Cell Biology by Harvey Lodish*et. al*. W. H. Freeman, 4th Ed.
3. Cell and Molecular Biology by E. D. P. De Roberties, International edition.
4. The Cell: A molecular approach by Geoffery M Cooper, 2nd Ed.
5. Principles of Genetics by Sinnet, McGraw Hill, 5th Ed.
6. Harper's Biochemistry by Robert K. Murray, Langeman.
7. Principles of Heredity by Robert Tymarin.A, Tata McGraw Hill, 7th Ed.
8. Genetics by M. W. Strickberger, Mac Millan, 3rd Ed.

M.Sc. (BIOCHEMISTRY) - I SEMESTER

SBC 705: BIOCHEMICAL TECHNIQUES

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

This course aims to provide knowledge of basic concepts and applications of various quantitative and qualitative biochemical techniques and skills required in various industries, research labs and in the field of human health. Completion of this course work will improve the knowledge of practical techniques used in designing and executing experiments in biochemical research. The number of conventional and modern analytical techniques along with their principle, instrumentation and applications are included in the course.

Course Objectives:

- To learn the basic concept and applications of various biochemical techniques.
- To study the isolation, purification and characterization of biomolecules using various centrifugal, chromatographic, electrophoretic and spectrophotometric techniques
- To understand the concept of radioactivity and handling function to perform operations in biochemical realm.
- To identify and apply the appropriate methodology in biochemical studies.

UNIT-I

Homogenization - Methods of disrupting cells and tissues. Centrifugation -Basic principles of sedimentation, Principle, methodology and applications of analytical and preparative ultracentrifugation.

Learning Outcomes:
By the end of this Unit, the student will be able to

- List the various methods of cell disruption and homogenization.
- Gains the basic principles of centrifugation and factors that determine the rate of sedimentation of a particle.
- Defining differential centrifugation, density centrifugation, and continuous centrifugation.
- Choose appropriate method for separation of cellular constituents.
- Extend the concepts of centrifugation in characterizing molecules.

UNIT-II

Principle, methodology and applications of chromatographic techniques - paper, thin layer, ion-exchange, gel permeation and affinity chromatography, GC, HPLC.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Understand the fundamentals behind the various separations methods.
- Describe the operating principles of the various column separation techniques, including gas chromatography and liquid chromatography.
- Select the operating conditions (mobile phase, temperature, flow rate, program rate, etc.) for the various separation techniques.
- Describe the instrumentation required for the various separation techniques and their associated operating principles.

UNIT-III

Principle, methodology and applications of electrophoretic techniques- native PAGE, SDS – PAGE, agarose gel electrophoresis, isoelectric focusing, two dimensional, pulse field gel electrophoresis and DIGE.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Perform protein/DNA analysis by polyacrylamide and agarosegel electrophoresis
- Use the operating principles of the various separation techniquesbased on charge and size isomers of proteins.
- Construct a standard curve for Protein/DNA markers migrating during SDS-PAGE/Agarose gel electrophoresis and extrapolating the size of an unknown fragment of protein/DNA.
- Simultaneously detect protein employing fluorescent dyes that are pH insensitive, photo-stable and spectrally distincts spots due to the multiplexing ability of DIGE
- Detect the presence or absence of proteins which might be an indicator of disease andaddress several biological questions.

UNIT-IV

Principles, methodology and applications of UV, Visible, Raman, Infrared, Atomic absorption spectroscopy, CD, NMR, GC-MS and MALDI-TOF. X-ray diffraction.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Will be able to interpret UV-Visible, IR, NMR spectroscopy.
- Explain working basic and using of elemental analysis device and report results of C,H,O,S analysis in sample.
- Explain working principles, taking spectrum and outline of atomic absorption spectroscopy device.
- Distinguish the specialties and applications of various types of spectroscopic methods
- Select the methods for determining size, shape, and 3D structure of bio-molecules and spectroscopic methods that are used to study biochemical processes.

UNIT-V

Radioactive tracer techniques: Nature and units of radioactivity, detection and measurement of radioactivity – GM and Scintillation counters. Autoradiography. Applications of radioisotopes in biology.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Will be able to Use first-order kinetics to examine the rates of nuclear decay and be able to calculate the half-life of a radioisotope.
- Estimate the remaining amount of a radioisotope, given the appropriate data.
- Compare the penetrating power of alpha, beta, neutron, and gamma radiation.
- Understand the factors that determine the biological effects of radiation.
- Identify the methods for determining absorbed dose, penetrating ability, ionizing ability and units of radioactivity.

Recommended Books:

1. A Biologists guide to Principles and techniques of practical Biochemistry by B.D.Williams, Edward Arnold.
2. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson, John Walker,Cambridge University Press,7th Ed.
3. Biophysical chemistry principles and techniques by Upadhyay, Upadhyay and Nath, Himalaya publishing.
4. Instrumental methods of chemical analysis by ChatwalandAnand, Himalaya Publishers,5thEd.
5. Modern Experimental Biochemistry by Rodney F. Boyer.

M.Sc. (BIOCHEMISTRY) - I SEMESTER

SBC 707: BASIC BIOINFORMATICS AND BIOSTATISTICS

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

Bioinformatics is an interdisciplinary field mainly involving molecular biology and genetics, computer science, mathematics, and statistics. The most common problems are modeling biological processes at the molecular level and making inferences from collected data. Bioinformatics is data intensive, and large-scale biological problems are addressed from a computational point of view. Biostatistics is basic application of statistics to biological observations to validate the laid hypothesis and orient towards the right pathway to achieve the goal in biological experiments. This course provides the methodology, basis of choosing correct methodology for biological observations

Course Objectives

- To understand explosion, nature and types of biological data and its role in biological research to solve real world biological problems.
- To understand the concept and applications of bioinformatics to solve real world biological problems.
- To understand the concept and types of literature databases, nucleic acid databases, metabolic, protein and interaction databases; and their uses to understand to biology.
- To learn basic concepts of representing biological data and analysing the data using central tendency and deviation methods.
- To understand the methodology for laying hypothesis and proving or disproving the hypothesis using different significance tests.

UNIT - I

Introduction to Bioinformatics; Types of Biological data and its applications using computational tools; Omics studies; Major resources of Bioinformatics – NAR databases, NCBI, EMBL-EBI and Expasy; Literature databases: PubMed, PubMed Central and Public Library of Sciences.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of bioinformatics to solve real biological problems.
- Explain about the scope of computers and their role in biological research.
- Describe the principles behind retrieving and analyzing biological data.
- Describe about the nature and types of biological data to understand to complex biological networks or systems.
- Illustrate the explosion of biological data and its role in biological research.

UNIT – II

Nucleic acid sequence databases - NCBI, EMBL and DDBJ; Protein sequence databases – NCBI Protein, TrEMBL and Uniprot; Concepts of pairwise and multiple sequence alignments; Similarity based search engines – BLAST and FASTA.

Learning Outcome:
By the end of this unit, the student will be able to

- Understand the concept and types of literature databases and their role biological research.
- Understand the concept and types of nucleic acid and protein databases.
- Understand the concept of sequence similarities and tools.

UNIT – III

Protein structure databases – RCSB PDB, SCOP and CATH; Metabolic pathway databases – KEGG, BioCyc and Reactome; Protein-Protein interaction databases – STRING, ConsensusPathDBandBioGRID.

Learning Outcome:
By the end of this unit, the student will be able to

- Understand the types of structural databases and their role in biological research.
- Understand the concept and types of metabolic and interaction databases.

UNIT-IV

Basics of Statistics: Biostatistics – Introduction and applications, scientific data description, tabulation and graphical representation. Measures of central tendency – Mean, Median and Mode.Measures of dispersion – Range, Standard deviation, Standard error and Variance.

Learning Outcomes:
By the end of this unit, the student will be able to

- Represent the given raw data in using different graphical methods
- Calculate the central tendency value of mean, median, mode for the given data
- Estimate the deviation among the raw data from the central tendency value
- Identify and choose correct statistical method to analyse the data

UNIT-V

Types of errors -Type I and Type II errors. Level of significance.Testing of Hypothesis: F-test, Students't' test, Chi-square test, Correlation co-efficient, Regression analysis, ANOVA.

Learning Outcomes:
By the end of this unit, the student will be able to

- Identify the errors made in the statistical analysis and their significance
- Lay down the hypothesis and subject it to validation using significance tests
- Correlate the two variables and able to make regression lines for prediction of correct observation in the data
- Choose best method of comparing sample data depending upon the variables

Recommended Books:

1. Introduction to Bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999
2. Lesk, A.M. (2014) "Introduction to Bioinformatics"; Oxford University Press, UK, Fourth ed.
3. JinXiong. Essential Bioinformatics, 01 Edition, 2009, Cambridge University Press.

M.Sc. (BIOCHEMISTRY) - I SEMESTER

SSE 701: BASIC COMPUTER TOOLS

Hours per week: 3 End Examination: 100Marks
Credits: 2

Preamble:
The course gives an understanding about the characteristics and classification of computers, various components of computer along with different operating systems that are available. It gives a hands on training on the packages MS-Word, MS-Power Point and MS-Excel. The course also comprehends AI tools.

Basics of Computers:

Definition of a Computer - Characteristics and Applications of Computers – Block Diagram of a Digital Computer – Classification of Computers based on size and working – Central Processing Unit – I/O Devices, Primary, Auxiliary and Cache Memory – Memory Devices. Software, Hardware, Firmware and People ware – Definition and Types of Operating System – Functions of an Operating System – MS-DOS –MS Windows, UNIX. Introduction to AI tools.

MS-Word

Features of MS-Word – MS-Word Window Components – Creating, Editing, ormatting and Printing of Documents – Headers and Footers – Insert/Draw Tables, Table Auto format – Page Borders and Shading – Inserting Symbols, Shapes, Word Art, Page Numbers, Equations – Spelling and Grammar – Thesaurus – Mail Merge.

MS-PowerPoint

Features of PowerPoint – Creating a Blank Presentation - Creating a Presentation using a Template - Inserting and Deleting Slides in a Presentation – Adding Clip Art/Pictures - Inserting Other Objects, Audio, Video- Resizing and Scaling of an Object –Slide Transition – Custom Animation.

MS-Excel

Overview of Excel features – Creating a new worksheet, Selecting cells, Entering and editing Text, Numbers, Formulae, Referencing cells – Inserting Rows/Columns –Changing column widths and row heights, auto format, changing font sizes, colors, shading.

Reference Books:

1. Fundamentals of Computers by V.RajaRaman, PHI Learning Pvt. Ltd, 2010.
2. Microsoft Office 2010 Bible by John Walkenbach, Herb Tyson, Michael R. Groh andFaithe Wempen, Wiley Publications, 2010.

Learning Outcomes:

- Able to understand fundamental hardware components that make up a computer's hardware and the role of each of these components
- Understand the difference between an operating system and an application program, and what each is used for in a computer.
- Acquire knowledge about AI tools.
- Create a document in Microsoft Word with formatting that complies with the APA guidelines.
- Write functions in Microsoft Excel to perform basic calculations and to convert number to text and text to number.
- Create a presentation in Microsoft PowerPoint that is interactive and legible content

M.Sc. (BIOCHEMISTRY) - I SEMESTER

SSE 703: INFORMATION TECHNOLOGY TOOLS

Hours per week: 3 End Examination: 100Marks
Credits: 2

Preamble:

The course enables the student to understand networking concepts related to Internet and introduce the social Networking sites and working of Email. It gives orientation of Block Chain technology. It give hands on training in SPSS, R Programming and creation of simple HTML documents.

Introduction to Internet:

Networking Concepts, Data Communication –Types of Networking, Internet and its Services, Internet Addressing –Internet Applications–Computer Viruses and its types –Browser –Types of Browsers.

Internet applications:

Using Internet Explorer, Standard Internet Explorer Buttons, Entering a Web Site Address, Searching the Internet– Introduction to Social Networking: twitter, tumblr, Linkedin, facebook, flickr, skype, yahoo!, google+, youtube, WhatsApp, etc.

E-mail :

Definition of E-mail, Advantages and Disadvantages,User Ids, Passwords, Email Addresses, Domain Names, Mailers, Message Components, Message Composition, Mail Management, Email Inner Workings.

WWW:

Web Applications, Web Terminologies, Web Browsers ,URL–Components of URL, Searching WWW –Search Engines and Examples**.**

Block Chain technology:

What is Block Chain, Blockchain Architecture, How Block chain Transaction Works? Why do we need Blockchain? Block chain versions, Block chain Variants, Block chain Use Cases, Important Real-Life Use Cases of Block chain Bitcoin cryptocurrency: Most Popular Application of Block chain, Block chain vs. Shared Database, Myths about Block chain, Limitations of Block chain technology.

SPSS :

SPSS Commands, Descriptive Statistics, Hypothesis Testing, Test of Difference, Analysis of Variance- One Way ANOVA, Non Parametric Tests, Correlation Analysis, Regression Analysis.

R Programming:

Becoming familiar with R, Working with Objects, Introduction to Graphical Analysis.

HTML:

WEB Terminology, Structure of HTML Document, HTML – Head and Body tags, Semantic tags- HR- Heading, Font, Image & Anchor tags, Different Types of Lists using Tags, Table Tags, Image Formats – Creation of Simple HTML Documents.

Recommended Books:

- In-line/On-line : Fundamentals of the Internet and the World Wide Web by Raymond Greenlaw and Ellen Hepp, 2nd Edition, TMH.
- Microsoft Office 2010 Bible by John Walkenbach, Herb Tyson, Michael R. Groh and Faithe Wempen, WileyPublications.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Enable to understand the basic networking concepts, types of networks, Internet Explorer and www.
- Outline the Block chain architecture, Bitcoin Crypto currency and Limitations of Block Chain.
- Choose different statistical tests to be performed on the data sets.
- Demonstrate the R programming with simple graphs.
- To make use of commands to structure HTML document.

M.Sc. (BIOCHEMISTRY) - I SEMESTER

SBC 721: BIOCHEMICAL TECHNIQUES LAB

Hours per week: 8 End Examination: 60Marks
Credits: 3 Sessionals: 40Marks

Analytical Techniques

1. Paper chromatography – separation of amino acids and sugars.
2. Thin layer chromatography – separation of amino acids and plant pigments.
3. Column chromatography – separation of plant pigments and their absorption spectra.
4. Separation of compounds/ proteins based on specificity - Affinity Chromatography.
5. Separation of compounds based on charge - Ion-Exchange chromatography.
6. Separation of compounds based on size - Gel permeation chromatography.
7. Analysis of a compound using HPLC.
8. Polyacrylamide gel electrophoresis of serum proteins.
9. Determination of molecular weight of a protein by SDS-PAGE.
10. Spectrophotometry: The absorption spectrum and determination of molar absorption coefficient of aromatic amino acids, nucleic acids and protein.

Recommended Books:

1. Biochemical methods by Sadasivam and Manikam, Wiley Eastern Limited.
2. An introduction to practical Biochemistry by D. T. Plummer, Mc Graw Hill.
3. Laboratory manual in Biochemistry by J. Jayaraman, Wiley Eastern Limited.
4. Introductory Practical Biochemistry by S. K. Sawhney and Randhir Singh, Narosa

M.Sc. (BIOCHEMISTRY) - I SEMESTER

SBC 723: QUANTITATIVE ANALYSIS AND BIOINFORMATICS LAB

Hours per week: 8 End Examination: 60Marks
Credits: 3 Sessionals: 40Marks

Quantitative analysis

1. Estimation of protein by Spectrophotometric method.
2. Estimation of protein by Lowry method.
3. Estimation of protein by Bradford method.
4. Determination of pK and pI value of an amino acid.
5. Estimation of total lipids.
6. Estimation of Carbohydrates

Bioinformatics Lab

1. Literature databases: PubMed, PMC and PLOS.
2. Nucleic acid sequence databases: NCBI, EMBL and DDBJ.
3. Protein sequence databases: Uniprot and TrEMBL.
4. Protein structure databases: PDB and SCOP.
5. Metabolic pathway databases: KEGG and Reactome.
6. Protein interaction databases: STRING and BioGRID.
7. Homologous sequence search by BLAST and FASTA.
8. Multiple sequence alignment and tree construction.

Recommended Books:

1. Lab manual in Biochemistry by J. Jayaraman, Wiley Eastern Limited
2. Biochemistry – a lab course by J.M. Becker, Academic Press
3. Experimental Biochemistry: A student companion by Beedu Sashidhar Rao and Vijay Deshpande, I.K. International Pvt. Ltd., New Delhi.
4. Biochemical methods by S Sadasivan and A Manickam. New Age international publishers
5. An introduction to practical Biochemistry by D. T. Plummer, Mc Graw Hill.
6. Introductory Practical Biochemistry by S. K. Sawhney and Randhir Singh, Narosa

M.Sc. (BIOCHEMISTRY) – II SEMESTER

SBC 702: METABOLISM AND BIOENERGETICS

Hours per week: 4 End Examination : 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

Metabolism encompasses the set of life sustaining chemical transformations within the cells of living organisms. Inter conversion of chemical compounds in the body, the pathways taken by individual molecules, their interrelationships and the mechanisms that regulate the flow of metabolites through the pathways are covered in this course. Various aspects of metabolism under different physiological conditions, their occurrence, regulation and interrelationship of metabolic events, flow of energy and the molecular/metabolic basis of a disease are explained.

Course Objectives:

- To understand the overview and interplay of metabolic pathways.
- To describe the individual reactions, cofactors, inhibition, energetics and regulation of pathways.
- To correlate the pathways with diseases associated directly or indirectly with them.
- To understand the clinical applications of synthetic purine and pyrimidine analogs

UNIT -I

Glucose transporters. Glycolysis and its regulation. TCA cycle - function and regulation. Gluconeogenesis and its regulation, HMP shunt and its significance. Glycogen metabolism and its regulation. Inborn errors of carbohydrate metabolism.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Understand the function of specific anabolic and catabolic pathways and how these pathways are controlled and interrelated.
- Predict the products of chemical reactions of carbohydrates (acetal/hemiacetal formation oroxidation).
- Describe what happens during carbohydrate digestion, glycolysis, glycogenesis, and Glycogenolysis.
- Discuss how disruptions in intermediary metabolism may lead to disease, and illustrate with selected examples.

UNIT -II

General metabolic reactions of amino acids. Ketogenic and glycogenic amino acids. Formation of Ammonia, Urea and regulation of urea cycle. Biosynthesis and regulation of branched chain amino acids, aromatic amino acids-tyrosine and phenyl alanine. Inborn errors of protein metabolism.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Explain what happens during digestion of proteins, catabolism of amino acids and the ureacycle.
- List the ketogenic and glycogenic amino acids and describe the general strategies for amino acid synthesis
- Analyze complex chemical problems and draw logical conclusions.
- Analyze the congenital disorders of protein metabolism.

UNIT -III

Oxidation of fatty acids. Formation and utilization of ketone bodies. Biosynthesis of fatty acids and regulation. Biosynthesis of triglycerides. Biosynthesis of cholesterol and its regulation. Metabolism of arachidonic acids - formation of prostaglandins, thrombaoxanes, leukotrienes. Inborn errors of lipid metabolism.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Describe what happens in fatty acid oxidation and synthesis as well as in ketogenesis.
- To differentiate lipolysis and Lipogenesis, cholesterol andcholesteryl ester.
- To explain how Blood Lipid Levels are Related to Risk of CVD.
- Distinguish the shift ofarachidonic acid (ARA) paradigm from a harm-generating molecule to its status of polyunsaturated fatty acid essential for normal health.
- To be familiar with basic changes in lipid metabolism during a critical illness.

UNIT -IV

Biosynthesis and degradation of purines and pyrimidines and their regulation. Structure and regulation of ribonucleotidereductase. Biosynthesis of ribonucleotides, deoxyribonucleotides and inhibitors of nucleotide biosynthesis. Inborn errors of nucleic acid metabolism. Biosynthesis and degradation of heme.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Describe where PRPP comes from and how it is used in nucleotide synthesis and its importance in determining the overall rate of de novo purine biosynthesis.
- Explain what happens if you don't have the enzyme HGPRT and how PRPP play a role in this.
- Describe how Allopurinol treatment will reduce the Uric Acid as well as PRPP by increasing salvage of Hypoxanthine in treatment of Gout.
- Understand the role of drugs in cancer treatment
  1. Hydroxy urea inhibits ribonucleotidereductase (baso cell carcinoma)
  2. 5-Fluorouracil inhibits thymidylate synthase (baso cell carcinoma)
  3. Methotrexate inhibits dihydrofolatereductase (DHFR) (anti tumor drug)
  4. Trimethoprim inhibits DHFR (anti microbial)
  5. Pyrimethamine inhibits DHFR (anti protozoal)

  All of these inhibit dTMP and dTMP is used to make DNA.
- Understand the steps involved in heme synthesis and degradation.

UNIT -V

Principles of bioenergetics: Free energy, enthalpy and entropy. Redox potential. Oxidation and reduction reactions. Mitochondrial electron transport system - organization of components and electron flow, inhibitors of ETC. Mechanism and theories of oxidative phosphorylation and uncouplers of oxidative phosphorylation.

Learning Outcomes:

By the end of this Unit, the student will be able to

- Define the major pathways of intermediary metabolism of biomolecules, and discuss their bioenergetics.
- Explain and give examples of the strategies of metabolism, emphasizing the role of ATPcoupled reactions, and coenzymes that exist in oxidized and reduced form.
- Describe what happens in the citric acid cycle, the electron transport chain and oxidativephosphorylation. Explain the role of each process in energy production.
- Identify the sites of drug action in ETC both as inhibitors and uncouplers

Recommended Books:

1. Text book of Biochemistry by West and Todd, Oxford and IBH, 4th Ed.
2. Principles of Biochemistry by Nelson cox, Freeman, 4th Ed.
3. Biochemistry by VoetandVoet, John Wiley and Sons, 3rd Ed.
4. Outlines of Biochemistry by Conn and Stumpf, John Wiley and sons, 5th Ed.
5. Biochemistry by Matthews, PSN, 3rd Ed.
6. Biochemistry by Lehninger, Kalyani Publishers, 2nd Ed.
7. Biochemistry by Stryer, WH Freeman and CO, 4th Ed.

M.Sc. (BIOCHEMISTRY) - II SEMESTER

SBC 704: ENZYMOLOGY AND ENZYME TECHNOLOGY

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

Enzymes are biological catalysts that speed up biochemical reactions in living organisms, and which can be extracted from cells and then used to catalyse a wide range of commercially important processes. Many enzymes are assisted by chemical substances called cofactors and other factors which influence their activity. Cofactors may be ions or organic molecules associated with an enzyme. The course covers the basic principles of enzymology, such as classification, structure, kinetics and inhibition, and also provides an overview of industrial and medical applications.

Course Objectives:

- To study the factors affecting enzyme activity, active site structure and nature of catalysis of enzyme
- To study the mechanism of action of chymotrypsin and lysozyme.
- To study the enzyme kinetics, enzyme inhibition, enzyme regulation and immobilized enzymes.

UNIT – I **10L**

Nature and catalysis: Remarkable properties of enzymes, classification and nomenclature of enzymes, Active site - Common features and chemical modifications of active site groups. Acid-base, covalent and metal ion catalysis. Coenzyme activity of vitamin B1, B2, B3 and B6. Structure function relations - ribonuclease, chymotrypsin, carboxypeptidase.

Learning outcomes
By the end of this unit, the student will be able to

- Gain knowledge of nature and factors affecting enzymes, active site structure and nature of catalysis of enzyme.
- Able to explain the role of coenzyme activity of vitamin B1, B2, B3 and B6.
- Understand the Structure function relations of ribonuclease, chymotrypsin and carboxypeptidase.

UNIT – II **10L**

Enzyme of catalysis. Factors affecting catalytic efficiency - proximity and orientation effects. Factors affecting enzyme activity. Enzyme kinetics - Concept of ES complex, derivation of Michaelis – Menten equation for uni -substrate reaction. Determination of Km and Vmax and their significance. Bi-substrate reactions- sequential and ping-pong reactions with examples.

Learning outcomes
By the end of this unit, the student will be able to

- Understand the concept of ES complex
- Able to derive Michaelis – Menten equation for unisubstrate reaction
- Able to determine Km and Vmax.
- Gain the knowledge on the importance of Kcat/Km
- Outline classification of multi-substrate reactions

UNIT – III **10L**

Enzyme inhibition: Reversible – competitive, non-competitive and un-competitive mode of enzyme inhibition. Irreversible – adduct formation, transition state and substrate analogs (suicide inhibition).Substrate inhibition. Feedback inhibition.

Learning outcomes
By the end of this unit, the student will be able to

- Understand the mechanism of competitive, non-competitive and un-competitive
- Able to explain irreversible, product, substrate and feedback enzyme inhibition
- Able to determine Ki by Dixon plot

UNIT – IV **10L**

Enzyme regulation: Covalent modification - glutamine synthetase, glycogen phosphorylase and digestive proteases. Salient features of allosteric enzymes, alloserism and cooperativity with special reference to ATCase. Model of allosteric enzymes. Multienzyme complex - Mechanism of action and regulation of PDH.

Learning outcomes
By the end of this unit, the student will be able to

- Gain the knowledge of enzyme regulation by covalent modification.
- Understand mechanism of allosteric regulation, cooperativity.
- Learn about the Hill and Scatchard plots.
- Explore the mechanism of action and regulation of PDH

UNIT – V **10L**

Immobilized enzymes: Properties, physical and chemical methods of immobilization, Factors affecting immobilized enzymes, Applications in industry and medicine. Principle and applications of enzyme electrodes. Abzymes and their applications. Ribozyme, Synzymes.

Learning outcomes
By the end of this unit, the student will be able to

- Explain the properties, physical and chemical methods of immobilization.
- Explore the applications of immobilized enzymes in industry and medicine.
- Gain the knowledge of Ribozyme, Synzymes, abzymes and their applications.

Recommended Books:

1. Fundamentals of Enzymology by Nicoles C. Price and Lewis Stevens, Oxford Uni. Press.
2. Understanding Enzymes by Trevor Palmer, Harvard publishing
3. Biochemistry by Voet and Voet, John Wiley and Sons, 3rd Ed.
4. Biochemistry by Stryer, WH Freeman and CO. 4th Ed.
5. Biochemistry by Lehninger, Kalyani Publishers.

M.Sc. (BIOCHEMISTRY) - II SEMESTER

SBC 706: SYSTEMS PHYSIOLOGY

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

Systems Physiology deals with the basic physiological function in animal and plant systems. In animal systems, the vital physiological systems involved to maintain life like respiration, circulation, excretion, reproduction, neurotransmission, vision, muscular system and endocrine system are explained along with abnormal functions. In plant systems, the process of photophosphorylation, CO_2 fixation, photorespiration, nitrogen fixation and biotic- abiotic responses are explained.

Course Objectives

- To acquire knowledge on composition blood, functions of Blood components, respiratory system, mechanism of respiration and regulation of respiration
- To understand kidney structure and function, heart function, gametogenesis, ovulation
- To learn about the neuron structure and function, biochemistry of vision and muscular contraction
- To study endocrine system with function and abnormalities of various hormonal changes
- To study the plant physiology with aspects of photophosphorylation, CO2 fixation, photorespiration, phytochromes, nitrogen fixation, defence mechanism and stress

UNIT-I

Haemopoiesis, Composition of blood, properties and functions of plasma proteins, Coagulation of blood and fibrinolysis. Mechanism of respiration – Haemoglobin, transport and exchange of gases. Regulation of respiration.

Learning Outcomes:
By the end of this unit, the student will be able to

- Identify blood components with their functions
- Explain blood clotting mechanism
- Describe the transport and exchange of gases in the body
- Highlight the role of Haemoglobin in respiration and regulation of respiration

UNIT-II

Structure of nephron, physiology of kidney - urine formation, concentration and excretion. Homeostasis - regulation of electrolytes, water and acid-base balance in the body. Physiology of heart, cardiac cycle. Reproductive processes - gametogenesis, ovulation, neuroendocrine regulation.

Learning Outcomes:
By the end of this unit, the student will be able to

- Explain the urine formation in the body
- Describe the maintenance of homeostasis in the body
- Illuminate about the heart function
- Educate on gametogenesis, ovulation and their regulation in reproductive process

UNIT-III

Structure of neuron and synapse. Origin of membrane potential, propagation of nerve impulsein unmyelinated and myelinated nerve fibres, Synaptic transmission of adrenergic andcholinergic nerve endings.Neurotransmitters.Biochemistry of vision. Types of muscles, structure and organization of muscle cell.Molecular organization of contractile systems. Molecular mechanisms and Biochemical changes associated with muscle contraction and relaxation.

Learning Outcomes:
By the end of this unit, the student will be able to

- Describe the neurotransmission mechanism
- Identify the role of neurotransmitters in nerve transmission
- Explain about the biochemical events occurring in vision
- Illuminate about the different types of muscles and muscle contraction

UNIT – IV

Endocrine glands.Functions and abnormalities of Pituitary hormones.Chemistry, biochemical functions and abnormalities of thyroid, parathyroid, adrenal and gonadal hormones. Biochemical functions of gastrointestinal, pancreatic and renal hormones. General mechanism of hormone action.

Learning Outcomes:

By the end of this unit, the student will be able to

- Explain the functions of pituitary hormones
- Describe about the functions and abnormalities of thyroid, parathyroid, adrenal and gonadal hormones
- Illuminate about the functions of gastrointestinal, pancreatic and renal hormones
- Lay down the general mechanism of hormone action

UNIT – V

Mechanism of photophosphorylation.Biochemistry of RuBISCO. Mechanism of CO_2 fixation in C3, C4 and CAM plants. Photorespiration.Phytochromes. Structure and Functions of auxins, gibberellins, abscisic acid and cytokinins. Mechanism of nitrogen fixation, NIF genes and their regulation. Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

Learning Outcomes:
By the end of this unit, the student will be able to

- Explain the mechanism of photophosphorylation, CO_2 Fixation, photorespiration and phytochromes.
- Differentiate the functions of auxins, gibberellins, abscisic acid and cytokinins
- Explain the nitrogen fixation, nif genes and regulation of nif genes
- Describe abiotic and biotic stress responses in plants

Recommended Books:

1. Textbook of human Physiology by Guyton, Elesvier,11th Ed.
2. Essentials of Medical Physiology by K. Sembulingam, Prema Sembulingam, Jaypee, 2nd Ed.
3. Textbook of Biochemistry & Human Biology by G.P.Talwar PHI, 3rd Ed.
4. Textbook of Medical Biochemistry by M.N.Chatterjee, Jaypee 6th Ed.
5. Molecular Endocrinology by Bolander, Elsevier 3rd Ed.

M.Sc. (BIOCHEMISTRY) - II SEMESTER

SBC 708: MOLECULAR BIOLOGY

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

The paper Molecular Biology encompasses the basic study and understanding the central dogma. It helps in understanding the basic organization of the genome of prokaryotes and eukaryotes. It is followed by prokaryotic and eukaryotic replication, transcription, translation processes and regyulation. This knowledge can be employed in determining the function of various genes and proteins for better understanding of cellular life processes.

Course Objectives

- To understand the difference between prokaryotic and eukaryotic genetic material, types of genes and other organelle genomes (mitochondrial & plastid).
- To explain the concept of DNA replication and study the enzymes involved at both prokaryotic and eukaryotic levels.
- To learn about eukaryotic and prokaryotic promoters, RNA polymerase, mechanism and inhibition of transcription.
- To outline the concept of translation, genetic code, mechanism of protein synthesis, post translation modifications in eukaryotes, protein processing and targeting.
- To study prokaryotic and eukaryotic gene regulation, sporulation in *Bacillus subtilis*, DNA methylation and epigenetic gene regulation.

UNIT -I

Organization of genetic material in prokaryotes & Eukaryotes. Fine structure of gene. Types of genes. Gene amplification. Polytene chromosomes. C -value paradox. Mitochondrial and plastid genomes.

Learning outcomes:
By the end of this Unit, the student will be able to

- Know the organization of genetic material in prokaryotes and eukaryotes.
- Describe gene amplification, fine structure of gene and their types.
- Understand the concept of polytene chromosome and C- value paradox.
- Explain mitochondrial and plastid genomes.

UNIT-II

DNA Replication: DNA polymerases of Prokaryotes. Mechanism of replication in prokaryotes. Eukaryotic DNA polymerases. Mechanism of replication in eukaryotes. DNA damage and repair

Learning outcomes:
By the end of this Unit, the student will be able to

- List the differences between prokaryotic and eukaryotic DNA polymerases
- Outline the different enzymes involved in DNA replication.
- To understand the mechanism of DNA replication in prokaryotes and eukaryotes.
- Illustrate the basic concept of DNA damage and repair.

UNIT-III

Transcription: Prokaryotic RNA polymerase. Nature of prokaryotic promoters. Mechanism of prokaryotic transcription. Eukaryotic RNA polymerases. Nature of eukaryotic promoters, Mechanism of eukaryotic transcription. Inhibitors of transcription. Post transcriptional processing of rRNA, mRNA and tRNA. Processing of tRNA. RNA editing, transport.

Learning outcomes:
By the end of this Unit, the student will be able to

- Compare and contrast prokaryotic, eukaryotic RNA polymerases & promoters.
- To understand mechanism of prokaryotic and eukaryotic transcription.
- Study the inhibitors of transcription.
- To learn the concepts of post transcriptional modifications, RNA editing and RNA transport.

UNIT –IV

Translation: General features of genetic code. Structural components of prokaryotic and eukaryotic ribosomes. Mechanism of protein synthesis in prokaryotes and eukaryotes. Post translational modifications in eukaryotes. Protein synthesis inhibitors. Protein processing and targeting.

Learning outcomes:
By the end of this Unit, the student will be able to

- To learn the general features of genetic code
- Illustrate the structural components of prokaryotic and eukaryotic ribosomes.
- To highlight the mechanism of prokaryotic and eukaryotic protein synthesis.
- Details of eukaryotic post translational modifications.
- To study the inhibitors of protein synthesis.
- Explore the concepts of protein processing and targeting.

UNIT - V

Prokaryotic gene regulation: Lac and Trp operons. Lytic and lysogenic phases of Bacteriophage λ life cycle. Sporulation in Bacillus subtilis.
Eukaryotic gene regulation: Role of chromatin in eukaryotic gene regulation. Cis-trans elements, DNA methylation, chromatin remodelling. Environmental gene regulation. RNAi in gene regulation. Epigenetic gene regulation

Learning outcomes:
By the end of this Unit, the student will be able to

- Compare and contrast Lac and Trp operons.
- List the difference between lytic and lysogenic phases of bacteriophage λ life cycle.
- Highlight prokaryotic gene regulation through sporulation in *Bacillus subtilis*.
- Illustrate the role of chromatin and chromatin remodelling in eukaryotic gene regulation.
- Learn about DNA methylation and Cis-trans elements.
- Describe the concept of environmental gene regulation, epigenetic gene regulation and RNAi mediated gene regulation.

Recommended Books:

1. Molecular Biology of the gene by Watson, Pearson, 5th Ed.
2. Molecular Biology of the cell by Alberts, Garland science, 4th Ed.
3. Biochemistry by Matthews, Pearson, 3rd Ed.
4. Biochemistry by Voet and Voet, John Wiley and sons, 3rd Ed.
5. Molecular cell Biology by Lodish, Freeman, 6th Ed.
6. Principles of Biochemistry by Nelson cox. PALG, 4th Ed.
7. Biochemistry by L.Stryer, Freeman, 5th Ed.
8. Molecular Biology by Robert F.Weaver, Mc Graw Hill

M.Sc. (BIOCHEMISTRY) - II SEMESTER

SAE 702: PROFESSIONAL COMMUNICATION SKILLS

Hours per week: 3 End Examination: 100Marks
Credits: 2

Preamble

This course is designed to expose students to the basics of academic and professional communication in order to develop professionals who can effectively apply communication skills, theories and best practices to meet their academic, professional and career communication needs.

Course Objectives:
To enable students to

- acquaint themselves with basic English grammar
- acquire presentation skills
- develop formal writing skills
- develop creative writing skills
- keep themselves abreast with employment-readiness skills

UNIT – I

BACK TO BASICS:
Tenses, Concord – Subject Verb Agreement, Correction of Sentences-Error Analysis, Vocabulary building. (10 hours)

Learning Outcomes:
At the end of the unit, the student will be able to:

- Use structures and tenses accurately
- apply the right verb to the right subject in a sentence
- Detect incorrect sentences in English and write their correct form
- Acquire new vocabulary and use in speaking and writing

UNIT - II

ORAL PRESENTATION:
What is a Presentation? Types of Presentations, Technical Presentation – Paper Presentation, Effective Public Speaking, Video Conferencing. (8 hours)

Learning Outcomes:
At the end of the unit, the student will be able to:

- Overcome speaking anxiety prior to presentation
- Plan and structure effective presentations that deliver persuasive messages
- Prepare slides that can catch the attention of the audience
- Engage the audience
- Skills in organizing, phrasing, and expressing the ideas, opinions and knowledge.
- Facilitate and participate in a video conference effectively

UNIT III

DOCUMENTATION :
Letter –Writing, E-mail Writing & Business Correspondence, Project Proposals, Report Writing, Memos, Agenda, Minutes, Circulars, Notices, Note Making. (10 hours)

Learning Outcomes:
At the end of the unit, the student will be able to:

- Write a business letter, which includes appropriate greetings, heading, closing and body and use of professional tone.
- Draft crisp and compelling emails
- Draft project proposals, reports and memos
- Prepare agenda and draft minutes
- Prepare circulars, notices and make notes.

UNIT IV

CREATIVE WRITING:
Paragraph Writing, Essay writing, Dialogue Writing, Précis Writing, Expansion of Hints, Story Writing. (6 hours)

Learning Outcomes:
At the end of the unit, the student will be able to:

- Write paragraphs on familiar and academic topics using a topic sentence, supporting detail sentences and a conclusion sentence.
- Learn the structure of a five-paragraph essay and write essays that demonstrate unity, coherence and completeness
- Structure natural, lucid and spontaneous dialogues
- Draft clear, compact logical summary of a passage
- Recognize the elements of a short story and develop their functional writing skills.

UNIT V

PLACEMENT ORIENTATION:
Resume preparation, group discussion – leadership skills, analytical skills, interviews –Types of Interviews, Preparation for the Interview, Interview Process. (8 hours)

Learning Outcomes:
At the end of the unit, the student will be able to:

- Write a professional resume that highlights skills, specific to the student's career field
- Acquire the personality traits and skills required to effectively participate in a G.D
- Understand the purpose of interviews
- Be aware of the processes involved in different types of interviews
- Know how to prepare for an interview
- Learn how to answer common interview questions

Recommended Books:
1. Essentials of Business Communication by Rajendra Pal and J S KorlahaHi, Sultan Chand & Sons.
2. Advanced Communication Skills by V. Prasad, Atma Ram Publications.
3. Effective Communication by Ashraf Rizvi, McGraw Hill Education; 1st Edition , 2005.
4. Interviews and Group Discussions How to face them by T.S.Jain, Gupta,1st Edition, Upkar Prakashan,2010.
5. High School English Grammar and Composition by P.C.Wren & Martin, N.D.V.Prasada Rao S.Chand.

M.Sc. (BIOCHEMISTRY) - II SEMESTER

SBC 721: ENZYMOLOGY LAB

Hours per week: 8 End Examination: 60Marks
Credits: 3 Sessionals: 40Marks

1. Assay of acid phosphatase in crude potato extract
2. Effect of pH on phosphatase activity
3. Effect of temperature on phosphatase activity
4. Effect of substrate concentration on phosphatase activity and determination of Michaelis – Menton constant
5. Inhibition of acid phosphatase by EDTA
6. Effect of irreversible inhibitor (PMSF) on trypsin activity.
7. Assay of Succcinate dehydrogenase
8. Immobilization of enzyme by sodium alginate
9. Assay of DNase
10. Assay of catalase by titrimetry method

Recommended Books:

1. Experimental Biochemistry: A student companion by Beedu Sashidhar Rao and Vijay Deshpande, I.K. International Pvt. Ltd., New Delhi.
2. Laboratory Manunal in Biochemistry by Jayaraman, New Age International Publishers, New Delhi.
3. Introductory practical biochemistry by SK Sawhney & Randhir singh. Narosa publications.
4. Biochemical methods by S Sadasivan & A Manickam. New Age international publishers

M.Sc. (BIOCHEMISTRY) - II SEMESTER

SBC 723: MOLECULAR BIOLOGY LAB

Hours per week: 8 End Examination: 60Marks
Credits: 3 Sessionals: 40Marks

1. Isolation of DNA from plant tissue/animal cells and determination of its purity
2. Quantification of isolated DNA by spectrophotometeric method
3. Isolation of plasmid DNA from bacteria and determination of its purity
4. Quantification of isolated plasmid DNA by spectrophotometeric method
5. Estimation of DNA using Diphenylamine reagent
6. Determination of Tm of DNA & estimation of G+C content
7. DNA electrophoresis in agarose gel
8. Isolation of RNA from Yeast and determination of its purity
9. Quantification of isolated RNA by spectrophotometeric method
10. Estimation of RNA using Orcinol reagent
11. RNA electrophoresis in formaldehyde-agarose gel
12. Effect of UV radiation on the survival of *E.coli*
13. Study of repair mechanism by photoreactivation in *E.coli* after UV irradiation

Recommended Books:

1. Lab manual in Biochemistry by J. Jayaraman, Wiley Eastern Limited
2. Biochemistry – a lab course by J.M. Becker, Academic Press
3. Experimental Biochemistry: A student companion by Beedu Sashidhar Rao and Vijay Deshpande, I.K. International Pvt. Ltd., New Delhi.
4. Biochemical methods by S Sadasivan and A Manickam. New Age international publishers

M.Sc. (BIOCHEMISTRY) – III SEMESTER

SBC 801: MICROBIOLOGY AND IMMUNOLOGY

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:
Microbiology is the study of the smallest living organisms (micro-organisms or microbes). Microbes are a major cause of disease in humans but they can also be useful in industrial processes from pollution control to the production of important therapeutic compounds. Immunology is the study of how the body defends itself against disease. It helps us understand how the immune system is tricked into attacking its own tissue, leading to diseases like rheumatoid arthritis, diabetes or allergy. The development of both has long been linked with the development of vaccines for smallpox and anthrax. More recently, the application of modern techniques of biology to the immune system has led to a dramatic increase in our understanding of the immune system and its impact on body function, as well as in the control of microbial and other types of disease. The oveall aim of this course is to give insights about the interface between immunology and microbiology which is a very active area for both fundamental research and for the development of new biotechnological products to diagnose or prevent disease.

Course Objectives:

1. To know the scope and development of microbiology and contributions of various scientists towards it.
2. To learn various cultural techniques and methods of microbial identification.
3. To learn the general characteristics, morphology and pathogenesis of various clinically important microorganisms.
4. To have an overview of immune system.
5. To learn about various classes of antibodies, cells of immune system and types of hypersensitivity.
6. To learn about various immunological techniques, transplantation immunology and immunomodulation.

UNIT - I

Development and Scope of Microbiology: Contributions of Antony Van Leeuwenhock, Joseph Lister, Pasteur, Koch, Jenner, AM Chakraborty. Microbial cultures- concept of pure culture and development. Identification methods – nutritional, cultural, biochemical, antigenic, ecological and ribotyping. Microbial interactions - mutualism, protocoperation, commensalism, predation, parasitism, competition and symbiosis.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Study the scope and development of microbiology and contributions of various scientists towards it.
- Learn various cultural techniques and methods of microbial identification.
- Learn various microbial interactions.

UNIT – II

Clinical Microbiology: general characteristics, morphology and pathogenesis of Bacteria - *Staphylococcus, Bacillus, Mycobacteria, Salmonella, Vibrio,* Fungi – *Candida. V*iruses - HIV, *Hepatitis, Influenza.* Life cycle of *Plasmodium* and *Entamoeba histolytica.* Immune response during bacterial (tuberculosis), parasitic (malarial) and viral (HIV) infections.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn the general characteristics, morphology and pathogenesis of various clinically important microorganisms.
- Learn the Life cycle of *Plasmodium* and *Entamoeba histolytica*
- Learn the Immune response during bacterial, parasitic and viral infections.

UNIT-III

Overview of immune system. Organs of immune system –primary and secondary, Immune Cells - B and T cells. Humoral and Cell mediated immunity. Innate and Adaptive immunity. Immune responses. Immune regulation. Antigens, Superantigens, Haptens, Epitopes, Adjuvants. Processing and presentation of antigens, APC's, receptors - BCR, TCR. MHC and HLA - types, polymorphism and role. Clonal selection of lymphocytes.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn the various Organs of immune system.
- Learn the typesof Immune Cells and their role in immune responses.
- Learn the components of immune regulation.
- Know about clonal selection of lymphocytes

UNIT-IV

Cytokines, Interleukins Interferons and their role. Immunoglobulin classes, structure and function. Isotypes, Allotypes and Idiotypes. Antibody diversity. Complement components and its role. Antigen-Antibody interactions and types. Types of hypersensitivity. Immunodeficiencies - SCID and AIDS. Autoimmunity and breakdown of self - tolerance.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn about Cytokines, Interleukins Interferons and their role
- Learn the classes of immunoglobulins, their structure and function..
- Learn about Antigen-Antibody interactions and types
- Learn about types of hypersensitivity
- Know about Autoimmunity and breakdown of self - tolerance

UNIT-V

Immunological tolerance and immunosuppression. Immune techniques- Rocket Immunoelectrophoresis, Immunoelectrophoresis, Immuno-flourescence, FACS, RIA, ELISA, FISH, GISH. Hybridoma technology - Monoclonal antibodies and their applications. Vaccines and their types, Transplantation immunology. Immunomodulation.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn about Immunological tolerance and immunosuppression.
- Learn about various Immune techniques.
- Learn about Monoclonal antibodies and their applications
- Learn about Vaccines and their types
- Know about Transplantation immunology. Immunomodulation.

Recommended Books:

1. Microbiology by Prescott, Tata McGraw –Hill, 7th Ed.
2. Textbook of Microbiology by Ananthnarayan, ORIE, 7th Ed.
3. Microbiology by Pelczar, Tata McGraw-Hill, 5th Ed.
4. Immunology Kuby.

M.Sc. (BIOCHEMISTRY) - III SEMESTER

SBC 803: GENETIC ENGINEERING

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

Genetic engineering also known as recombinant DNA technology is the field of biology that studies the various techniques used to cut and join together genetic material, especially DNA from different biological species, and to introduce the resulting hybrid DNA into an organism in order to form new combinations of heritable genetic material. It has been used to create powerful research tools and model organisms, and also used to address current problems in agriculture and medical fields. Applications for genetic engineering are increasing to identify the locations and functions of specific genes in the DNA sequence of various organisms so as to develop transgenic varieties with superior qualities and desired traits.

Course Objectives

- To understand the concept of recombinant DNA technology, mapping of genes and chemical synthesis of genes.
- Tocompare different types of cloning and expression vectors. To learn about construction and screening of gene libraries.
- To learn about different types of gene transfer and blot analysis techniques.
- List several present day applications of genetic engineering and analyse the benefits and drawbacks of manipulating an organism's DNA
- Learn the concept of RNA silencing
- To study various methods of gene therapy, delivery systems for gene therapy and applications of genetic engineering.

UNIT – I

Outlines of recombinant DNA technology. Restriction endonucleases, RFLP, restriction maps. Mapping genes – chromosomal walking, chromosomal jumping. Isolation of gene fragments using restriction endonucleases, cDNA, PCR, RACE PCR. Chemical synthesis of genes. Ligation of fragments.

Learning outcomes:
By the end of this unit, the student will be able to

- Learn the outlines of recombinant DNA
- Concept of mapping genes- chromosomal walking and chromosomal jumping
- Understand the concept of chemical synthesis of genes and ligation of fragments.
- Explain isolation of gene fragments using restriction endonucleases, cDNA, PCR and RACE PCR.

UNIT – II

Cloning vectors – plasmids, bacteriophages, cosmids, Ti - plasmid. Expression vectors, CRISPR-Cas 9 technology. Construction of gene libraries – cDNA library, genomic library, YAC, BAC library. Cloning strategies – shot gun experiments, cDNA cloning in bacteria. Screening of libraries

Learning outcomes:
By the end of this unit, the student will be able to

- Compare and contrast cloning and expression vectors.
- To learn the concepts of construction of gene libraries and its types
- To highlight cloning strategies- short gun experiments and cDNA cloning in bacteria.
- Illustrate the concept of screening of libraries.

UNIT – III

Gene transfer techniques: Biological delivery systems - *Agrobacterium tumefaciens*, SV40, Retroviral systems, Artificial delivery systems - Gene gun, Microinjection, Lipofection, Electroporation, Ca - DNA coprecipitation. Identification of recombinants. Expression of cloned genes in bacteria, plant and animal cells. Blot analysis - Southern, Northern and Western blot, dot and slot blot.

Learning outcomes:
By the end of this unit, the student will be able to

- Learn about the different gene transfer techniques.
- Compare and contrast biological and artificial delivery systems.
- To understand the mechanism of expression of cloned genes in bacterial, plant and animal cells.
- To learn the concept of different types of blot analysis.

UNIT - IV

Transgenic plants - production of golden rice, transgenic animaIs – mouse and sheep.
RNA silencing – siRNAs, shRNA and anti- sense RNAs -mechanism and applications

Learning outcomes:
By the end of this unit, the student will be able to

- To highlight the importance of transgenic plants and animals.
- To learn the concept of RNA silencing and its mechanism
- Explore the applications of RNA silencing.

UNIT – V

Gene therapy: Methods of gene therapy- *Ex vivo, In situ, In vivo*, somatic and germline. Types and use of rDNA constructs for Gene therapy, Delivery systems for gene therapy. Biological, Medical and Industrial applications of genetic engineering.

Learning outcomes:
By the end of this unit, the student will be able to

- Illustrate the different methods of gene therapy.
- List the types and application of rDNA constructs for gene therapy.
- Describe the different delivery systems for gene therapy.
- Highlight the applications of genetic engineering in biological, medical and industrial fields.

Recommended Books:

1. Human Molecular Genetics by Tom Strachan and Andrew Read, Taylor & Francis Publisher, 3rd Ed.
2. Principles of gene manipulation & genomics by Primrose & Twyman, Oxford, 7th Ed.
3. Molecular cell biology by Lodish, Freeman, 6th Ed.
4. Molecular Biotechnology - Principles and applications of Recombinant DNA by Glick, 2nd Ed.

M.Sc. (BIOCHEMISTRY) - III SEMESTER

SBC 805: BIOPROCESS TECHNOLOGY AND BIOETHICS

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

This course encompasses areas such as enzyme production, vitamin production, fuel and waste management and imparts basic concepts for the development of useful products taking advantage of natural resources. This course also gives insights into the bioethical problems created by biological and medical progress and its impact along with intellectual property rights and their protection.

Course objectives:

- To study the microbiology, biochemistry and engineering in an integrated fashion with the goal of using microorganisms and cell and tissue cultures to manufacture useful products.
- Acquainting with the major products of traditional biotechnology industry of food and flavor ingredients, industrial alcohol, antibiotics and citric acid.
- Impart an overview of relevance use of microbial biofertilisers and biopesticides.

UNIT – I

Fermentation technology - surface, submerged and continuous culture techniques. Design and operation of fermentors, Agitation and Aeration, selection and growth of microorganisms in controlled environments, medium development. Downstream processing, Strategies for improvement and maintenance of the industrial strains, Bioreactors.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Get aquainted with the industrial aspect of the field of Microbiology, and also learn about growth pattern of microbes in different industrial systems.
- Acquire experimental knowhow of microbial production of various industrial products such as alcohol, exopolysaccharides, enzymes, etc.
- Develop an understanding of process control, upstream and downstrem process.
- Analyze different methods like media optimization, mutation and screening, genetic engineering and biocatalyst conversion for improvement of the production.

UNIT – II

Production of fermented milks, cheese, alcoholic beverages and breads. Fermentative production of penicillin, citric acid, amylase, glutamic acid, Vitamins B12 and vitamin C.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Recognize the advantages of bioreactors over conventional chemical methods.
- Identify different strains of microbes used in fermentation of cheese, bread etc.
- Recognize the role of fermentation in producing drugs and different strains used.
- Describe how species are often genetically modified to yield the maximum amounts of antibiotics, amino acids, vitamins and enzymes.

UNIT – III

Microbial transformation - types, techniques and commercial applications, Bioleaching and biosorption, Biodegradation and Bioremediation, Biomass and Bioenergy, Biopolymers and Biosurfactants.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Understand the approaches and synthetic methods in tandem for generating compounds around core structures, which can be screened for various biological activity studies.
- Learn the principles& mechanisms of microorganisms enzyme and its applications in environmental pollution control.
- Gain an overview of key topics on sustainable bioenergy production, including the main biomass systems for bioenergy generation.
- Reflect on the polymeric material choices for biomedical applications and pharmaceutical formulations.

UNIT – IV

Sewage water treatment - primary, secondary and tertiary treatments. Principle, types and applications of biosensors. Biofertilizers - Aneabena, Azolla; Biocontrol agents- Insecticidal toxins of *Bacillus thuringiensis*, *Beauveriabassiana* and Trichoderma

Learning Outcomes:
By the end of this Unit, the student will be able to

- Identify methods to extract pollutants, remove toxicants, neutralise coarse particles, kill pathogens so that quality of discharged water is improved.
- Understand the reduction of BOD, COD, eutrophication etc. of receiving water bodies and prevention of bio-magnification of toxic substances in food chain.
- Familiarize with the microbes used as bio fertilizers for various crop plants and their advantages over chemical fertilizer.
- Identify and apply pesticides in a legal, safe, correct and environmentally conscious manner.

UNIT – V

Biosafety guidelines and regulations, animals in research, Legal and socio-economic impacts of Biotechnology, Ethical, legal and social implications (ELSI) of HGP. Bioethics in biodiversity. Ethics in clinical trials. Intellectual property rights and protections for biological inventions.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Apply intellectual property law principles (including copyright, patents, designs and trademarks) to real problems and analyse the social impact of intellectual property law and policy.
- Analyse ethical and professional issues which arise in the intellectual property law context.
- Ensure the ethical conduct of research and recommend educational efforts in research ethics to investigators and members of research ethics committees.
- Introduces the science and the economic, political, ethical, legal and social issues of the HGP.

Recommended Books:

1. Industrial Microbiology by Prescott, CBS Publishers, 4th Ed.
2. Biotechnology by Crueger, PANI Publishhers.
3. Principles of Fermentation Technology by Stanbury
4. Industrial Microbiology by A.H.Patel

GENERIC ELECTIVES

M.Sc. (BIOCHEMISTRY) – III SEMESTER

SBC 841: GENOMICS AND PROTEOMICS

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

Genomics and proteomics is the fast growing field of developing large data as a whole for particular organism to a particular condition and helps in dealing with complex condition in many case. The knowledge of genomics and proteomics help in narrow down the experimental procedures to achieve the reliable results faster and validating them.

Course Objectives

- To acquire knowledge on genome sequencing strategies, methods of assembly and comparative genomics.
- To identify different regions of genome sequence with predicting their functions using different methods.
- To understand different strategies and methods employed in protein separation and quantification for whole samples of proteins at a time.
- To attain basic principles involved in protein structure determination and correlating structure to function.
- To know the different application of genomics and proteomics in clinical, plant breading and genetically modified plants.

UNIT-I

Genome Sequencing and Assembly: Genome sequencing strategies - shot gun, hierarchal, Fragment and map assembly, Genome assembly and annotation, tools for genome assembly - Phred, Phrap, Consed. Metagenomics and their uses. Basic concepts and applications of comparative genomics, Tools for comparative genomics.

Learning Outcomes:
By the end of this unit, the student will be able to

- Explain the strategies employed in genomics with their advantages and disadvantages.
- Understands fragment and map assembly which is required for genome assembly.
- Describe about the tools employed in genome assembly and annotating the genome sequencing.
- Understand the importance of metagenomics and its application.
- Describe the basic concepts of comparative genomics, tools used and its applications.

UNIT-II

Structural and Functional Genomics: Identification and annotation of exons, introns, promoters, enhancers, DNA motifs, splice sites, repetitive elements, CpG islands. Assigning gene functions - sequence based, structure-based, derived databases, machine learning approaches. SNP arrays, cDNA, EST, SAGE, MPSS, RNA expression, DNA microarray and its applications.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understands the basic concepts of Structural and Functional Genomics.
- Describe the methods to employ to identify gene segments in prokaryotes and eukaryotes (like exons and introns) in genome sequence.
- Explain the process of identification regulatory parts in genome sequence like promoters, enhancers, DNA motifs, repetitive elements and CpG islands.
- Explain about the sequence based, structure based and machine learning approaches to assign gene functions.
- Understand the importance of different methods like SNP arrays, EST, SAGE, DNA microarray in genomics.

UNIT-III

Need, Scope, Challenges and Applications of Proteomics. Strategies for protein separation – Preparation of extract, Measurement of protein quantity. Protein purification by Precipitation, Adsorption – Gel permeation, HPLC, Ion-exchange, Affinity chromatography and Gel filtration. Novel approaches to protein expression analysis – 2D-gel electrophoresis, DIGE and protein chip technology.

Learning Outcomes:
By the end of this unit, the student will be able to

- Enumerate the need, challenges and application of proteoimcs.
- Describe methods employed in protein separation for basic small samples
- Explain principles behind different purification methods and their quantification
- Understand the complex analysis methods employed in proteomics like 2DGE, DIGE and protein chip technology.

UNIT-IV

Protein sequence-structure-function relationship, Techniques for solving protein structures - XRD, NMR, Mass spectroscopy – MALDI-TOF, ESI-MS, Tandem-MS, Protein-Protein Interaction, Library based methods - Phage interaction display and Yeast Two-Hybrid system, Protein-DNA interactions.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understands the relationship between protein sequence-structure-function.
- Explain about the different technologies engaged for protein structure determination like XRD, NMR and Mass Spectroscopy.
- Describe the principles behind the XRD, NMR and Mass Spectroscopy with their advantages and disadvantages.
- Enlighten the methods to find the protein function using protein structure and protein-protein interaction methods
- Understand the protein-DNA interactions to solve biological problems.

UNIT-V

Application of genomics and proteomics: Clinical proteomics - Discovery of Biomarker. Target identification and development of drugs. Plant proteomics - plant breeding and genetics, analysis of genetically modified plants, analysis of secondary metabolism.

Learning Outcomes:
By the end of this unit, the student will be able to

- Illustrate the different applications of genomics and proteomics.
- Explain the use of genomics and proteomics in biomarker discovery.
- Understand the importance of genomics and proteomics in drug targeting.
- Describe the application of genomics and proteomics in plant breeding and genetically modified plants.
- Describe the application of genomics and proteomics in analysis of secondary metabolites.

Recommended books:

1. Bioinformatics, Andrzej Polanski and Marek Kimmel, First Edition, Springer Publications.
2. Bioinformatics and Functional Genomics, Pevsner, J., John Wiley and Sons.
3. Principles of genome analysis and Genomics, Primrose, S.B. and Twyman, R.M., 3rdEd, Blackwell PubComp
4. Essential Bioinformatics, Jin xiong, Cambridge University Press.
5. Bioinformatics: Sequence and Genome Analysis, Mount, D., 1stEd, Cold Spring Harbor Laboratory Press.
6. Essentials of Genomics and Bioinformatics, Sensen, C.W., First Edition, Wiley-VCH Publishers.
7. Principles of Proteomics – RM. Twyman, Spl. Indian Ed.
8. Introduction to protein science – AM. Lesk, 2nd Ed.
9. Protein Purification: Principles and Practice – RK. Scopes, 3rd Ed.
10. Proteomics: From Protein sequence to Function – Pennington and Dunn.

M.Sc. (BIOCHEMISTRY) - III SEMESTER

SBC 843: ENVIRONMENTAL BIOCHEMISTRY AND BIODIVERSITY

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

Environmental biochemistry helps in understanding the ecosystem and the environment's effect on living organisms as they interact with environmental pollutants such as xenobiotics. The acquired insights will enable students to develop strategies, tools, and methods for improvement and advancement in drinking water and waste water purification technologies, bioremediation processes and biodiversity strategies.

Course Objectives

- To learn the scope, importance and various components of ecosystems.
- To understand the different types of environmental pollution, their causes and effect on the environment.
- To understand the concept of ecotoxicology, pharmacodynamics, chemodynamics and xenobiotic metabolism
- To study the mechanism of toxicity, altered calcium homeostasis and toxicity testing.
- To learn the concept of bioremediation and biodiversity and study their role in improving the environment

UNIT - I

Definition, scope and importance of an ecosystem. Structure and functions of ecosystem. Concepts of Ecological succession. Structure and functional aspects of ecosystem– Components, Ecological pyramids, Food chain, Food web, productivity, Energy flow and Bio-Geo chemical cycles.
Environmental pollution-Causes, effects and control measure of Air, Water and Soil pollution.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn the scope, structure , function and importance of an ecosystem
- Describe the components of ecosystem, food web, food chain and Bio geo chemical cycles.
- Explain the different types of environmental pollution, their causes, effects and control measure.

UNIT- II

Concepts of Ecotoxicology and its environmental significance. Pharmacodynamics and chemodynamics. Xenobiotic metabolism - phase I reaction - oxidation-reduction, hydrolysis, phase-II reaction - conjugation and methylation, detoxification, toxicity of pesticides, insecticides, fungicides, herbicides and biopesticides. Toxicity of food additives, heavy metals - arsenic, mercury, lead and cadmium.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Understand the concept of ecotoxicology, pharmacodynamics and chemodynamics.
- Compare and contrast between the phases of xenobiotic metabolism
- Learn about toxicity of food additives and various heavy metals.

UNIT- III

Mechanisms of toxicity: disturbance of excitable membrane function. Altered calcium homoeostasis. Covalent binding to cellular macromolecules & genotoxicity. Tissue specificity of toxicity. Toxicity testing- genetic toxicity testing. Toxicity control.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Understand the mechanism of toxicity and altered calcium homeostasis.
- Learn the concept of tissue specificity of toxicity and genotoxicty.
- Compare and contrast the different methods of toxicity testing.

UNIT- IV

Bioremediation- advantages and disadvantages; In situ and ex-situ bioremediation; Bioremediation of contaminated ground water and phytoremediation of soil metals; microbiology of degradation of xenobiotics

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn the concept of In situ and ex-situ bioremediation
- List the advantages and disadvantages of bioremediation.
- Describe phytoremediation of soil metals and microbioal degradation of xenobiotics.

UNIT- V

Biodiversity-Definition, types, significance. Threats to Biodiversity, hotspots. Conservation of biodiversity-in-situ, ex-situ, current levels of biodiversity.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Understand the concept of biodiversity, types and their significance.
- Learn about threats to biodiversity and hotspots.
- Describe in-situ and ex-situ methods of biodiversity conservation

Recommended books:

1. An Introduction to Environmental Biotechnology by Milton Wain Wright. Kluwar Acad Publ. Group, Springer, 1999.
2. Klaassen C D, Amdur M O & Doull J (1986) Casarett and Doull's Toxicology, 3rd edition, Macmillan publishing company, New York. 26
3. Hayes A W (1988) Principles and methods of toxicology, 2nd edition, Raven press New York.
4. Basic Environmental Toxicology : Lorris G. Corkerhem and Barbara S. S. Shane CRP Press Inc.

M.Sc. (BIOCHEMISTRY) - III SEMESTER

SBC 845: DEVELOPMENTAL BIOLOGY

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

The journey from totipotency to pluripotency and further differentiation towards functional specialization making a complex and self-propagating system is developmental biology. The course includes concepts of developmental biology, molecular mechanisms, model systems and medical implications. The course imparts knowledge regarding the ability to reverse the life processes of developmental biology which helps to address important aspects of human health.

Course Objectives

- To understand the basic concepts of development.
- To explain the concept of gametogenesis, fertilization and early development.
- To learn about morphogenesis, organogenesis and senescence in animals.
- To outline the concept of model systems: *C. elegans, Drosophila* and Mouse.
- To study medical implications of developmental biology in therapeutic cloning and regenerative medicine.

UNIT- I

Basic concepts of development: Potency, commitment, specification, induction, competency, determination and differentiation, morphogenetic gradients, cell fate and cell lineages, Stem Cells, genomic equivalence and the cytoplasmic determinants, imprinting; mutants and transgenics in analysis of development.

Learning outcomes:
By the end of this Unit, the student will be able to

- Define the concepts of development.
- Explain stem cells, genomic equivalence and cytoplasmic determinants.
- Highlight competency, determination and differentiation

UNIT - II

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals, zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, embryogenesis.

Learning outcomes:
By the end of this Unit, the student will be able to

- Define gametogenesis, fertilization and early development of embryo.
- Explain sperm – egg recognition, zygote formation and cleavage.
- Learn about blastula formation, gastrulation and embryogenesis.
- Understand the lineage of specialized tissues from the three germ layers.

UNIT - III

Morphogenesis and organogenesis in animals - Animal models of Cell aggregation and differentiation, axes and pattern formation, organogenesis, eye lens induction, limb

development and regeneration, differentiation of neurons, post embryonic development- larval formation, metamorphosis, environmental regulation of normal development. Aging and senescence.

Learning outcomes:
By the end of this Unit, the student will be able to

- Able to demonstrate a systematic in depth understanding of morphogenesis and organogenesis.
- Identify animal models of cell aggregation, differentiation axes and pattern formation.
- Define the concepts pre-embryonic and post-embryonic developmental stages; and aging.
- Recognize the role of environment in normal development.

UNIT - IV

Model systems: *C. elegans* - Study of cell lineage, mosaic development and organogenesis (vulva formation). Drosophila - Pattern formation, polarity determination of embryo by maternal genes, formation of body segments and Homeotic genes. Mouse - Vertebrate development, determining function of genes during development by generation of knockout and knock-in models.

Learning outcomes:
By the end of this Unit, the student will be able to

- Have a macroscopic view of model systems for *C. elegans, Drosophila* and mouse.
- Learn the concepts of cell lineage, mosaic development and organogenesis.
- Identify different pattern formation and influence of maternal genes and homeotic genes in *Drosophila* model.
- Identify the importance of genes during development by generation of knock-out and knock-in models in vertebrate development.

UNIT -V

Medical implications of developmental biology - Genetic errors of human development, gene expression and human diseases, induced pluripotency, *in vitro* fertilization, environmental assaults on human development, design of future medicines - therapeutic cloning and regeneration therapy.

Learning outcomes:
By the end of this Unit, the student will be able to

- Distinguish genetic errors of human development and their manifestation in gene expression.
- Identify the processes involved in induction of pluripotency and *in vitro* fertilization.
- Identify the implications of environmental assaults on human development.
- Understand the therapeutic and regenerative interventions in future medicine.

Recommended Books:

1. S. F. Gilbert. 2006. Developmental Biology, Sinauer Associates, Inc., MA, USA.
2. L. Wolpert, R. Beddington, T. Jessell. 2001. Principles of Development, Oxford University Press, New York, USA.
3. H. Lodish, A. Berk, C.A. Kaiser, M. Krieger, M.P. Scott, A. Bretscher, H. Ploegh, P. Matsudaira. 2003. Molecular Cell Biology, W.H. Freeman, New York, USA.
4. G.J. Siegel, B.W. Agranoff, R.W. Alberts, S.K. Fisher, M.D. Uhler. 1999. Basic Neurochemistry: Molecular, Cellular, and Medical Aspects, Lippincott, Williams & Wilkins, New York, USA.

OPEN ELECTIVES

(To be chosen from University Pool of Open Electives)

M.Sc. (BIOCHEMISTRY) - III SEMESTER

SOE 821: CANCER – DIAGNOSIS, THERAPY AND PREVENTION

Hours per week: 3 End Examination: 60Marks
Credits: 3 Sessionals: 40Marks

Course Objectives:

- To study the characteristics, sign and symptoms, types and risk factors of cancers and epidemiology of breast, cervical, oral and lung cancers.
- To identify different types of carcinogens and understand mechanism of carcinogenesis.
- To study the role of oxidative stress in cancer.
- To learn about mechanism of tumor formation, spread of cancer cells and biology of cell death.
- To list out common myths and misconceptions of cancer.
- To learn about clinical examination of cancer and applications of computational tools in cancer prediction.
- To understand the role of antioxidants and dietary fibre and yoga and meditation in cancer prevention.

UNIT I **10L**

Overview:
Normal vs Cancer cell. Characteristics of cancer and cancer cells. Sign and symptoms of cancers. Risk factors of cancer - Life style and dietary factors. Benign and malignant tumors. Types of cancers. Epidemiology of breast, cervical, oral and lung cancers.

Learning outcomes
By the end of this unit, the student will be able to

- Know about characteristics, sign and symptoms, types and risk factors of cancers
- Learn about epidemiology of breast, cervical, oral and lung cancers.

UNIT II **8L**

Carcinogenesis:
Carcinogens and carcinogenesis. Environmental carcinogens. Oxidative stress and Cancer. Concept of tumor suppressor and oncogenes.

Learning outcomes
By the end of this unit, the student will be able to

- Able to identify carcinogens and understand the mechanism of carcinogenesis
- Understand relation between oxidative stress and cancer.
- Understand the concept of tumor suppressor and oncogenes.

UNIT III **8L**

Pathology:
Tumor formation - Initiation, promotion and progression. Spread of cancer cells. Biology of cell death. Common myths and misconceptions of cancer.

Learning outcomes
By the end of this unit, the student will be able to

- Understand mechanism of tumor initiation, promotion and progression.
- To learn the mechanism of spread of cancer cells, biology of cell death.
- To learn about common myths and misconceptions of cancer.

UNIT IV **10L**

Prediction and Diagnosis:
Clinical examination - Blood Tests, Pap smear test and Biopsy. Radiological examination - X-rays, CT scan, MRI and Mammography. Applications of Computational tools in cancer prediction.

Learning outcomes
By the end of this unit, the student will be able to

- Learn about clinical examination of cancer by blood tests, pap smear test and biopsy. Learn about diagnosis of cancer by X-rays, CT scan, MRI and Mammography.
- Able to apply computational tools in cancer prediction

UNIT V

Prevention and therapy:
General principles of cancer therapy. Biomedical applications of nanotechnology in cancer prevention. Concept of cancer vaccine. Antioxidants and dietary fibre in cancer prevention. Complementary therapy – Yoga and meditation.

Learning outcomes
By the end of this unit, the student will be able to

- Understand general principles of cancer therapy
- Gain knowledge about biomedical applications of nanotechnology in cancer prevention.
- Understand the concept of cancer vaccine.
- Understand the role of antioxidants and dietary fibre and yoga and meditation in cancer prevention.

Recommended Books:

1. Molecular Pathology and Diagnostics of Cancer (Cancer Growth and Progression), Domenico Coppola, Springer.
2. An Introduction to Cellular and Molecular Biology of Cancer, Oxford Medical publications.
3. The Biology of Cancer, Janice Gabriel, John Wiley & Sons Ltd., 2nd Ed.
4. Cancer Biology, Raymond W. Ruddon, Oxford University Press, Inc., 4th Ed.
5. Introduction to Cancer Biology, Momna Hejmadi, Ventus Publishers. Molecular Biology of Human Cancers, Wolfgang Arthur Schulz, Springer Science, Business Media, Inc.

M.Sc. (BIOCHEMISTRY) - III SEMESTER

SOE 823: FUNDAMENTALS OF BIOINFORMATICS

Hours per week: 3 End Examination: 60Marks
Credits: 2 Sessionals: 40Marks

Preamble:

Bioinformatics is an interdisciplinary field mainly involving molecular biology and genetics, computer science, mathematics, and statistics. The most common problems are modeling biological processes at the molecular level and making inferences from collected data. Bioinformatics is data intensive, and large-scale biological problems are addressed from a computational point of view. A bioinformatics solution usually involves the following steps: collect statistics from biological data, build a computational model, solve a computational modeling problem, test and evaluate a computational algorithm. This course helps in understanding and solving biological problems.

Course Objectives

- To understand explosion, nature and types of biological data and its role in biological research to solve real world biological problems.
- To understand the concept and applications of bioinformatics to solve real world biological problems.
- To understand the concept and types of literature databases, nucleic acid databases, gene expression databases, RNA databases, genome databases, and protein databases; and their uses to understand to biology.
- To understand the concept of specialized databases like metabolic pathway databases, signaling pathway databases, immunological databases, cell organelle databases, human genetics databases, polymorphism databases, cancer gene databases, gene-, system- or disease-specific databases to solve real biological problems.
- To, understand the concept and principles of keyword and sequence based database searches to retrieve the biological data from biological databases.

UNIT-I

Introduction to bioinformatics: Scope of computers in Biological research, Biological Data, Retrieving and analyzing the data, Nature and Types of Biological Data, Explosion of biological data.

Learning Outcomes:

By the end of this unit, the student will be able to

- Understand the concept of bioinformatics to solve real biological problems.
- Explain about the scope of computers and their role in biological research.
- Describe the principles behind retrieving and analyzing biological data.
- Describe about the nature and types of biological data to understand to complex biological networks or systems.
- Illustrate the explosion of biological data and its role in biological research.

UNIT-II

Literature databases: PubMed, BioMed Central, Public Library of Sciences (PloS), CiteXplore.

Learning Outcome:

By the end of this unit, the student will be able to

- Understand the concept and types of literature databases and their role in biological research.

UNIT-III

Nucleic acid databases - NCBI, EBI and DDBJ, EST, STS, GSS, Gene expression databases, RNA databases, Genome databases. Protein databases – Uniprot, PDB, SCOP, CATH.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept and types of nucleic acid databases.
- Understand the concept and types of gene expression databases.
- Describe about RNA and Genome databases their uses to understand to biology.
- Understand the concept and types of protein databases.

UNIT-IV

Specialized databases: Metabolic pathway databases, Signalling pathway databases, Immunological databases, Cell organelle databases, Human genetics databases, Polymorphism databases, Cancer gene databases, Gene-, system- or disease-specific databases.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of specialized databases to solve real biological problems.
- Explain about specialized databases – metabolic and signaling pathway databases.
- Describe about specialized databases - immunological databases, cell organelle databases with their advantages and disadvantages.
- Understand about human genetics, polymorphism, cancer gene, gene-, system- or disease-specific databases to solve real biological problems.

UNIT-V

Database Searches: Keyword-based Entrez and SRS; Sequence based: BLAST & FASTA; Use of these methods for sequence analysis including the on-line use of the tools and interpretation of results from various sequence and structural as well as bibliographic databases.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the concept of database searches to retrieve the biological data from biological databases.
- Understand the principles of keyword and sequence based searches to retrieve the biological data from biological databases.
- Compare and contrast different keyword and sequence based searches.
- Describe about methods and online tools for sequence analysis.
- Interpretation of results from the analysis of sequence data, structural data as well as bibliographic databases.

Recommended Books:

1. Introduction to Bioinformatics – Arthur M. Lesk, 3rd Ed.
2. Bioinformatics and Functional Genomics – Jonathan Pevsner, 2nd Ed.
3. Essential Bioinformatics – Jin Xiong.

M.Sc. (BIOCHEMISTRY) - III SEMESTER

SBC 821: MICROBIOLOGY AND IMMUNOLOGY LAB

Hours per week: 8 End Examination: 60Marks
Credits: 3 Sessionals: 40Marks

Microbiology

1. Morphological characterization of bacterial isolates by simple staining, Gram's staining, acid – fast staining, capsule staining and spore staining.
2. Motility of bacterial isolates by hanging drop technique.
3. Biochemical characterization of bacterial isolates – Sugar fermentation, IMViC and catalase test.
4. Antimicrobial activity using disc diffusion and well diffusion methods.
5. Analysis of domestic and industrial effluents – MPN, BOD, COD and DO.

Immunology

1. Determination of nature of antigen using Ouchterlony double immunodiffusion assay
2. Quantification of Antigens by Radial Immunodiffusion
3. Detection of antibodies in serum against *Salmonella* antigen by Widal test
4. Separation of antibody in serum by immunoelectrophoresis
5. Detection of human chorionic gonadotropin in urine for Pregnancy
6. Determination of antibody concentration by ELISA
7. Detection of protein by Western blotting

Recommended Books:

1. Microbiology: A laboratory manual by Cappuccino and Sherman, Pearson Education, 6th Ed.
2. Laboratory experiments in Microbiology by M.Gopal Reddy, M.N. Reddy, D.V.R.Saigopal and K.V.Mallaiah. Himalaya publishing house
3. Miocrobiology: A laboratory manual by S.M.Reddy and S.Ram Reddy, Sri Padmavathi publications. 3rd Ed.
4. Lab manual in Biochemistry by J. Jayaraman, Wiley Eastern Limited
4. Biochemistry – A lab course by J. M. Becker, Academic Press.

- Separate antibodies in serum by immunoelectrophoresis.
- Detect human chorionic gonadotropin in urine.
- Determine antibody concentration by ELISA.
- Detect proteins in a given sample by Western blotting .

M.Sc. (BIOCHEMISTRY) - III SEMESTER

SBC 823: GENETIC ENGINEERING AND BIOPROCESS TECHNOLOGY LAB

Hours per week: 8 End Examination: 60Marks
Credits: 3 Sessionals: 40Marks

Genetic Engineering:

1. Construction of restriction map using restriction enzymes
2. Ligation of restricted DNA fragments
3. DNA finger printing using RFLP techniques
4. Amplification of DNA using specific primers by PCR
5. Preparation of competent *E.coli* cells, transformation and expression of cloned gene
6. *Agrobacterium* – mediated gene transfer into plants and expression of transferred gene in bacteria (LacZ) and plants (GUS)
7. Dot / Southern Blot for identification of abiotic stress tolerant gene

Bioprocess Technology:

1. Fermentative production of citric acid by *Aspergillus niger* and quantification of citric acid
2. Fermentative production of amylase by *Bacillus subtilis* and quantification of amylase
3. Fermentative production of fruit wine
4. Quantification of fruit wine and calculation of fermentation efficiency
5. Production of Biofertilizer using Azolla / Nostoc

Recommended Books:

1. A manual of Industrial Microbiology and Biotechnology by Demain A.L.
2. Immobilization of enzymes and cells: Methods in Biotechnology by Bickerstaff G.F.
3. Biotechnology: A laboratory course by Becker J.M.
4. Molecular Cloning: A laboratory manual Vals. 1-3, Sambrook, J.
5. Lab manual in Biochemistry by J. Jayaraman, Wiley Eastern Limited
6. Biochemistry – A lab course by J. M. Becker, Academic Press.

M.Sc. (BIOCHEMISTRY) - IV SEMESTER

SBC 802: CLINICAL BIOCHEMISTRY AND CANCER BIOLOGY

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

Clinical biochemical studies help in suggesting, evaluating, interpreting biochemical investigations in a given clinical situation and apply knowledge in clinical problems. Study of this course will impart basic concepts on diagnosis, prognosis and management of various diseases through the analysis of blood, urine and other body fluids using analytical techniques. The students will also learn about the diagnosis, treatment and prevention of cancer along with its regulatory pathways and immunological aspects.

Course Objectives:

- To familiarize students with the specific characteristics of a laboratory of clinical biochemistry.
- To understand the pathophysiology and molecular basis of the most prevalent diseases.
- To identify and perform the analytical methods commonly used in the clinical laboratory.
- To know how basic biochemistry and analytical chemistry can be applied to medical diagnosis, treatment and management of diseases.

UNIT – I

Disorders of gastric function, methods of evaluation. Pancreatic exocrine disorders-common pancreatic diseases, steatorrhea, malabsorption syndromes. Pancreatic endocrine disorders-Diabetes mellitus, hypoglycemia. Glucose Tolerance Test.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Assess gastric physiology, the most importantly acid secretion, as well as gastric motility and gastric emptying.
- Measure the presence of functional gland failure both exocrine and endocrine insufficiencies.
- Provide a framework for differential diagnosis of exocrine pancreatic insufficiency vs other malabsorptive conditions.
- Demonstrate a systematic in-depth understanding of diabetes and its clinical management.

UNIT –II

Plasma lipoproteins, cholesterol, triglycerides and phospholipids in health and disease, hyperlipidemia, hyperlipoproteinemia, Abetalipoproteinemia. Clinical features of atherosclerosis. Enzyme patterns in acute pancreatitis, liver damage, bone disorders, myocardial infarction and muscle wasting. Hemoglobinopathies, thalassemias and anemias.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Describe and Identify inborn defects in metabolism and correlate them with deficiency of key metabolic enzymes.
- Report the enzymes assayed in the clinical laboratory, their common methods of analysis, and their clinical significance.

- Relate laboratory results to clinical diagnosis and relationship to heart, liver, bone, muscle and pancreas function.
- Know the biochemical and molecular tools needed to accomplish preventive, diagnostic, and therapeutic intervention on hereditary and acquired disorders.

UNIT – III

Liver function tests, liver diseases - Jaundice, Hepatitis, Cirrhosis, Gallstones, Fatty liver. Detoxification mechanism. Kidney function tests, Renal disorders.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Describe and explain the role of liver function in bilirubin metabolism and identify thetests used for bilirubin analysis, and relate laboratory results of SGOT,SGPT, GGT, ALPto clinical diagnosis.
- Perform various biochemical tests to determine creatinine, urea clearance and albumin, ketone bodies, glucose in urine.
- Describe metabolism, detoxification and removal of waste products from the body as essential for healing and regenerative process.

UNIT – 1V **12L**

Mechanism of chemical, radiation and viral induced carcinogenesis. Oncogenes (c-Myc) and tumor suppressor genes (p53). Mechanism of metastasis, apoptosis and angiogenesis. Epigenetics - DNA methylation and histone modification. Role of signaling networks in cancer - Wnt, Notch and Hedgehog signaling.

Learning outcomes
By the end of this unit, the student will be able to

- Understand the mechanism of chemical, radiation, and viral induced carcinogenesis.
- Learn about the role of oncogenes (c-Myc) and tumor suppressor genes (p53) in cancer.
- Understand the mechanism of metastasis, apoptosis, angiogenesis, and epigenetic modification.
- Recognize the role of signaling networks in cancer.

UNIT – V **10L**

Tumor Immunology – Tumor antigens, immunological surveillance of cancer. Cancer therapy - Principles and mode of action of chemotherapy, Radiotherapy, immunotherapy, gene therapy and Stem cell therapy. Role of nanoparticles in drug delivery and imaging of cancer.

Learning outcomes
By the end of this unit, the student will be able to

- Identify the role of tumor antigens.
- Understand the mechanism of immunological surveillance of cancer.
- Understand the principles and mode of action of chemotherapy, radiotherapy, immunotherapy, gene therapy, and stem cell therapy.
- Able to implement nanoparticles in drug delivery and imaging of cancer.

Recommended Books:

1. Biochemical aspects of human disease by RS Elkeles and AS.Tavil, Blackwell Scientific publications.
2. Textbook of Medical Biochemistry by M. N. Chatterjee, Jaypee, 6th Ed.
3. Textbook of Biochemistry with clinical corelationships by Devlin, JOHN publishers, 6th Ed.
4. Textbook of Biochemistry by S. Nagini, Scitech publishers.
5. Clinical biochemistry by S. Ramakrishna and Rajiswami.
6. Biochemistry of cancer, by Jesse Philip Greenstein, Academic Press.
7. The Biology of Cancer by Janice Gabriel, John Wiley and Sons Ltd, 2nd Ed.
8. Cancer Biology by Raymond W. Ruddon, Oxford University Press Inc., 4th Ed.

GENERIC ELECTIVES

M.Sc. (BIOCHEMISTRY) - IV SEMESTER

SBC 842: DRUG DESIGNING AND NANOTECHNOLOGY

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

The discovery of drug and developing new drug is a very long term process and very costly. Modern drug design and discovery involves the implementation of various computational approaches to discover and analyze biologically related active compounds. Methods such as virtual screening, virtual library design, lead optimization and ADMET profile studies speed up the development of new active biological compounds. This course helps in understanding the variety of methods for developing candidate drug for treatment of many disease types.

Course Objectives

- To let students to understand the use of informatics in drug design and development, finding new targets to treat disease; mechanism of drug designing.
- To provide brief idea of various drug targets and their mechanisms of action.
- To understand the concept of nanotechnology, methods and applications.

UNIT-I

Introduction to Drugs: Drug discovery and Design – A historical outline, Sources of leads and drugs, Classification of drugs, Drug properties, barriers, solubility and permeability, ADMET properties. Drug administration and dosing, Bioavailability.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the historical outline of drugs evolution.
- Explain about sources of various drugs, their classification and properties.
- Describe the ADMET properties and their importance in drug designing studies.

UNIT-II

Introduction to Drug targets: Properties and types of drug targets – Enzymes, Receptors, DNA, RNA, Transport proteins, Structural proteins, Lipids, Carbohydrates.

Learning Outcomes:
By the end of this unit, the student will be able to

- Describe the types of drug targets, their properties with their mechanisms of action.

UNIT-III

Types of drug design: Traditional drug design, Rational drug design, Steps in Modern drug design cycle, Target identification strategies, Target validation methods, Lead identification through screening approaches – High Throughput Screening (HTS), Virtual Screening (VS) strategies.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the major types of drug designing methods.
- Explain the steps involved in modern drug discovery.
- Describe the various screening techniques employed in drug designing.

UNIT-IV

SBDD: Molecular docking: Steps, Methods of docking, Search algorithms and Scoring functions. LBDD: Lead optimization methods – Pharmacophore identification, Structure Activity Relationship (SAR), Drug Metabolism and PharmacoKinetics (DMPK) parameters.

QSAR: Parameters, Descriptors, Analysis and Case study, 3D-QSAR, Pre-clinical studies, Clinical trials and FDA approval.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the principles behind docking, its alogrithms and methods..
- Describe the various lead optimization methods used in drug designing studies.
- Explain the QSAR methodology and its application in LBDD.
- Describe the types of clinical details and role of FDA approval.

UNIT-V

Nanobiotechnology: Nanoparticles – metal based, lipid based and polymer based. Properties of nanoparticles and routes of administration. Role of nanosized carriers and nanoparticles in drug delivery. Nanotubes and nanowires.

Learning Outcomes:
By the end of this unit, the student will be able to

- Understand the principles of nanobiotechnology and its application in medicine.
- Describe the various types of nanoparticles.
- Explain the methods of nano-based drug delivery.

Recommended Books:

1. An Introduction to Medicinal Chemistry – Graham L. Patrick, 5th edition, Oxford
2. Medicinal Chemistry – Gareth Thomas, 2nd Ed.
3. Computational Drug Design – David C.Young.
4. Lead Generation Approaches in Drug Discovery – Zoran & Richard, Wiley.
5. Chemoinformatics in Drug Discovery, Tudor, Vol. 23, Wiley.
6. Foye's Principles of Medicinal Chemistry – Lemke and Williams, 6th Ed.

M.Sc. (BIOCHEMISTRY) - IV SEMESTER

SBC 844: NUTRITIONAL BIOCHEMISTRY

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

This course encompasses the knowledge of nutrients and other food components with emphasis on their range of function and influence on mammalian physiology and health. The students will learn the processing of the food we eat and the effect of nutrients on biochemical processes. Pathologies associated with nutrient deficiencies, nutrient toxicities, common metabolic disorders and dietary requirements in various clinical conditions are covered in this course.

Course Objectives:

- Teach students to apply the principles of interconnection, holism, transformation, diversity, and resilience in life and in the field of nutrition
- Prepare students to educate others about holistic nutrition, lifestyle, wellness, and healthy living in clinical, community, and educational settings
- Critically analyse and evaluate conceptsin nutritional biochemistry that areimportant for an understanding ofhuman nutrition

UNIT – I

Nutrients and their classification. Carbohydrates – dietary requirements, glycemic index. Proteins - determination of protein quality, SDA, improvement, supplementation and fortification. Nitrogen balance. Nutritional aspects of Lipids.

Learning Outcomes:
By the end of this Unit, the student will be able to

- List the different types of nutrients and classify them.
- Recognise the importance of maintenance of proper carbohydrate levels in body and how nutrition helps in this.
- Realise the importance of nitrogen balance in the body, understand the effects of protein deficiency and malnutrition.
- Understand the effect of lipid nutrition on health and disease.

UNIT – II

Regulation of food intake, energy value of foods, energy requirements, BMR. Water: daily requirements, regulation of water metabolism, distribution of body water, electrolytes, types, sources, composition of body fluids. Maintenance of fluid and electrolyte balance, over hydration, dehydration and water intoxication.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Know about energy value of foods and energy requirements of different age groups.
- Understand the mechanism and importance of maintenance of total body water and also in various compartments
- List the various electrolytes seen in the body, their distribution and importance
- Know about the cause of fluid electrolyte imbalance and its restoration

UNIT – III

An overview of vitamins and minerals – food sources, requirements, functions, deficiency disorders and toxicity. Enrichment and fortification of vitamins. Antioxidant and oxidative stress. Importance of nutrition under stress conditions.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Identify different forms and dietary sources, biological functions of vitamins.
- List the cause and clinical manifestations in case of deficiencies
- Define oxidative stress, reactive oxygen species and recognize its role in oxidative stress
- Pathologies associated with nutrient deficiencies, nutrient toxicities, and with common metabolic disorders

UNIT – IV

Biological effects of non-nutrients – dietary fiber, Anti-nutrients-protease inhibitors, hemeagglutinins, hepato toxins, goitrogens, cyanogenicglucosides, oxalates. Biological effects of food contaminants – pesticide residues, microbialtoxins, mycotoxins, food additives, drugs and antibiotics.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Identify the biochemical and toxicological/unfavourable impacts ofplant's auxiliary metabolites.
- State common causes of microbiological, physical,chemical and allergenic hazards and how the risk fromeach can be controlled.
- Describe major types of food contaminants and the wide variety of signs, symptoms, and effects they may have on the human body in the short and long-term.
- Identify absolute necessity for the monitoring and continuous improvement of food quality and safety.

UNIT – V

Clinical nutrition – role of diet and nutrition in prevention of atherosclerosis and obesity, role of leptin and regulation of body mass. Protein sparing treatment during fasting. Dietary influences in the process of carcinogenesis and role of diet.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Assess pathophysiology, risk factors and clinical manifestation of diseases related to nutrition.
- to assess nutritional status of individuals in various life-cycle stages and determine nutrition-related conditions and diseases by applying knowledge of metabolism and nutrient functions, food sources, and physiologic systems.
- Evaluate nutrition information based on scientific reasoning for clinical, community, and food service application.
- Evaluate the normal and therapeutic nutrition needs of adults and children and design appropriate dietary plans based on individual and group needs.

Recommended Books:

1. Advanced text book on Food & Nutrition by Dr. M. Swaminathan.
2. Text book of Human Physiology by G.P. Talwar.
3. Toxic Constituents of Plant food stuffs by Liener, T.E., Academic press, NewYork
4. Trace elements in Human health and diseases by Prasad A.S. (Ed) Academic press, NewYork

M.Sc. (BIOCHEMISTRY) - IV SEMESTER

SBC 846: STEM CELL BIOLOGY AND REGENERATIVE MEDICINE

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessionals: 40Marks

Preamble:

Stem cells and regenerative medicine has emerged as a new and most exciting field of life science in view of its potential clinical applications. Our understanding of stem cells has grown rapidly over the last decade, but the apparently tremendous therapeutic potential of stem cells has not yet been realized. The routine use of stem cells in regeneration and restoration of tissue and organ function is greatly anticipated. To this end, many investigators continue to push the boundaries in areas such as the reprogramming, the stem cell niche, nanotechnology, biomimetics and 3D bioprinting, to name just a few. The objective of the units in the Stem Cell Biology and Regenerative Medicine course is to capture and consolidate these developments in a timely way and give explicit insights into the technologies behind creating "designer" cells that will redefine approaches to the diagnosis and treatment of various diseases. Each unit is thought-provoking in identifying problems, offering solutions, and providing ideas to excite further innovation in the stem cell and regenerative medicine fields.

Course Objectives:

- Learn the various types of stem cells, their identification, isolation and cultural techniques.
- To learn the applications of cord blood stem cells in treating various diseases and understand the concept of stem cell niche and its importance
- To learn stem cell cycle regulation and explore various animal models used in stem cell research.
- To learn about stem cell transplantation and explore recent advances and challenges in pluripotent stem cell research.
- To learn various methods of gene therapy and its applications.
- To learn about translational research and its applications in the treatment of diabetes and prostate cancer.
- To learn about cancer stem cells and study the various cell signalling pathways up regulated in cancer stem cells.
- To study the mechanisms of tissue regeneration in the treatment of Myocardial infarction.
- To explore the recent advances in the application of regenerative technologies to combat and overcome problems associated with ageing- Parkinson’s disease.

UNIT - I

Stem cell Biology: Characteristic features of stem cells. Types – Embryonic, adult and Umbilical cord blood stem cells. Identification and culture of embryonic and adult stem cells. Isolation of embryonic stem cells from cord blood and their preservation. Stem cell niche. Role of stem cells in the treatment of diabetes.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn the various types of stem cells their identificationand isolation.
- Learn stem cell cultural techniques and establishment of stem cell lines.
- Understand the concept of stem cell niche and its importance.
- Study the applications of cord blood stem cells in treating various diseases.

UNIT – II

Isolation and characterization of stem cells-Localization of adult stem cells in various tissues-Hematopoietic, mesenchymal, neural, cardiac and muscle. Stem cell markers. Mechanism of stem cell self renewal and differentiation. Culture and maintenance of stem cells in vitro. Animal models in stem cell research. Stem cell cycle regulation.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn the isolation and characterization of stem cells.
- Localization of adult stem cells and their identification.
- Understand about stem cell cycle regulation.
- Explore various animal models used in stem cell research.

UNIT-III

Stem cell therapy- Autologous and allogenic stem cell transplantation, HLA typing. Gene therapy using stem cells: Methods of gene therapy. Applications of stem cells in gene therapy. Tissue derivation from different germ layers. Significance of pluripotency. Induced pluripotency of stem cells. Recent advances, applications and challenges in the production of pluripotent stem cells.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn about autologous and allogenic stem cell transplantation.
- Learn various methods of gene therapy and its applications.
- Explore recent advances and challenges in pluripotent stem cell research.

UNIT-IV

Translational research- Overview and phases of translational research. Importance of translational research in diabetes and prostate cancer. Origin of cancer stem cells and their role in tumor recurrence and relapse of breast cancer and prostate cancer. Cell signalling pathways upregulated in cancer stem cells,

Learning Outcomes:
By the end of this Unit, the student will be able to

- Understand about translational research and various phases involved in it.
- Explore the applications of translational research in diabetes and prostate cancer.
- Learn about cancer stem cells their identification and isolation.
- Study the various cell signalling pathways upregulated in cancer stem cells

UNIT-V

Regenerative medicine: Concept and overview of regenerative medicine. Mechanisms underlying the regeneration of tissues in the treatment of Myocardial infarction Applications of regenerative technologies to combat and overcome problems associated with ageing-Parkinson's disease.

Learning Outcomes:
By the end of this Unit, the student will be able to

- Learn about concepts of regenerative medicine.
- Study the mechanisms of regeneration of tissues in the treatment of Myocardial infarction various Immune techniques.
- Explore the recent advances in the application of regenerative technologies to combat and overcome problems associated with ageing- Parkinson's disease.

Recommended Books:

1. Stem cell biology and Gene therapy, Peter J QuesenBerryr, Willey – Less.
2. Essentials of Stem Cell Biology by Robert Lanza and Anthony Atala, Elsevier
3. Stem Cells: From Basic Research to Therapy, Volume 1: Basic Stem Cell Biology, Tissue Formation during Development, and Model Organisms by Federico Calegari, Claudia Waskow, Taylor and Francis group.

M.Sc. (BIOCHEMISTRY) - IV SEMESTER

SBC 822: CLINICAL BIOCHEMISTRY AND CANCER BIOLOGY LAB

Hours per week: 8 End Examination: 60Marks
Credits: 3 Sessionals: 40Marks

Clinical Biochemistry

1. Estimation of blood glucose by enzymatic method
2. Estimation of glycosylated hemoglobin
3. Estimation of Fibrinogen in plasma
4. Prothrombin time.
5. Lipid profile
6. Determination of serum Creatine and Creatinine
7. Determination of Uric acid in serum
8. Determination of serum Bilirubin
9. Determination of SGOT
10. Determination of SGPT
11. Determination of serum Alkaline Phosphatase
12. Determination of serum Chlorides
13. Determination of serum Calcium
15. Qualitative tests and microscopic examination of urine
16. Glucose Tolerance Test (Group experiment)

Cancer Biology

1. Study of cancer cell morphology
2. Determination of Cell proliferation by MTT assay
3. Determination of Cell Viability by Tryphan blue exclusion test

Recommended Books:

1. Practical Clinical Biochemistry by Harold Varley.
2. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, IKI Pvt. Ltd.
3. Cell Death techniques; A Laboratory Manual by Rickey John Stone and John Silke, Coldspring Harbor Press.

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