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 and Molecular Biology

(w.e.f. 2021-22 Admitted batch)

Website: www.gitam.edu

Master of Science in Biochemistry and Molecular Biology
(M.Sc. Biochemistry and Molecular Biology)
REGULATIONS
(w.e.f. 2021-22 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:

Notwithstanding anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

M.Sc. Biochemistry and Molecular Biology

Program Educational Objectives (PEOs)

M.Sc. Biochemistry and Molecular Biology students within two years of graduation should

1. Gain capability to employ fundamental knowledge related to Biochemistry and Molecular Biology in an interdisciplinary manner for delivering inventive solutions to academia and industry.
2. Be able to analyze, demonstrate expertise, draw conclusions and apply the gained knowledge for the human health and wellbeing.
3. Familiarise with changing world through sustained learning and professional development.
4. Gain domain knowledge and know-how for successful career in academia, industry and research.
5. Develop ethical, interpersonal and team skills meeting the professional demands.

Program Outcomes (POs)

At the end of this program, the student will be able to

PO 1: Understand various aspects of biomolecules and an overview of their metabolic events

PO 2: Understand various aspects of cell, cellular events, and genetic basis of life.

PO 3: Gain knowledge in conventional techniques, modern analytical techniques, omics, bioinformatic approaches and nanotechnologies.

PO 4: Acquaint the principles of enzymology, kinetics and their applications in industry and medicine

PO 5: Gain an overview of the organization of vital physiological systems, their function and abnormalities in both animal and plant systems

PO 6: Gain theoretical and practical knowledge of genome, expression of genes and, their regulation, repair and application of rDNA technology for superior traits.

PO 7: Understand various clinically important microorganisms; and the elicitation and regulation of immune response.

PO 8: Gain knowledge of microorganisms and bioprocess technologies with reference to production of enzymes, vitamins, antibiotics and organic acids.

PO 9: Acquire knowledge regarding ethical conduct of research, clinical trials, economic, political, ELSI of the HGP

PO 10: Acquaint and apply intellectual property rights (IPR) principles to real problems and analyse the social impact

PO 11: Gain knowledge in diagnosis, prognosis and management of various diseases and addressing clinical problems

PO 12: Understand the ecosystem, biodiversity, developmental biology and holistic nutrition for betterment of human life

Program Specific Outcomes (PSOs)

PSO 1: Gain knowledge and insights on various aspects of Biochemistry

PSO 2: Apply knowledge, tools and techniques for solving biochemical problems

PSO 3: Acquaint Central Dogma of life and understands the various facets of Molecular Biology

Scheme of Instruction

M.Sc. Biochemistry and Molecular Biology – 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	Systems Physiology	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	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 and Molecular Biology - 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	Basic Bioinformatics and Biostatistics	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 722	Enzymology Lab	PP	3	0	8	8	3	--	100
7	SBC 724	Molecular Biology and Bioinformatics Lab	PP	3	0	8	8	3	--	100
8	SBC 792	Viva voce	--	1	--	--	--		50	
		Total		25	16	19	35	--	750	

M.Sc. Biochemistry and Molecular Biology - 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 and Molecular Biology – 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 AND MOLECULAR BIOLOGY) - I SEMESTER

SBC 701: BIOMOLECULES

Hours per week: 4 End Examination: 60Marks
Credits: 4 Sessional: 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 bio molecular 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 the structure of amino acids, proteins & its structural organization and conformation. Naturally occurring peptides
- To gain the concept of lipids, their biological and chemical roles.
- To acquire and understand the structures of DNA and RNA, sequence determination and synthesis.
- To study the structure & biological role of porphyrins and to remember 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

- Understand the classification and chemical properties of carbohydrates (L2).
- Describe the chemistry and biological roles of mono and disaccharides (L1).
- Describe the structure and role of homo, heteropolysaccharides (L1).
- Understand the structure and biological role of peptidoglycans, glycosaminoglycans and glycoproteins (L2).
- Elucidate the structure of starch (L2).

UNIT-II

Amino acids- classification, structure and physic chemical 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 (L2).
- Describe naturally occurring peptides, peptide synthesis (L2).
- Understand the protein structure, its purification and criteria of homogeneity (L2).

- Understand the conformation of protein structure by Ramachandran plot (L2), sequence determination (L1).
- Study different methods of denaturation of proteins (L1)

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 (L1)
- Describe the chemistry and biological roles of phospholipids in membranes (L2).
- Describe the biological roles of phospholipids and sphingolipids (L2).
- Understand the biological role of prostaglandins (L2).
- Explain the structure and properties of cholesterol (L2).

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 (L1).
- Describe the properties of nucleic acids (L1).
- Understand the structure of DNA, RNA and its forms (L2).
- Explain base pairing, forming helices between A, U, G (L2).
- Learn the importance of nucleotides as regulatory molecules and mediators (L2).

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 – Heme (L1).
- Know the structure and biological role of Cytochromes and Chlorophyll (L1).
- Describe physiological roles of fat-soluble vitamins (L2).
- Understand the physiological role of water-soluble vitamins (L2).
- Discuss the deficiencies of fat- and water-soluble vitamins (L2).

Course Outcomes
By the end of this course, the student will be able to

- Understand the biological roles of carbohydrates in and their structures (CO1).
- Learn the structure of amino acids, organization of proteins and natural peptides (CO2).
- Understand the concept of lipids and their biological roles (CO3).

- Understand the concept of nucleic acid structures, its sequence and synthesis (C04).
- Gain knowledge on structure and biological role of porphyrins and vitamins (CO5).

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 AND MOLECULAR BIOLOGY) - 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.
- To understand the basic concepts of inheritance and factors affecting the inheritance patterns.
- To understand the extrachromosomal inheritance, genetic equilibrium and gene fine structure.

UNIT-I

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 (L1)
- Distinguish the structure of prokaryotic and eukaryotic cell (L2).
- Understand the organization of plasma membrane and membrane transport mechanisms (L2)
- Recognize intracellular trafficking (L2)
- Gain knowledge of structure and functions of mitochondria, chloroplast, nucleus, endoplasmic reticulum, golgi, lysosomes, ribosomes, cytoskeletal elements (L1).

UNIT-II

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

- Learn the principles and applications of phase contrast, fluorescent, confocal and electron microscopy (L1)
- Compare and contrast the events of cell cycle and its regulation (L3)
- Know the types of extracellular matrix components and their functions (L1)
- Understand cell-cell and cell - matrix interactions (L2).
- Explain mechanisms of cellular communications in prokaryotes and eukaryotes (L2).

UNIT-III

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

- Learn the general features of signal transduction and types of signal transducers (L1)
- Understand the signal transduction mechanisms and their significance normal and diseases cells (L2)
- Compare and analyze the functions of G – proteins and secondary messengers (L3)
- Compare growth factor signaling cascade in normal and diseased cells (L3)
- Learn the regulation of signaling pathways (L1).

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 ofinheritance (L1)
- Explain deviations from basic laws of inheritance (L2)
- Lay down the genetic mechanisms of inheritance andvariations (L3)
- Differentiate the inheritance mechanisms with the affecting factors (L4)
- Evaluate the various genetic crosses observed in differentexperiments (L5)

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 geneticrecombination (L2)
- Differentiate extra-chromosomal inheritance fromchromosomal inheritance (L2)
- Illuminate, how genetic equilibrium is maintained in thepopulation (L2)

- Recognize the experimental design to find out the fine structure of gene (L1)
- Lay down the experimental strategies to find out genestructure (L3)

Course Outcomes

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

- Draw the structure of cell, distinguish bacterial, plant and animal cells, locate cell organelles along with their functions and understand membrane transport mechanisms (CO1).
- Observe cell and its internal structures using different types microscopes, compare and contrast the phases of cell cycle and its regulation, understand cell-cell interactions and explain different types of cellular communications (CO2).
- Understand mechanisms signal transduction, explain growth factor signaling cascade and regulation of signaling pathways (CO3).
- Explain the genetic basis of inheritance, linkage, factors affecting the inheritance and understand the establishing mechanisms of inheritance (CO4).
- Understand the recombination mechanism, extrachromosomal inheritance, genetic equilibrium and experimental design to find fine structure of gene (CO5)

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, Internationaledition.
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 AND MOLECULAR BIOLOGY) - I SEMESTER

SBC 705: BIOCHEMICAL TECHNIQUES

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

Preamble:

The syllabus supports to acquire an advanced knowledge and understanding of the core principles of Biochemical techniques, methodologies and execute operations related to isolation, purification and characterization of biomolecules.

Course Objectives:

- To learn the basic concepts 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.
- To execute the methodology for biochemical characterization of biomolecules.

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 (L1).
- Gains the basic principles of centrifugation and factors that determine the rate of sedimentation of a particle (L2).
- Execute differential centrifugation, density centrifugation, continuous and discontinuous centrifugation. (L2).
- Choose appropriate method for separation of cellular constituents (L2).
- Extend the concepts of centrifugation in characterizing molecules (L3).

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 (L1).
- Describe the operating principles of the various column separation techniques, including gas chromatography and liquid chromatography (L2).
- Select the appropriate column, its configuration and composition for a given separation problem (L2).
- Select the operating conditions (mobile phase, temperature, flow rate, program rate, etc.) for the various separation techniques (L2).
- Plan the instrumentation required for the various separation techniques and their associated operating principles (L3).

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 agarose gel electrophoresis (L1).
- Use the operating principles of the various separation techniques based on charge and size isomers of proteins (L2).
- 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 (L2).
- Simultaneously detect protein employing fluorescent dyes that are pH insensitive, photo-stable and spectrally distinct spots due to the multiplexing ability of DIGE (L3).
- Detect the presence or absence of proteins which might be an indicator of disease and address several biological questions (L3).

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 (L1).
- Explain working basic and using of elemental analysis device and report results of C, H,O,S analysis in sample (L2).
- Explain working principles, taking spectrum and outline of atomic absorption spectroscopy device (L2).
- Distinguish the specialties and applications of various types of spectroscopic methods (L2).
- Select the methods for determining size, shape, and 3D structure of biomolecules and spectroscopic methods that are used to study biochemical processes. (L3).

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 (L1).
- Estimate the remaining amount of a radioisotope, given the appropriate data (L2).
- Compare the penetrating power of alpha, beta, neutron, and gamma radiation (L1).
- Understand the factors that determine the biological effects of radiation (L2).

- Identify the methods for determining absorbed dose, penetrating ability, ionizing ability and units of radioactivity (L1).

Course outcomes:

- Gains knowledge about the basic concept and applications of various biochemical Techniques (CO1).
- Will be conversant with the techniques required for isolation, purification and characterization of biomolecules (CO2).
- Gains knowledge about the application of radioactive techniques in biological realm (CO3).
  Gains expertise to handle proteomic studies (CO4).
- Learn about the methodology and application of biochemical techniques characterization of biomolecules (CO5).

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 Chatwaland Anand, Himalaya Publishers,5thEd.
5. Modern Experimental Biochemistry by Rodney F. Boyer.

M.Sc. (BIOCHEMISTRY AND MOLECULAR BIOLOGY) - II SEMESTER

SBC 707: 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 Bloodcomponents, respiratory system, mechanism of respiration and regulation ofrespiration.
- 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 varioushormonal changes.
- To study the plant physiology with aspects of photophosphorylation, CO2fixation, photorespiration, phytochromes, nitrogen fixation, defense mechanism andstress.

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 (L1).
- Explain blood clotting mechanism (L2).
- Describe the transport and exchange of gases in the body (L2).
- Highlight the role of Haemoglobin with structural importance in respiration (L2).
- Understand regulatory mechanism of respiration and respiratory changes observed in different conditions (L2).

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 (L2).
- Describe the maintenance of homeostasis in the body (L2).
- Understand the role of kidneys in maintaining the human health (L2).

- Illuminate about the heart function (L1).
- Educate on gametogenesis, ovulation and their regulation in reproductive process (L2).

UNIT-III

Structure of neuron and synapse. Origin of membrane potential, propagation of nerve impulse in unmyelinated and myelinated nerve fibres, Synaptic transmission of adrenergic and cholinergic 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 (L2).
- Identify the role of neurotransmitters in nerve transmission (L1).
- Explain about the biochemical events occurring in vision (L2).
- Illuminate about the different types of muscles in the human body and their structural organization (L2).
- Understand the biochemical associate with muscle contraction (L2).

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

- Identify the organs involved in the endocrine system and their locations in the human body (L1).
- Explain the functions of pituitary hormones and disorders related to pituitary hormones (L2)
- Describe about the functions and abnormalities of thyroid, parathyroid, adrenal and gonadal hormones (L2)
- Illuminate about the functions of gastrointestinal, pancreatic and renal hormones (L2)
- Lay down the general mechanism of hormone action (L2)

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 and CO_2 Fixation (L2)
- Identify the role photorespiration andphytochromes in photosynthesis (L1)
- Differentiate the functions of auxins, gibberellins, abscisic acid and cytokinins (L2)
- Explain the nitrogen fixation, nif genes and regulation of nifgenes (L2)
- Describe abiotic and biotic stress responses in plants (L2)

Course Outcomes

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

- Gain the knowledge on blood components, function of blood, respiratory mechanism and regulation of respiration (CO1).
- Learn the structure of kidney, nephron, formation of urine, role of kidney in maintaining the homeostasis in the body, functioning of heart and gametogenesis (CO2).
- Explain the nerve transmission, role of neurotransmitters in transmission, biochemical basis of vision, muscular organization and mechanism of muscle contraction (CO3).
- Understand the role of different hormones in maintenance of body metabolism, disorders associate with the abnormal levels of different hormones and mechanism of hormone action (CO4).
- Describe the mechanism of photophosphorylation, CO_2 fixation, role of photorespiration &phytochromes and mechanism of nitrogen fixation (CO5).
- Explain the role of plant hormones in plant metabolism and abiotic & biotic stress responses in plants (CO6).

Recommended Books:

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

M.Sc. (BIOCHEMISTRY AND MOLECULAR BIOLOGY) - 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.

Course Objectives:

- To introduce components of digital computer and their working along with the outline of Operating Systems.
- To give hands on training on features, components of MS-Word
- To give hands on training on features, components of Power Point
- To give hands on training on features, components of Excel

UNIT – I

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.

Learning Outcomes:

- A basic understanding of computer hardware and software.
- Demonstrate Block diagram of a digital computer.
- Recognize various storage devices.
- Demonstrate basic understanding of Operating Systems.

UNIT – II

MS-Word: Features of MS-Word – MS-Word Window Components – Creating, Editing, formatting 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.

Learning Outcomes:

- Navigate and perform common tasks in Word, such as opening, viewing, editing, saving, and printing documents, and configuring the application.
- Format text and paragraphs, add a header and footer to a document.
- Use the spelling and grammar checker. Add graphic to a document.
- Perform repetitive operations efficiently using tools such as Find and Replace, Format Painter, and Styles.

UNIT – III

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.

Learning Outcomes:

- Examine slide show presentation concepts and explore the Microsoft Office PowerPoint environment.
- Create a new presentation.
- Modify presentation themes.
- Add and edit text to slides.
- Add new slides to a presentation.
- Insert clipart images and shapes to slides.
- Insert and modify tables and charts.

UNIT – IV

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.

Learning Outcomes:

- Learn how to start Excel. Become familiar with the Excel workbook
- Understand how to navigate worksheets.
- Examine spreadsheet concepts and explore the Microsoft Office Excel environment.
- Create, open and view a workbook, Save and print workbooks.
- Enter and edit data, Modify a worksheet and workbook.
- Work with cell references.
- Learn to use functions and formulas.
- Create and edit charts and graphics.
- Filter and sort table data.
- Work with pivot tables and charts

Course Outcomes:

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

- Understand fundamental hardware components that make up a computer's hardware and the role of each of these components (CO1).
- 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 (CO2).
- Create a document in Microsoft Word with formatting that complies with the APA guidelines (CO3).
- Write functions in Microsoft Excel to perform basic calculations and to convert number to text and text to number (CO4).
- Create a presentation in Microsoft PowerPoint that is interactive and legible content (CO5).

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.

M.Sc. (BIOCHEMISTRY AND MOLECULAR BIOLOGY) - 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 gives hands on training in SPSS, R Programming and creation of simple HTML documents.

Course Objectives:

To learn the basics of networking concepts
To understand the application of internet
To learn the basic concepts and working of email
To understand the concepts of web applications
To learn the basic concepts of block chain technology
To learn basic basic commands in statistical packages and R programming language

UNIT I

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. 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.

Learning Outcomes:

By the end of the unit the student will be able to:

- Define network. (L1)
- Describe types of networking. (L2)
- Explain different applications of internet. (L2)
- Describe the concepts of Internet Explorer. (L2)
- Identify the use of social networking. (L2)
- Explain the concepts of social networking. (L2)

UNIT II

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**.**

Learning Outcomes:

By the end of the unit the student will be able to:

- Define e-mail. (L1)
- Understand the concepts of domain names. (L2)
- Explain the concepts of e-mail. (L2)
- Understand the concept of web terminologies. (L2)

- Explain the use of web browser. (L2)
- Define search engine. (L1)

UNIT III

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.

Learning Outcomes:

By the end of the unit the student will be able to:

- Define block chain. (L1)
- Identify the need of block chain. (L1)
- Explain the limitations of block chain technology. (L2)
- Study block chain variants (L2)
- Learn applications of block chain and shared databases (L1)

UNIT IV

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.

Learning Outcomes:

By the end of the unit the student will be able to:

- Explain analysis of variance. (L2)
- Use correlation analysis. (L3)
- Apply regression analysis. (L3)
- Understand the concepts of R. (L2)
- Illustrate the usage of graphical analysis. (L3)

UNIT V

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.

Learning Outcomes:

By the end of the unit the student will be able to:

- Understand the structure of HTML document. (L2)
- Explain different HTML tags. (L2)
- Develop a simple HTML page. (L3)
- Learn various web terminology (L1)
- Creation of semantic tags (L3)

Course Outcomes:

Upon completion of this course, the student will be able to

- Understand different types of computer networks, viruses. (CO1)
- List different social networking websites. (CO2)
- Understand the features of email, browser and a search engine (CO1)

- Understand the concepts of block chain technology, R programming language (CO1)
- List the commands used in statistical packages, tags used in HTML (CO2)

Recommended Books:

1. In-line/On-line: Fundamentals of the Internet and the World Wide Web by Raymond Greenlaw and Ellen Hepp, 2nd Edition, TMH.
2. Microsoft Office 2010 Bible by John Walkenbach, Herb Tyson, Michael R. Groh and Faithe Wempen, WileyPublications.
3. Computer Networks, Andrew S Tanenbaum, David J. Wetherall, Fifth Edition, Pearson Education, 2011.
4. The Basics of Bitcoins and Blockchains, Antony Lewis, Jan 2019, Two Rivers Distribution.
5. Introduction to HTML how to use tag, Kabir Das, Notion Press

M.Sc. (BIOCHEMISTRY AND MOLECULAR BIOLOGY) - I SEMESTER

SBC 721: BIOCHEMICAL TECHNIQUES LAB

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

Preamble:

Biochemical techniques lab deals with gaining the best skills for performing and establishing operational procedures in the lab conditions for analyzing the biomolecules. The lab provides the student to perform and improve operational skills in techniques like chromatography methods, electrophoresis and spectrophotometric methods used in research.

Course Objectives

- To understand the principles of separating the amino acids, sugars, plant pigments and other biomolecules using appropriate chromatographic method.
- To understand the principles of separating the proteins using electrophoresis method.
- To understand the principle for calculating the concentration of amino acids, nucleic acids and proteins using spectrophotometry.

Practical's Laboratory Sessions

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.

Learning outcome:

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

- separate and identify amino acids and sugars using paper chromatography and separate amino acids and plant pigments by thin layer chromatography (L3).
- separate plant pigments using column chromatography (L3) and determine their absorption spectra (L5).
- separate compounds by using affinity chromatography, ion-Exchange chromatography, gel permeation chromatography and HPLC and serum proteins using polyacrylamide gel electrophoresis (L3).
- determine the molecular weight of proteins using SDS-PAGE (L3).
- determine the molar absorption coefficient of aromatic amino acids, nucleic acids and protein using spectrophotometer (L3).

Course Outcomes

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

- Understand the principles of separating the amino acids, sugars, pigments, and compounds using chromatographic methods (CO1).
- Understand the principles of separating the proteins using electrophoresis method CO2).

- Understand the principle for calculating the concentration of amino acids, nucleic acids and proteins using spectrophotometry (CO3).
- Understand the principle of affinity, ion-exchange and gel permeation chromatography (CO4).
- Calculate molar absorption coefficient of unknown compounds

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 AND MOLECULAR BIOLOGY) - I SEMESTER

SBC 723: QUANTITATIVE ANALYSIS LAB

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

Preamble:

This course aims to analyze biomolecules like carbohydrates, lipids and proteins as well as bioactive compounds like total phenolics using various by quantitatively using colorimetric, spectrophotometric and titrimetric methods. The course covers the method for estimation of biomolecules and bioactive compounds and provides an overview of industrial and medical applications.

Course Objectives:

- To estimate the amount of protein present in the given sample using colorimetric and spectrophotometric methods
- To determine the pK and pI value of an amino acids
- To estimate the total carbohydrates, reducing sugars using colorimetric methods
- To estimate the total lipids using colorimetric methods
- To estimate the total phenolics by Folin-Ciocalteu reagent.

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
7. Estimation of reducing sugars by Dinitrosalicylic acid method.
8. Estimation of Total Phenolics by Folin-Ciocalteu reagent.

Learning Outcomes:

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

- Estimate the amount of protein present in the given sample using colorimetric Lowry and Bradford methods (L5)
- Estimate the amount of protein present in the given sample using spectrophotometric methods (L5)
- Determine the pK and pI value of an amino acids (L5)
- Analyse the total carbohydrates and reducing sugars using anthrone and dinitrosalicylic acid methods (L4)
- Analyse the total lipids and total phenolics using colorimetric methods (L4)

Course Outcomes

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

- Estimate quantitatively protein in different biological samples (CO1)
- Estimate quantitatively total carbohydrates, reducing sugars in different biological samples (CO2)
- Estimate quantitatively total lipids in different biological samples (CO3)
- Distinguish the pK and pI value of different types of amino acids (CO4)
- Analyse the total phenolics in different biological samples (CO5)

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 AND MOLECULAR BIOLOGY) – II SEMESTER

SBC 702: METABOLISM

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

Preamble:

The student will be able to review and consolidate concepts in the areas of Metabolism and Bioenergetics, focusing on the main metabolic pathways in a living cell, their regulation and disturbances in disease, and how energy is obtained and transduced to meet the cell's requirements. The focus will be on bringing the students up to date on advances in these areas while stressing the essential principles and molecules involved.

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
- To comprehend the thermodynamics involved in energetics of biochemical pathways

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 (L1).
- Predict the products of chemical reactions of carbohydrates (acetal/hemiacetal formation or oxidation) (L2).
- Describe what happens during carbohydrate digestion, glycolysis, glycogenesis, and glycogenolysis (L2).
- Discuss how disruptions in intermediary metabolism may lead to disease, and illustrate with selected examples (L3).

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 urea cycle (L1).
- List the ketogenic and glycogenic amino acids and describe the general strategies for amino acid synthesis (L2).
- Analyze complex chemical problems and draw logical conclusions (L3).
- Analyze the congenital disorders of protein metabolism (L3).

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 (L1).
- To differentiate lipolysis and lipogenesis, cholesterol and cholesteryl ester (L2).
- To explain how blood lipid levels are related to risk of CVD (L3).
- Distinguish the shift of arachidonic acid (ARA) paradigm from a harm-generating molecule to its status of polyunsaturated fatty acid essential for normal health (L2).
- To be familiar with basic changes in lipid metabolism during a critical illness (L2).

UNIT -IV

Biosynthesis and degradation of purines and pyrimidines and their regulation. Structure and regulation of ribonucleotide reductase. 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 origin and utilization of PRPP in nucleotide synthesis and its importance in determining the overall rate of de novo purine biosynthesis (L1).
- Explain what happens if you don't have the enzyme HGPRT and how PRPP play a role in this (L2).
- Describe how Allopurinol treatment will reduce the Uric Acid as well as PRPP by increasing salvage of Hypoxanthine in treatment of Gout (L2).
- Understand the role of drugs in cancer treatment
  1. Hydroxy urea inhibits ribonucleotide reductase (baso cell carcinoma)
  2. 5-Fluorouracil inhibits thymidylate synthase (baso cell carcinoma)
  3. Methotrexate inhibits dihydrofolate reductase (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 (L3).
- Understand the steps involved in heme synthesis and degradation (L2).

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 (L1).
- Explain and give examples of the strategies of metabolism, emphasizing the role of ATP coupled reactions, and coenzymes that exist in oxidized and reduced form (L2).
- Describe what happens in the citric acid cycle, the electron transport chain and oxidative phosphorylation. Explain the role of each process in energy production (L2).
- Identify the sites of drug action in ETC both as inhibitors and uncouplers (L3).

Course outcomes:

- Gains an overview and interplay of metabolic pathways (CO1).
- Understands the role of enzymes, cofactors and the mechanisms involved in inhibition, and regulation of pathways (CO2).
- Understands the correlation between enzyme insufficiencies in the pathways and manifestation of diseases (CO3).
- Gains insights into potent clinical applications of synthetic purine and pyrimidine analogs in treatment of diseases (CO4).
- Understands the thermodynamics involved in energetics of biochemical pathways (CO5).

Recommended Books:

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

M.Sc. (BIOCHEMISTRY AND MOLECULAR BIOLOGY) - 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 remarkable properties of enzymes, active site structure and nature of catalysis of enzyme
- To understand the structure function relations of ribonuclease, chymotrypsin, carboxypeptidase
- To learn the enzyme kinetics, enzyme inhibition and enzyme regulation
- To ascertain the knowledge about methods of immobilized enzymes
- To find the applications of enzymes in industry and medicine and to provide overview on enzyme electrodes, Abzymes, Ribozyme and Synzymes

UNIT – I

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 remarkable properties of enzymes (LO2)
- Learn the general features and identify active site groups of enzymes (LO1)
- Understand nature of catalysis of enzyme (LO2)
- Learn the coenzyme activity of vitamin B1, B2, B3 and B6 (LO1)
- Understand the Structure function relations of ribonuclease, chymotrypsin and carboxypeptidase (LO2)

UNIT – II

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

- Analyse the effect of proximity and orientation on enzyme activity (LO4)
- Learn the effect of substrate concentration, temperature and pH on enzyme activity (LO1)
- Understand the concept of ES complex (LO2)
- Derive Michaelis – Menten equation for uni-substrate enzyme reactions (LO3)

- Determine Km and Vmax for enzymes and gain the knowledge on the importance of Km and Vmax (LO3)
- Learn about types and examples of bi-substrate reactions (LO1)

UNIT – III

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

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

- Learn the concept of enzyme inhibition (LO1)
- Understand the mechanism of competitive, non-competitive and un-competitive enzyme inhibitors (LO2)
- Explain the types and mechanisms of action of irreversible enzymes inhibitors
- Understand enzyme inhibition by substrate (LO2)
- Describe types of feedback enzyme inhibition (LO3)

UNIT – IV

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 (LO1)
- Learn the salient features of allosteric enzymes (LO1)
- Apply the concepts allosterism and cooperativity to regulatory enzymes of metabolic pathways (LO3)
- Learn about the Hill and Scatchard plots (LO1)
- Explore the mechanism of action and regulation of PDH (LO2)

UNIT – V

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 immobilized enzymes (LO2)
- Learn the physical and chemical methods of immobilization (LO1)
- Explore the applications of enzymes in industry and medicine (LO3)
- Gain the knowledge of Ribozyme, Synzymes, abzymes and their applications in health and diseases (LO2)
- Understand principle and find the applications of enzyme electrodes (LO2)

Course Outcomes
By the end of this course, the student will be able to

- Identify the catalytic and binding groups at active site of enzymes (CO1)
- Understand the theories of enzyme kinetics and the mechanisms of enzyme regulation in the cell (CO2)
- Apply principles of enzyme inhibition in discovery of novel drugs (CO3)

- Apply knowledge of enzymes in research, medicine and industry (CO4)
- Utilize principles of bioanalytics in biosensors and enzyme reactors (CO5)

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 AND MOLECULAR BIOLOGY) - I SEMESTER

SBC 706: BASIC BIOINFORMATICS AND BIOSTATISTICS

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

Preamble:

Bioinformatics is an emerging branch in the field of life science. The management and analysis of biological data is done with the aid of computers.It is a field in which biological information collected, compared, studied and analyses to find the interrelation between them for solving structural, functional and evolutionary problems using computational technologies. The biological information stored in various databases is available online through internet. This course will provide common basic knowledge of Bioinformatics and also provide emphasis on Statistical concepts as well need of biostatistics in biology.

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 biology.
- To understand the concept of specialized databases like metabolic pathway databases, and interaction network databases to understand the inter-connectivity of cellular processes.
- To understand scientific data representation, measuring central tendency, dispersion and their use in analyzing the biological data
- To employ testing of Hypothesis using student 't' test, Chi-square test, Correlation co-efficient, Regression analysis and ANOVA for analysis of data.

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. (L2)
- Explain about the scope of computers and their role in biological research. (L2)
- Describe the principles behind retrieving and analysing biological data. (L2)
- Describe about the nature and types of biological data. (L1)
- Explain about various biological literature databases and retrieval in different formats. (L1)

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

- Understand various nucleic acid and protein sequence databases with sequence retrieval formats and their further application for bioinformatic analysis.(L3)
- Understand the concept of pairwise and multiple sequence alignments and their uses. (L2)
- Describe and perform the sequence similarity searches using BLAST and FASTA tools. (L3)

UNIT – III

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

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

- Understand the concept and types of protein structural and structure classification databases. (L2)
- Understandvarious metabolic databases and usage of biological pathways data for further applications. (L2)
- Understand the inter-connectivity of cellular processes mainly by the protein interaction networks. (L2)

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 graphicalmethods (L3).
- Calculate the central tendency value of mean, median, mode for the given data (L3).
- Estimate the deviation among the raw data from the central tendencyvalue (L3).
- Identify and choose correct statistical method to analyze thedata (L4).
- Check the statistical data published using the appropriate methods (L5).

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 theirsignificance (L2).
- Lay down the hypothesis and subject it to validation using significancetests (L4).
- Correlate the two variables and able to make regression lines for prediction of correct observation in thedata (L3)
- Choose best method of comparing sample data depending upon the variables (L5)
- Critic the operational methods by analyzing and can suggest improvement areas to achieve the goal (L5).

Course Outcomes:
By the end of course, the student will be able to

- Understands explosion, nature and types of biological data and its role in biological research to solve real world biological problems. (CO1)
- Understands the concept and applications of bioinformatics to solve real world biological problems. (CO2)
- Describe the methods and online tools for sequence analysis and interpretation of results from the analysis of sequence data, structural data as well as bibliographic databases. (CO3)
- Understands the concept and types of literature databases, nucleic acid databases, and protein databases; and their applications to perform bioinformatics analysis. (CO4)
- Understands the concept of specialized databases like metabolic pathway databases, protein interaction databases to understand the interconnectivity of cellular processes and regulations. (CO5)

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 AND MOLECULAR BIOLOGY) - II SEMESTER

SBC 708: MOLECULAR BIOLOGY

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

Preamble:

Molecular Biology deals with the basics and understanding of the central dogma. It helps the student in knowing the organization of the genome, replication, transcription, translation and their regulation in both prokaryotes and eukaryotes. This knowledge can be employed in determining the function of various genes and proteins for better understanding of cellular life.

Course Objectives

- To understand the organization of nuclear genome (prokaryotes and eukaryotes), and organelle genomes (mitochondrial & plastid).
- To learn the mechanism and enzymes involved in DNA replication (prokaryotes and eukaryotes).
- To acquire the knowledge of promoters, RNA polymerase, mechanism and inhibition of transcription in both prokaryotes and eukaryotes.
- To gain the knowledge of genetic code, mechanism and inhibition of translation (protein synthesis), post translational modifications, protein processing and targeting.
- To study the regulation of gene expression in both prokaryotes and eukaryotes.

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

- Understand the organization and the role of nuclear genome (prokaryotes and eukaryotes) and organelle genomes (mitochondrial and plastid genomes) (L2).
- Explain the differences between the genetic material in both prokaryotes and eukaryotes (L2).
- Describe the fine structure of gene (prokaryotes and eukaryotes) types of genes (L1).
- Describe the natural and artificial amplification of genes (L1), knows how to artificially amplify genes (L3), and produce DNA fragment via PCR (L6).
- Understand the concept of giant chromosomes (polytene and lampbrush chromosome) and C- value paradox (L2).

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

- Explain the mechanism of DNA replication in both prokaryotes and eukaryotes (L2).
- Explain about the enzymes involved and their role in DNA replication (L2).
- Describe the role and types of DNA polymerases in both prokaryotes and eukaryotes (L1).
- List the differences between DNA polymerases in both prokaryotes and eukaryotes (L2).
- Describe the concept of DNA damage and different mechanisms of DNA repair (L1).

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

- Understand the mechanism of transcription in both prokaryotes and eukaryotes (L2).
- Compare and contrast RNA polymerases & promoters in both prokaryotes and eukaryotes (L2).
- Understand the role of inhibitors used for inhibition of transcription in both prokaryotes and eukaryotes (L2)
- Apply the knowledge of inhibitors to inhibit transcription of various prokaryotes and eukaryotes (L3).
- Describe the concepts of post transcriptional modifications, RNA editing and RNA transport (L2).

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

- Learn the general features of genetic code (L1), and the structural components of ribosomes in both prokaryotes and eukaryotes (L2).
- Understand the mechanism of protein synthesis in both prokaryotes and eukaryotes (L2)
- Study inhibitors of protein synthesis (L1) and use the knowledge to inhibit protein synthesis of various prokaryotes and eukaryotes (L3).
- Understand post translational modifications in eukaryotes (L2).
- Learn the concepts of protein processing and targeting (L2).

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

- Understand the concept of operon and compare & contrast Lac and Trp operons (L2).
- List the difference between lytic and lysogenic phases of bacteriophage λ life cycle (L2).
- Highlight prokaryotic gene regulation through sporulation in *Bacillus subtilis* (L1).
- Illustrate the role of chromatin, chromatin remodelling, DNA methylation and Cis-trans elements in eukaryotic gene regulation (L2).
- Learn the concept of environment and RNAi mediated gene regulation (L2).

Course Outcomes
By the end of this course, the student will be able to

- Understand the organization of nuclear genome (prokaryotes and eukaryotes), organelle genome (mitochondrial & plastid); and amplification of genes (CO1).
- Learn the mechanism and enzymes involved in DNA replication (prokaryotes and eukaryotes) (CO2).
- Explain the concept of DNA damage and different mechanisms of DNA repair (CO3).
- Acquire the knowledge of promoters, RNA polymerase, mechanism of transcription, transcriptional inhibitors, post-transcriptional modifications, RNA editing and RNA transport (C04).
- Gain the knowledge of genetic code, ribosomes, mechanism and inhibition of translation (protein synthesis), post translational modifications, protein processing and targeting as well as regulation of gene expression in prokaryotes (operons, bacteriophage λ life cycle and sporulation) and eukaryotes (chromatin remodelling, DNA methylation, Cis-trans elements, environment, and RNAi mediated) (CO5).

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 AND MOLECULAR BIOLOGY) - 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

Course Outcomes:
At the end of the course, the student will be able to:

- Acquaint themselves with basic English grammar (CO1)
- Acquire presentation skills (CO2)
- Develop formal writing skills (CO3)
- Develop creative writing skills (CO4)
- Keep themselves abreast with employment-readiness skills (CO5)

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 AND MOLECULAR BIOLOGY) - II SEMESTER

SBC 722: ENZYMOLOGY LAB

Hours per week: 8 End Examination: 60Marks
Credits: 3 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. The course covers the assay of acid phosphatise, DNases and catalase activity in different biological samples, determination of effect of substrate concentration, pH and temperature on phosphatase activity, reversible inhibition of phosphatase by EDTA and irreversible inhibition of trypsin by PMSF and preparation of immobilized by enzymes.

Course Objectives:

- To assay of acid phosphatase activity in crude potato extract and to determine the effect of pH, temperature and EDTA on phosphatase activity
- To evaluate effect of substrate concentration on phosphatase activity and to determine Michaelis – Menton constant
- To assess the effect of irreversible inhibitor (PMSF) on trypsin activity
- To prepare the immobilized enzymes using sodium alginate method
- To assay DNAse and catalase activities in different enzymes sources

Experiments:

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

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

- Assay acid phosphatase activity in various enzyme sources (LO1)
- Understand the effect of pH, temperature and substrate concentration on activity of industrially important enzymes (LO2)
- Understand effect of irreversible inhibitors on enzyme activity (LO2)
- Analyze DNAse, succinate dehydrogenase and catalase activity in various biological samples (LO3)
- Learn methods of immobilization of enzymes (LO1)

Course Outcomes
By the end of this course, the student will be able to

- Determine the acid phosphatase activity in various biological samples (CO1)
- Apply knowledge of effect of pH, temperature and metal chelators on various industrially important enzymes (CO2)
- Apply knowledge of reversible and irreversible enzyme inhibition to design drugs (CO3)

- Apply Michaelis – Menton kinetics for analysing effect of drugs on therapeutically important enzymes (CO4)
- Apply knowledge of immobilization methods for various industrially important enzymes (CO5)

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 AND MOLECULAR BIOLOGY) - II SEMESTER

SBC 724: MOLECULAR BIOLOGY AND BIOINFORMATICS LAB

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

Preamble:

Molecular Biology laboratory deals with understanding the principles of isolating DNA & RNA, determining the purity of isolated DNA & RNA, and quantifying the isolated DNA & RNA from different sources. It helps the student to analyse isolated DNA content for better understanding of cellular life.

Course Objectives

- To understand the principles of isolating DNA & RNA, determining the purity of DNA & RNA, and quantity of DNA & RNA
- To study the effect of UV radiation on the survival of *E. coli* and study the repair mechanism by photoreactivation in *E. coli* after UV irradiation.

Molecular Biology Practical's Laboratory Sessions

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

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.

Learning outcomes:

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

1. Isolate DNA from plant tissue/animal cells (L3) and determine its purity (L5).
2. Quantify the isolated DNA by spectrophotometeric method (L3).
3. Isolate plasmid DNA (L3) and determine its purity (L5).
4. Quantify the isolated plasmid DNA by spectrophotometeric method (L3).

5. Estimate the isolated DNA by DPA method (L3).
6. Determine Tm of DNA and estimate G + C content (L3).
7. Understand separation of DNA molecules (L3) and determine the purity of DNA by gel electrophoresis (L5).
8. Isolate RNA from Yeast (L3) and determine its purity (L5).
9. Quantify the isolated RNA by spectrophotometric method (L3).
10. Estimate the isolated RNA by Orcinol method (L3).
11. Understand separation of RNA molecules (L3) and determine the purity of RNA by formaldehyde-agarose gel electrophoresis (L5).
12. Understand effect of UV radiation on the growth or survival of *E.coli*
13. Understand how to induce UV damage (L3) and study the repair mechanism of *E.coli* (L5).

Course Outcomes

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

- Understand the principles of isolating DNA & RNA (CO1).
- Understand the principles of determining the purity of DNA & RNA (CO2).
- Understand the principles of quantifying DNA & RNA (CO3).
- Understands the effect of UV radiation on the survival of *E.coli* and the repair mechanism by photoreactivation in *E.coli* after UV irradiation (CO4).

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 AND MOLECULAR BIOLOGY) – 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 overall 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:

- To know the scope and development of microbiology and contributions of various scientists towards it.
- To learn various cultural techniques and methods of microbial identification.
- To learn the general characteristics, morphology and pathogenesis of various clinically important microorganisms.
- To have an overview of immune system and learn about various classes of antibodies, cells of immune system and types of hypersensitivity.
- 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 (L1).
- Learn various cultural techniques of microbial identification (L2).
- Learn various methods of microbial identification (L2).
- Learn ribotyping (L2).
- Learn various microbial interactions and differentiate between them (L4).

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 *Entamoebahistolytica.* 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 (L2).
- Learn the Life cycle of *Plasmodium* (L2)
- Learn the life cycle of *Entamoebahistolytica*(L2)
- Learn the Immune response during bacterial, parasitic infections (L4).
- Understand the role of immune response in viral infections with an emphasis on HIV (L2).

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 (L2).
- Learn the typesof Immune Cells and their role in immune responses (L2).
- Learn the components of immune regulation(L2).
- Know about clonal selection of lymphocytes (L2).
- Learn about HLA typing (L2).

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(L2).
- Learn the classes of immunoglobulins, their structure and function (L2).
- Learn about Antigen-Antibody interactions and types(L2).
- Learn about types of hypersensitivity(L4).
- Know about Autoimmunity and breakdown of self – tolerance (L1).

UNIT-V

Immunological tolerance and immunosuppression. Immune techniques- Rocket Immunoelectrophoresis, Immunoelectrophoresis, Immuno-fluorescence, 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 (L2).
- Learn about various Immune techniques (L2).
- Learn about Monoclonal antibodies and their applications (L2).
- Understand about Vaccines and their types (L2).
- Know about Transplantation immunology. Immunomodulation (L3).

Course Outcomes:

1. Know the scope and development of microbiology and contributions of various scientists towards it.
2. Learn various cultural techniques and methods of microbial identification.
3. Learn the general characteristics, morphology and pathogenesis of various clinically important microorganisms.
4. Have a overview of immune system and learn about various classes of antibodies, cells of immune system and types of hypersensitivity.
5. Learn about various immunological techniques, transplantation immunology and 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 AND MOLECULAR BIOLOGY) - 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.
- To compare different types of cloning and expression vectors. To learn about construction, screening of gene libraries 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 and remember the outlines of recombinant DNA (L1)
- Understand the types, role and function of restriction endonucleases and how to construct restriction map (L2).
- Concept of mapping genes- chromosomal walking and chromosomal jumping (L2).
- Understand the concept of chemical synthesis of genes and ligation of fragments (L2).
- Explain and understand the isolation of gene fragments using restriction endonucleases, cDNA, PCR and RACE PCR (L3).

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 (L2).
- Understand the CRIPSR Cas 9 technology (L2).
- To learn the concepts of construction of gene libraries and its types (L1).
- To highlight cloning strategies- short gun experiments and cDNA cloning in bacteria (L2).
- Illustrate the concept of screening of libraries (L2).

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 (L2).
- Understand the different biological delivery systems (L2).
- Compare and contrast biological and artificial delivery systems (L1).
- To understand the mechanism of expression of cloned genes in bacterial, plant and animal cells (L2).
- To learn the concept of different types of blot analysis (L2).

UNIT - IV

Transgenic plants - production of golden rice, transgenic animals – 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 (L2).
- Understand the production of transgenic plants (L2).
- Understand the production of transgenic animals (L2).
- To learn the concept of RNA silencing and its mechanism (L1).
- Explore the applications of RNA silencing (L2).

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 (L1).
- List the types and application of rDNA constructs for gene therapy (L2).
- Describe the different delivery systems for gene therapy (L2).
- Highlight the applications of genetic engineering in biological and medical fields (L2).
- Remember the role of genetic engineering in industrial applications (L2).

Course Outcomes

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

- Understand the concept of rDNA technology, map and chemically synthesize genes (CO1).
- Learn the different types of vectors, construction of gene library and blotting techniques (CO2).
- Understand the present day applications of genetic engineering with both advantages and disadvantages (CO3).
- Understand the concept of RNA silencing (C04).
- Gain knowledge on methods of gene therapy, delivery systems and applications (CO5).

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 AND MOLECULAR BIOLOGY) - III SEMESTER

SBC 805: BIOPROCESS TECHNOLOGY AND BIOETHICS

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

Preamble:

This course gives a detailed overview on principles of bioprocess technology involved in production of various commercially important compounds, technologies involved in environment friendly technologies and imparts understanding about bioethical principles and guidelines.

Course objectives:

- To study microbiology, biochemistry and engineering in an integrated fashion with the goal of using microorganisms, cell and tissue cultures to manufacture useful products.
- To gain knowledge about the major products of traditional biotechnology industry.
- Acquainting with the major products of traditional biotechnology industry of food and flavor ingredients, industrial alcohol.
- To gain knowledge about the processes involved in the production of antibiotics and citric acid
- To impart an overview of relevance and use of microbial biofertilizers 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 acquainted with the industrial aspect of the field of Microbiology, and also learn about growth pattern of microbes in different industrial systems (L1).
- Acquire experimental knowhow of microbial production of various industrial products such as alcohol, exopolysaccharides, enzymes, etc (L2).
- Develop an understanding of process control, upstream and downstream process (L2).
- Analyze different methods like media optimization, mutation and screening, genetic. engineering and biocatalyst conversion for improvement of the production (L3).

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 (L1).
- Identify different strains of microbes used in fermentation of cheese, bread etc (L2).
- Recognize the role of fermentation in producing drugs and different strains used (L2).
- Describe how species are often genetically modified to yield the maximum amounts of antibiotics, amino acids, vitamins and enzymes (L1).

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 (L1).
- Learn the principles & mechanisms of microorganisms enzyme and its applications in
- environmental pollution control (L2).
- Gain an overview of key topics on sustainable bioenergy production, including the main biomass systems for bioenergy generation (L2).
- Reflect on the polymeric material choices for biomedical applications and pharmaceutical formulations (L2).

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*, *Beauveria bassiana* 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 (L1).
- Understand the reduction of BOD, COD, eutrophication etc. of receiving water bodies and prevention of bio-magnification of toxic substances in food chain (L2).
- Familiarize with the microbes used as bio fertilizers for various crop plants and their advantages over chemical fertilizers (L2).
- Identify and apply pesticides in a legal, safe, correct and environmentally conscious manner (L3).

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 (L1).
- Analyse ethical and professional issues which arise in the intellectual property law context (L2).
- Ensure the ethical conduct of research and recommend educational efforts in research ethics to investigators and members of research ethics committees (L3).
- Introduce the science and the economic, political, ethical, legal and social issues of the HGP (L2).

Course Outcomes:

- Able to integrate microbiology, biochemistry and engineering with the goal of using microorganisms, cell and tissue cultures to manufacture useful products (CO1).
- Gains knowledge about the major products of traditional biotechnology industry (CO2)
- Learns the importance and utilization of flavor ingredients in food industry and in beverages (CO3).
- Gains knowledge regarding processes involved in the production of antibiotics and citric acid (CO4).
- Attain knowledge regarding relevance and use of microbial biofertilizers and biopesticides (CO5).

Recommended Books:

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

GENERIC ELECTIVES

M.Sc. (BIOCHEMISTRY AND MOLECULAR BIOLOGY) – 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 (L2)
- Understands fragment and map assembly which is required for genome assembly (L2)
- Describe about the tools employed in genome assembly and annotating the genome sequencing (L1)
- Understand the importance of metagenomics and its application (L2)
- Describe the basic concepts of comparative genomics, tools used (L1) and its applications (L3)

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 (L2)
- Describe the methods to employ to identify gene segments in prokaryotes and eukaryotes (like exons and introns) in genome sequence (L1)
- Explain the process of identification regulatory parts in genome sequence like promoters, enhancers, DNA motifs, repetitive elements and CpG islands (L2)

- Explain about the sequence based, structure based and machine learning approaches to assign gene functions (L2)
- Understand the importance of different methods like SNP arrays, EST, SAGE, DNA microarray in genomics (L2)

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 scope, need, and challenges of proteomics (L2)
- Understand the application of proteomics (L2)
- Describe methods employed in protein separation for basic small samples (L1)
- Explain principles behind different purification methods and their quantification (L2)
- Understand the complex analysis methods employed in proteomics like 2DGE, DIGE and protein chip technology (L2)

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 (L2)
- Explain about the different technologies engaged for protein structure determination like XRD, NMR and Mass Spectroscopy (L2)
- Describe the principles behind the XRD, NMR and Mass Spectroscopy with their advantages and disadvantages (L1)
- Enlighten the methods to find the protein function using protein structure and protein-protein interaction methods (L2)
- Understand the protein-DNA interactions to solve biological problems (L2)

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 (L2)
- Explain the use of genomics and proteomics in biomarker discovery (L2)
- Understand the importance of genomics and proteomics in drug targeting (L2)
- Describe the application of genomics and proteomics in plant breeding and genetically modified plants (L1)
- Describe the application of genomics and proteomics in analysis of secondary metabolites (L1)

Course Outcomes:
By the end of course, the student will be able to

- Understand the concept of genomics and proteomics and its necessity to solve biological problems and employ good strategies for sequencing genome of a particular sample (CO1).

- Use different methods and tools to assembly the gene fragments obtained in genome sequencing (CO2).
- Identify and annotate the different sequences in the genome assembled and predict the function of the genome sequences by employing suitable tools (CO3).
- Understand the basic principles of protein separation and purification and employ suitable methods of protein purification and identification (CO4).
- Explain the different methods employed in characterization and prediction of protein structure and function and understand the importance of genomics and proteomics in biomarker identification, drug targeting, plant breeding, genetically modified plants, and analysis of secondary metabolites (CO5).

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 AND MOLECULAR BIOLOGY) - 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 wastewater 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(L1)
- Describe the components of ecosystem, food web, food chain and Bio geo chemical cycles(L2)
- Explain the different types of environmental pollution, their causes, effects and control measure (L3)

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 (L2)
- Compare and contrast between the phases of xenobiotic metabolism (L3)
- Learn about toxicity of food additives and various heavy metals (L1)

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 (L2)
- Learn the concept of tissue specificity of toxicity and genotoxicity (L1)
- Compare and contrast the different methods of toxicity testing (L4)

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 (L1)
- List the advantages and disadvantages of bioremediation (L3)
- Describe phytoremediation of soil metals and microbials degradation of xenobiotics (L3)

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 (L2)
- Learn about threats to biodiversity and hotspots (L1)
- Describe in-situ and ex-situ methods of biodiversity conservation (L3)

Course Outcomes:

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

- Understand the importance, and various components of ecosystems (CO1).
- Gain knowledge about different types of pollution, their causes and effect on the environment (CO2).
- To understand the concept of ecotoxicology, xenobiotics, and chemodynamics (CO3)
- Understand the toxicity mechanism, and toxicity testing (CO4).
- To learn the concept of bioremediation and biodiversity and study their role in improving the environment (CO5).

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 AND MOLECULAR BIOLOGY) - 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 (L1)
- Explain stem cells, genomic equivalence and cytoplasmic determinants (L2)
- Highlight competency, determination and differentiation (L3)

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 (L1)
- Explain sperm – egg recognition, zygote formation and cleavage(L2)
- Learn about blastula formation, gastrulation and embryogenesis (L1)
- Understand the lineage of specialized tissues from the three germ layers (L2)

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 (L4)
- Identify animal models of cell aggregation, differentiation axes and pattern formation (L3)
- Define the concepts pre-embryonic and post-embryonic developmental stages; and aging (L1)
- Recognize the role of environment in normal development (L3)

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 (L2)
- Learn the concepts of cell lineage, mosaic development and organogenesis (L1)
- Identify different pattern formation and influence of maternal genes and homeotic genes in *Drosophila* model (L2)
- Identify the importance of genes during development by generation of knock-out and knock-in models in vertebrate development (L2)

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 (L3)
- Identify the processes involved in induction of pluripotency and *in vitro* fertilization (L2)
- Identify the implications of environmental assaults on human development (L2)
- Understand the therapeutic and regenerative interventions in future medicine (L3)

Course Outcomes

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

- Understand the basic concepts of development (CO1).
- Explain the concept of gametogenesis, fertilization and early development (CO2).
- Learn about morphogenesis, organogenesis and senescence in animals (CO3).
- Outline the concept of model systems: *C. elegans, Drosophila* and Mouse (CO4).
- Study medical implications of developmental biology in therapeutic cloning and regenerative medicine (CO5).

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 AND MOLECULAR BIOLOGY) - III SEMESTER

SOE 821: CANCER – DIAGNOSIS, THERAPY AND PREVENTION

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

Preamble

This course is designed with characteristics, sign and symptoms, types and risk factors of cancers and epidemiology of breast, cervical, oral and lung cancers. It introduces types of carcinogens and carcinogenesis mechanisms, stages of tumor formation, Biology of cell death, spreading of cancer cells, common myths and misconceptions of cancers. It also introduces principles of clinical, radiological and non-radiological examination methods of cancer prediction and diagnosis. It presents principles of cancer therapy, biomedical applications of nanotechnology in cancer treatment, concepts of cancer vaccine, antioxidants and dietary fibre, Yoga and meditation in cancer prevention.

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 learn about mechanism of tumor formation, spread of cancer cells and biology of cell death.
- 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 of cancers (L1)
- Learns types and risk factors of cancers (L2)
- Learn about epidemiology of breast, cervical, oral and lung cancers(L2).
- Know the differences between benign and malignant tumors (L3)
- Know the types of cancers (L1)

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 **(L1)**
- Learn the environmental carcinogenesis **(L2)**
- Understand relation between oxidative stress and cancer **(L2)**.
- Understand the concept of tumor suppressor **(L2)**
- Understand the concept of oncogenes **(L2)**

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**(L1)**.
- Learn the mechanism of spread of cancer cells**(L2)**
- Understand the mechanism of cell death**(L2)**.
- To learn about common myths of cancer(L2).
- To learn about common misconceptions of cancer**(L3)**.

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**(L3)**.
- Learn about clinical examination of cancer by pap smear test and biopsy**(L3)**.
- Learn about diagnosis of cancer by CT scan and MRI**(L3)**.
- Learn about diagnosis of cancer by X-rays and Mammography**(L3)**.
- Able to apply computational tools in cancer prediction**(L2)**

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 **(L2)**
- Gain knowledge about biomedical applications of nanotechnology in cancer prevention**(L2)**.
- Understand the concept of cancer vaccine**(L3)**.
- Understand the role of antioxidants and dietary fibre in cancer prevention**(L3)**.
- Understand the role of yoga and meditation in cancer prevention**(L3)**.

Course outcomes

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

- Study the characteristics, sign and symptoms, types and risk factors of cancers and epidemiology of breast, cervical, oral and lung cancers (CO1).
- Identify different types of carcinogens and understand mechanism of carcinogenesis. (CO2)
- Study the pathology of cancer (CO3)
- Study the principles and applications of cancer prediction and diagnostic methods (CO4)
- Study the principle and applications of different types of therapies and prevention of cancer by antioxidants, fibre, Yoga and meditation (CO5).

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 AND MOLECULAR BIOLOGY) - 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 modelling 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 modelling 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 (L2)
- Explain about the scope of computers and their role in biological research (L1)
- Describe the principles behind retrieving and analyzing biological data (L3)
- Describe about the nature and types of biological data to understand to complex biological networks or systems (L3)
- Illustrate the explosion of biological data and its role in biological research (L4)

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 (L2)

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 (L2)
- Understand the concept and types of gene expression databases (L2)
- Describe about RNA and Genome databases their uses to understand to biology (L3)
- Understand the concept and types of protein databases (L2)

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 (L2)
- Explain about specialized databases – metabolic and signaling pathway databases (L2)
- Describe about specialized databases - immunological databases, cell organelle databases with their advantages and disadvantages (L3)
- Understand about human genetics, polymorphism, cancer gene, gene-, system- or disease-specific databases to solve real biological problems (L2)

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 (L2)
- Understand the principles of keyword and sequence-based searches to retrieve the biological data from biological databases (L2)
- Compare and contrast different keyword and sequence-based searches (L3)
- Describe about methods and online tools for sequence analysis (L3)
- Interpretation of results from the analysis of sequence data, structural data as well as bibliographic databases (L4)

Course outcomes

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

- Understand explosion, nature and types of biological data and its role in biological research to solve real world biological problems (CO1).
- Understand the concept and applications of bioinformatics to solve real world biological problems (CO2).
- 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 (CO3).

- 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 (CO4).
- Understand the concept and principles of keyword and sequence-based database searches to retrieve the biological data from biological databases (CO5).

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 AND MOLECULAR BIOLOGY) - III SEMESTER

SBC 821: MICROBIOLOGY AND IMMUNOLOGY LAB

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

Preamble

Microbiology and Immunology has wide applications in the field of medical, agriculture, industry and environment. The practical knowledge of the course equips the students with better learning outcomes of microbiology and immunology in all fields to address current problems.

Course Objectives

- To characterize bacterial isolates morphologically, and biochemically.
- To determine the motility of the bacterial isolates
- To analyze the antimicrobial activity of bacterial isolates and the quality of domestic and industrial effluents.
- To separate, detect and quantify antigens
- To separate, detect and quantify antibodies

Microbiology

1. Morphological characterization of bacterial isolates by simple staining, Gram'sstaining, 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 andcatalase test.
4. Antimicrobial activity using disc diffusion and well diffusion methods.
5. Analysis of domestic and industrial effluents – MPN, BOD, COD and DO.

Learning outcomes

By the end of the practical's the students will be to

- Morphological characterize bacterial isolates by simple staining, Gram's staining, acid – fast staining, capsule staining and spore staining.
- Determine the motility of bacterial isolates by hanging drop technique.
- Biochemically characterize bacterial isolates by sugar fermentation test, IMViC test andcatalase test.
- Determine the antimicrobial activity using disc diffusion and well diffusion methods.
- Determine MPN, BOD, COD and DO to analyze the domestic and industrial effluents.

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

Learning outcomes

By the end of the practical's the students will be to

- Determine the nature of antigen using Ouchterlony double immunodiffusion assay
- Quantify antigens by radial immunodiffusion
- Detect antibodies in serum against *Salmonella* antigen by Widal test
- 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.

Course outcomes

By the end of the course the students will be to

- Characterize bacterial isolates morphologically, and biochemically (CO1).
- Determine the motility of the bacterial isolates (CO1).
- Analyze the antimicrobial activity of bacterial isolates and analyze the quality of domestic and industrial effluents (CO3).
- Separate, detect and quantify antigens (CO4)
- Separate, detect and quantify antibodies (CO5)

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
5 Biochemistry – A lab course by J. M. Becker, Academic Press.

M.Sc. (BIOCHEMISTRY AND MOLECULAR BIOLOGY) – III SEMESTER

SBC 823: GENETIC ENGINEERING AND BIOPROCESS TECHNOLOGY LAB

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

Preamble:

Genetic engineering has wide applications in the field of medical, agriculture, industry and environment. The practical knowledge of the course equips the students with better learning outcomes of rDNA technology in all fields to address current problems. Bioprocess technology provides technical information on fermenter designing and kinetics involved in the fermentation production of products.

Course Objectives:

- To provide students with experimental knowledge and hands on experience in understanding how to manipulate specific genes to produce desired traits to address current problems facing humanity.
- To empower the students with various designs of fermenter. The growth and process kinetics of the fermentation process enable the students to manipulate for improvement of product formation.

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

Learning outcomes

By the end of the practical's the students will be to

- Able to list present day applications of genetic engineering (L1).
- Able to describe techniques involved in manipulating DNA and their expression (L2).
- Able to analyze the basic bioprocess concepts of growth and product formation (L3).

Course outcomes:
By the end of the course the students will be to

- Acquires working knowledge of manipulating genes and techniques involved in the process (CO1).
- Obtains knowledge about design of a fermentor, kinetics of growth and product formation (CO2).

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. Green, M. R., & Sambrook, J. Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
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 AND MOLECULAR BIOLOGY) - IV SEMESTER

SBC 802: CLINICAL BIOCHEMISTRY AND CANCER BIOLOGY

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

Preamble:

Clinical Biochemistry has contributed enormously to the growth of modern medical and health science. Clinical Biochemistry has applications in clinical diagnosis, understanding pathology of diseases, treatment of diseases, designing of drugs and understanding their metabolism. Keeping in pace with the developmental trends in various subareas of Biochemistry it is expected that the students undertaking Clinical Biochemistry and Cancer Biology course become conversant with the fundamentals and at the same time at the end of the programme they exhibit certain levels of learning outcomes.

Course Objectives:

- To familiarize students with the specific characteristics features of clinical biochemistry laboratory.
- To understand the pathophysiology and molecular basis of the most prevalent diseases.
- To know how basic biochemistry and analytical chemistry can be applied to medical diagnosis, treatment and management of diseases.
- To understand the molecular mechanism of cancer
- To study fundamentals of biology of cancer cells and principles of therapies

UNIT – I

Disorders of gastric function, methods of evaluation. Pancreatic exocrine disorders-common pancreatic diseases, steatorrhea, malabsorption syndromes. Pancreatic endocrine disorders-Diabetis 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 (L1).
- Measure the presence of functional failureexocrine gland (L2).
- Measure functional endocrine insufficiencies (L2).
- Provide a framework for differential diagnosis of exocrine pancreatic insufficiencyvs other malabsorptive conditions (L2).
- Demonstrate a systematic in-depth understanding of diabetes and its clinical management (L2).

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 ofkey metabolic enzymes (L1).
- Report the enzymes assayed in the clinical laboratory, their common methods of analysis, and their clinical significance (L2).
- Relate laboratory results to clinical diagnosis and relationship to heart, liver, bone, muscle andpancreas function (L3).
- Know the biochemical and molecular tools needed to accomplishpreventive, diagnostic, and therapeutic intervention on hereditary and acquireddisorders (L2).
- Understands the biochemical basis of blood related 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 the tests used for bilirubin analysis (L1).
- Relate laboratory results of SGOT,SGPT, GGT, ALPto clinical diagnosis(L3).
- Perform various biochemical tests to determine creatinine, urea clearance and albumin, ketone bodies, glucose in urine (L2).
- Describe metabolism, detoxification and removal of waste products from the body as essential for healing and regenerative process (L2).
- Understands common disorders of liver and kidney (L2).

UNIT – 1V

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. The impact of microRNAs, ultra-conserved long non-coding RNAs and environmental cancer.

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

- Describe the mechanism of chemical, radiation and viral induced carcinogenesis (L1).
- Explain the role of oncogenes (c-Myc), tumor suppressor genes (p53), metastasis, apoptosis, angiogenesis, and epigenetics in carcinogenesis (L3).
- Describe the role of signaling networks (Wnt, Notch and Hedgehog signaling) in cancer (L2).
- Describe the impact of microRNAs, ultra-conserved long non-coding RNAs on cancer (L2).
- Describe the impact of environment on cancer (L2).

UNIT – V

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

- Understand about tumor antigens (L2)
- Understand about immunological surveillance (L2)
- Understand general principles of cancer therapy (L2)

- Gain the principles and mode of action of chemotherapy, Radiotherapy, immunotherapy, gene therapy and Stem cell therapy (L2)
- Gain knowledge about biomedical applications of nanotechnology in cancer prevention. (L1)

Course Outcomes:
By the end of this course, the student will be able to

- Familiarize with the specific characteristics of a clinical biochemistry laboratory (CO1).
- Understand the pathophysiology and molecular basis of the most prevalent diseases (CO2).
- Understand the implications of basic clinical biochemistry and analytical chemistry in medical diagnosis, treatment and management of diseases (CO3).
- Understand the mechanism of carcinogenesis, metastasis, apoptosis, angiogenesis and epigenetics. Role of oncogenes (c-Myc), tumor suppressor genes (p53), microRNAs, ultra-conserved long non-coding RNAs, and environment in cancer (CO4).
- Understand tumor antigens, immunological surveillance, chemotherapy, radiotherapy, immunotherapy, gene therapy and stem cell therapy. Explains the role of nanoparticles in drug delivery and imaging of cancer (CO5).

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 AND MOLECULAR BIOLOGY) - 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, ADMET profile studies, etc. speed up the development of new active biological compounds. Nanotechnology is the science of dealing with atoms with only a few nanometers in dimensions. Nanotechnology is considered more powerful than even the industrial revolution, with applications ranging from automobiles to medicine. This course helps in understanding the variety of methods for developing candidate drug for treatment of many disease types.

Course Objectives

- To understand the use of informatics in drug design and development, finding new targets to treat disease; mechanism of drug designing
- To learn about various drug targets and their mechanisms of action
- To acquire the knowledge in drug design by various approaches
- To gain the knowledge of structure activity relationships and clinical trails
- To study 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. (L2)
- Explain about sources of various drugs, their classification and properties. (L2)
- Describe the ADMET properties and their importance in drug designing studies. (L1)
- Describe the various routes of drug administration. (L1)
- Understand the relationship between solubility, permeability and bioavailability. (L2)

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 and mechanisms of action. (L1)
- Explain about enzymes, receptors, DNA and RNA as drug targets. (L2)
- Describe the role of transport and structural proteins as drug targets. (L1)
- Explain about lipids and carbohydrates as drug targets. (L2)
- Differentiate between drug targets and their selection in targeting of drugs. (L2)

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. (L2)
- Explain the steps involved in modern drug discovery. (L2)
- Explain various target identification methods. (L2)
- Compare and contrast various approaches in target validation. (L2)
- Describe the various screening techniques employed in drug designing. (L2)

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 algorithms and methods. (L2)
- Describe the various lead optimization methods used in drug designing studies. (L2)
- Describe about drug metabolism and pharmacokinetics parameters. (L2)
- Explain the QSAR methodology and its application in LBDD. (L2)
- Describe the types of clinical details and role of FDA approval. (L2)

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. (L2)
- Describe the various types and properties of nanoparticles. (L2)
- Explain the nanosized carriers and nanoparticles in drug delivery. (L2)
- Describe the applications of nanotubes and nanowires in biology. (L2)
- Explain the methods of nano-based drug delivery (L2).

Course Outcomes:

By the end of course, the student will be able to

- Explain the sources of drugs, properties of drugs and drug targets and ADMET studies. (CO1)
- Differentiate between each type of drug target, its function and role in drug targeting. (CO2)

- Describe various approaches in target identification and validation methods. (CO3)
- Perform drug designing studies based on structure, ligand or De novo, screening methods. Understand the theory of QSAR, types of clinical trials and drug development methods. (CO4)
- Understand the application of nanoparticles in drug delivery. (CO5)

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 AND MOLECULAR BIOLOGY) - IV SEMESTER

SBC 844: NUTRITIONAL BIOCHEMISTRY

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

Preamble:

Diet plays a major role in promotion of health and wellbeing of individual. A good and balanced diet habit improves the quality of life while poor diet may lead to morbidity and diseases. Nutritional Biochemistry imparts knowledge pertaining to nutrients in food, how the body uses them, and the relationship between diet, health, and disease. Nutritionists use ideas from molecular biology, biochemistry to understand how nutrients affect the human body.

Course Objectives:

- Teach students about energy value of foods and energy requirements of different age groups
- Prepare students to educate others about holistic nutrition, lifestyle, wellness, and healthy living in clinical, community, and educational settings
- Can apply the role of nutrition and healthy eating for disease prevention and wellness
- Critically analyse and evaluate concepts in nutritional biochemistry that are important for an understanding of human nutrition
- To evaluate the normal and therapeutic nutrition needs of adults and children and design appropriate dietary plans

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 (L1).
- Recognise the importance of maintenance of proper carbohydrate levels in body and how nutrition helps (L2).
- Realise the importance of nitrogen balance in the body, understand the effects of protein deficiency and malnutrition (L2).
- Learns about quality improvement of proteins (L2).
- Understand the effect of lipid nutrition on health and disease (L2).

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

- Understand BMR and its importance in health and disease (L1).
- Know about energy value of foods and energy requirements of different age groups (L1).
- Understand the mechanism and importance of maintenance of total body water and also in various compartments (L2).
- List the various electrolytes seen in the body, their distribution and importance (L3).

- Know about the cause of fluid electrolyte imbalance and its restoration (L4).

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 (L1).
- List the cause and clinical manifestations in case of deficiencies (L1).
- Learns about enrichment and fortification of vitamins (L2).
- Define oxidative stress, reactive oxygen species and recognize its role in oxidative stress (L1).
- Understand the pathologies associated with nutrient deficiencies, nutrient toxicities, and with common metabolic disorders (L2).

UNIT – IV

Biological effects of non-nutrients – dietary fiber, Anti-nutrients-protease inhibitors, hemeagglutinins, hepato toxins, goitrogens, cyanogenic glucosides, oxalates. Biological effects of food contaminants – pesticide residues, microbial toxins, 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 of plant's auxiliary metabolites (L1).
- State common causes of microbiological, physical, chemical and allergenic hazards and how the risk from each can be controlled (L2).
- Describe major types of food contaminants (L1).
- Identify wide variety of signs, symptoms, and effects of food contaminants on the human body in short and long-terms (L1).
- Identify absolute necessity for the monitoring and continuous improvement of food quality and safety (L2).

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 (L1).
- To assess nutritional status of individuals in various life-cycle stages (L1).
- Determine nutrition-related conditions and diseases by applying knowledge of metabolism and nutrient functions, food sources, and physiologic systems (L3).
- Evaluate nutrition information based on scientific reasoning for clinical, community, and food service application (L3).
- Evaluate the normal and therapeutic nutrition needs of adults and children and design appropriate dietary plans based on individual and group needs (L3).

Course Outcomes:

- Gains knowledge about energy value of foods and energy requirements of different age groups (CO1).
- Gains expertise about holistic nutrition, lifestyle, wellness, and healthy living in clinical, community, and educational settings (CO2).
- Can apply the role of nutrition and healthy eating for disease prevention and wellness (CO3).
- Understands the role of major types of food contaminants and the signs, symptoms and effects on the human body (CO4).
- Can evaluate the normal and therapeutic nutrition needs of adults and children and design appropriate dietary plans (CO5).

Recommended Books:

1. Advanced textbook on Food & Nutrition by Dr. M. Swaminathan.
2. Textbook 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 AND MOLECULAR BIOLOGY) - 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 and understand the concept of stem cell niche and its importance
- To learn stem cell cycle regulation,transplantation and explore recent advances and challenges in pluripotent stem cell research.
- To learn various methods of gene therapy and its applications in translational research.
- To learn about cancer stem cells and study the various cell signalling pathways up regulated in cancer stem cells.
- 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 (L2).
- Learn stem cell cultural techniques and establishment of stem cell lines(L2).
- Understand the concept of stem cell niche and its importance(L2).
- Understand the concept of embryonic stem cells and their isolation.(L2)
- Study the applications of cord blood stem cells in treating various diseases.(L2)

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(L2).
- Localization of adult stem cells and their identification(L2).
- Understand the characterization of stem cells(L2).
- Understandabout stem cell cycle regulation(L2).
- Explore various animal models used in stem cell research(L2).

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(L3).
- Learn various methods of gene therapy and its applications (L3).
- Understand the concept of pluripotency(L2).
- Undertsand the concept of induced pluripotent stem cells(L2).
- Explore recent advances and challenges in pluripotent stem cell research(L2).

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(L2).
- Explore the applications of translational research in diabetes and prostate cancer(L3).
- Learn about cancer stem cells their identification and isolation(L2).
- Learn the role of cancer stem cells in tumor recurrence and relapse(L2).
- Study the various cell signalling pathways upregulated in cancer stem cells(L2)

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(L2).
- Study an overview of regenerative medicine and its applications in the treatment of various diseases (L3).
- Study the mechanisms of regeneration of tissues in the treatment of Myocardial infarction(L3).
- Learn concepts of various Immune techniques(L2).
- Explore the recent advances in the application of regenerative technologies to combat and overcome problems associated with ageing- Parkinson’s disease (L3).

Course outcomes:

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

- Learn the various types of stem cells, their identification, isolation and cultural techniques and understand the concept of stem cell niche and its importance (CO1)
- Learn stem cell cycle regulation, transplantation and explore recent advances and challenges in pluripotent stem cell research (CO2).
- Learn various methods of gene therapy and its applications in translational research (CO3).
- Learn about cancer stem cells and study the various cell signalling pathways up regulated in cancer stem cells (CO4).
- Explore the recent advances in the application of regenerative technologies to combat and overcome problems associated with ageing- Parkinson's disease (CO5).

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.
4. Recent research publications and review articles regarding stem cell biology and their role in tissue regeneration.

M.Sc. (BIOCHEMISTRY AND MOLECULAR BIOLOGY) - IV SEMESTER

SBC 822: CLINICAL BIOCHEMISTRY AND CANCER BIOLOGY LAB

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

Preamble:

Clinical Biochemistry has applications in clinical diagnosis, understanding pathology and treatment of lifestyle and other diseases. The global burden of cancer is high and continues to increase. The practical knowledge of diagnostics in Clinical Biochemistry and Cancer Biology lab course equips the students with better learning outcomes in diagnosis and research.

Course Objectives:

- To acquires working knowledge of analytical methods commonly used in the clinical laboratory.
- To learn about cancer cell morphology, proliferation and viability used in diagnosis and research.

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

Learning Outcomes:

- Will be able to clinically assess the laboratory indicators of physiologic conditions and diseases (L2).
- Relate laboratory results to clinical diagnosis of marker molecules in diseases pertaining to heart, liver, kidney, pancreas, bone, blood and urine (L2).
- Gain ability to apply knowledge of clinical biochemistry in health and diagnostic purposes (L3).

Course Outcomes:

- Acquires working knowledge of analytical methods commonly used in the clinical laboratory (CO1).
- Gains expertise in handling clinical biochemistry in health and diagnostic purposes (CO2).

- Obtains knowledge about studying cancer cell morphology, proliferation and viability (CO1).

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.

M.SC. BIOCHEMISTRY AND MOLECULAR BIOLOGY (IV SEMESTER)

SBC 892: PROJECT WORK AND SEMINAR