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

BACHELOR OF SCIENCE (HONOURS) BIOTECHNOLOGY

(w.e.f. 2020-21 admitted batch)

Website: www.gitam.edu

PROGRAMME EDUCATIONAL OBJECTIVES (PEO's)

1. To train students on methodologies of Modern Biotechnology

2. To make the student acquainted with all the laboratory protocols to undertake research in Biotechnology

3. To make the student learn the protocols that are useful in designing breakthrough products.

4. To make the students useful for medical, pharma and other industrial sectors by enhancing their ability in exploring, designing and employing latest technologies.

5. To build careers for the students in Biotechnology wherein they apply their academic knowledge and experimental skills and make them more efficient for the Biotech industry and research.

PROGRAMME OUTCOMES

PO1	To acquire the knowledge on most important classes of biological macromolecules and maintain biochemical homeostasis by metabolic regulation
PO2	To gain the fundamental knowledge on statistics/computers/biophysics and apply them in biological sciences.
PO3	To improve the understanding on multi-disciplinary nature of environment and its application on natural processes that sustain life.
PO4	To equip with theoretical and practical understanding of microbiology, its significance in causing infectious diseases and appreciate the diversity of microbes in bioprocess and fermentation technologies
PO5	To gain the latest knowledge of the diversification in normal cells, stem cells, cancer cells along with their cellular processes in the progression of developmental biology and cancer biology
PO6	To describe the basic concepts of enzymology and immunology along with gaining practical knowledge in various techniques
PO7	To comprehend the basic concepts and practical implications of classical genetics / plant diversity / animal diversity
PO8	To absorb the knowledge on basics of molecular biology and its advances in rDNA technology revolutionizing in fields of plant, animal, fermentation and medical biotechnology
PO9	To apply literature survey, ethical principles, research methodology, biosafety and intellectual properties in various fields of biotechnology
PO10	To spread over the principles, quantifiable techniques, skills, critical thinking and manage to do work as a member and a leader in team to handle projects in diverse environments
PO11	To improve the interaction skills and entrepreneurship abilities to sustain in multi-disciplinary teams
PO12	To identify, formulate, comprehend, and analyse the theories in general and in functional organic chemistry

PROGRAM SPECIFIC OUTCOMES (PSOS)

PSO1: To conceptualize and apply biological sciences that provides an essential platform across the modern biotechnological processes designed according to the current needs of the society.

PSO2: To understand and evaluate the various cellular processes and understand the basics behind them along with development of a diverse technologies.

PSO3: To provide a platform for encompassing research with proficient and ethical responsibilities towards meeting societal needs.

B.Sc. (Hons.) Biotechnology

REGULATIONS

(w.e.f. 2020-21 admitted batch)

ADMISSIONS

Admissions into B.Sc. (Hons.) Biotechnology program, of Gandhi Institute of Technology and Management (GITAM) Deemed to be University, are governed byGITAM admission regulations.

ELIGIBILITY CRITERIA

A pass in Intermediate/XII with Chemistry, Botany and Zoology or Chemistry, Mathematics, Physics with a minimum aggregate of 50% marks or any other equivalent Examination approved by GITAM (Deemed to be University).

Admission to the B.Sc. (Hons.) Biotechnology program is based on the merit i.e., marks obtained in Intermediate / equivalent examination and the rule of reservation, wherever applicable.

CHOICE BASED CREDIT SYSTEM

Choice Based Credit System (CBCS) is introduced with effect from the admitted batch of 2015 - 16 in accordance with the 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.

STRUCTURE OF THE PROGRAM

The program consists of

(i) Ability Enhancement Compulsory Core courses (AECC)
(ii) Core Courses (compulsory) (CC)
(iii) Discipline Specific Electives (DSE)
(iv) Generic Elective (GE)
(v) Skill Enhancement Course (SEC)
(vi) Practical Proficiency Courses (PPC): Laboratory

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

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.
- One credit for two hours of practical.

The curriculum of six semesters B.Sc. (Hons.) Biotechnology program is designed to have a total number of **140 credits** for the award of B.Sc. (Hons.) Biotechnology degree.

5.0 MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and case studies) shall be English.

6.0 REGISTRATION

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

ATTENDANCE REQUIREMENTS

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

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

EVALUATION

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).

A student has to secure an aggregate of 40% in the course in 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.

The assessment of the student's performance in a laboratory course shall be based on two components: Continuous Evaluation (60 marks) and Semester-end examination (40 marks). A student has to secure an aggregate of 40% in the course in the two components put together to be declared to have passed the course.

Viva voce / Project / Industrial visit / SEC courses are completely assessed under Continuous Evaluation for maximum marks specified 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 (CC,DSE,GE,)	40	Continuous evaluation	(i) Three mid semester examinations shall be conducted for 15 marks each. (Best two out of three will be considered) (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	Theory (AECC, SEC)	100	Continuous evaluation	(i) Three mid semester examinations shall be conducted for 15 marks each. (Best two out of three will be considered) (ii) 5 marks are allocated for quiz. (iii) 5 marks are allocated for assignments. (iv) 30 marks are allocated for case study
	Total	100		
3	Practical (PPC)	60	Continuous evaluation	Sixty (60) marks for continuous evaluation are distributed among the components: regularity, preparation for the practical, performance, submission of records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the semester.
		40	Semester-end examination	One practical examination will be conducted at the end of the semester for 40 marks by the concerned lab Teacher and one external examiner nominated by the HoD.
	Total	100		

REAPPEARANCE

A student who has secured 'F' grade in a theory course shall have to reappear at the subsequent semester end examinations held for that course.

A student who has secured 'F' grade in a practical course shall have to attendspecial instruction classes held during summer.

SPECIAL EXAMINATION

A student who has completed his / her period of study and still has "F" grade in a maximum of four theory courses is eligible to appear for special examination normally held during summer vacation.

BETTERMENT OF GRADES

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 Theory courses of any semester of his / her choice, conducted in summer vacation along with the special examinations.

Betterment of grades is permitted 'only once' immediately after completion of the program of study.

REPEAT CONTINUOUS EVALUATION:

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.

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

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.

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.

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.

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

GRADING SYSTEM

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

S. 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	-

A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, and is deemed to have earned the credits assigned to that course, subject to securing a GPA of 5 for a Pass in the semester.

GRADE POINT AVERAGE

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

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

Where

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

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 theparticular point of time.

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

Distinction	≥ 8.0*
First Class	≥ 7.0
Second Class	≥ 6.0
Pass	≥ 5.0

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

ELIGIBILITY FOR AWARD OF THE DEGREE

Duration of the program: A student is ordinarily expected to complete B.Sc. (Hons.) Biotechnology program in six semesters of three years. However, a student may complete the program in not more than four years including study period.

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

A student shall be eligible for award of the B.Sc. (Hons.) Biotechnology 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.

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

16.0 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.

I SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
GEL-131	Communicative English	AECC	2	-	2	40	60	100
SBH 101	Biomacromolecules	PC	4	-	4	40	60	100
SPH 105	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	PC	4	-	4	40	60	100
	Generic Elective –I (Choose any one)	GE	4	-	4	40	60	100
SBH 103	Fundamentals of Statistics							
SBH 105	Fundamentals of Computers							
SBH 107	Fundamentals of Biophysics							
SBH 111	Biomacromolecules Lab	PPC	-	4	2	60	40	100
SPH 125	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab	PPC	-	4	2	60	40	100
	Generic Elective Lab – I (Choose any one corresponding to theory course)	PPC	-	4	2	60	40	100
SBH 113	Fundamentals of Statistics Lab							
SBH 115	Fundamentals of Computers Lab							
SBH 117	Fundamentals of Biophysics Lab							
	TOTAL				20			700

II SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SFC 102	Environmental Science	AECC	2	-	2	100	-	100
SBH 102	General Microbiology	PC	4	-	4	40	60	100
SPH 106	Chemical Energetics, Equilibria & Functional Organic Chemistry	PC	4	-	4	40	60	100
	Generic Elective –II (Choose any one)	GE	4	-	4	40	60	100
SBH 104	Classical Genetics							
SBH 106	Plant Diversity							
SBH 108	Animal Diversity							
SBH 112	Microbiology lab	PPC	-	4	2	60	40	100
SPH 124	Chemical Energetics, Equilibria & Functional Organic Chemistry Lab	PPC	-	4	2	60	40	100
	Generic Elective Lab – II (Choose any one corresponding to theory course)	PPC	-	4	2	60	40	100
SBH 114	Classical Genetics Lab							
SBH 116	Plant Diversity Lab							
SBH 118	Animal Diversity Lab							
	TOTAL				20			700

III SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SBH 201	Bioanalytical Techniques	PC	4	-	4	40	60	100
SBH 203	Enzymology	PC	4	-	4	40	60	100
SBH 205	Cell biology	PC	4	-	4	40	60	100
	Generic Elective –III (Choose any one)	GE	-	4	4	40	60	100
SBH 207	Metabolism							
SBH 209	Food and Nutrition							
SBH 211	Basics of Forensic Science	SEC	2	-	2	100	-	100
SBH 213	Bioanalytical Techniques Lab	PPC	-	4	2	60	40	100
SBH 215	Enzymology Lab	PPC	-	4	2	60	40	100
SBH 217	Cell biology Lab	PPC	-	4	2	60	40	100
	TOTAL				24			800

IV SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SBH 202	Molecular Biology	PC	4	-	4	40	60	100
SBH 204	Genetic Engineering	PC	4	-	4	40	60	100
SBH 206	Immunology	PC	4	-	4	40	60	100
	Generic Elective –IV (Choose any one)	GE	-	4	4	40	60	100
SBH 208	Bioprocess Engineering							
SBH 210	Molecular Diagnostics							
MBA 201	Fundamentals of Entrepreneurship							
SBH 212	Research Methodology	SEC	2	-	2	100	-	100
SBH 214	Molecular Biology Lab	PPC	-	4	2	60	40	100
SBH 216	Genetic Engineering Lab	PPC	-	4	2	60	40	100
SBH 218	Immunology Lab	PPC	-	4	2	60	40	100
SBH 220	Industrial Visit	AECC			2			50
	TOTAL				26			850

V SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SBH 301	Plant and Animal Biotechnology	PC	4	-	4	40	60	100
SBH 303	Genomics & Proteomics	PC	4	-	4	40	60	100
SBH 305	Developmental Biology	DSE	4	-	4	40	60	100
SEM 241	Environmental Biotechnology							
SBH 307	Physiology	DSE	4	-	4	40	60	100
SBH 309	Drug designing							
SBH 311	Plant and Animal Biotechnology Lab	PPC	-	4	2	60	40	100
SBH 313	Genomics & Proteomics Lab	PPC	-	4	2	60	40	100
SBH 315	Dissertation based on literature survey	PPC			4			100
	TOTAL				24			700

VI SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SBH 302	Medical Biotechnology	PC	4	-	4	40	60	100
SBH 304	Industrial Fermentations	PC	4	-	4	40	60	100
SBH 306	Cancer Biology	PC	4	-	4	40	60	100
SBH 308	Biosafety, IPR and Ethics	DSE	4	-	4	40	60	100
SBH 310	Stem Cell Biology							
SBH 312	Human infectious diseases	DSE	4	-	4	40	60	100
SBH 314	Protein Engineering							
SBH 390	Project work	PPC			6			150
	TOTAL				26			550

PC-Program Core **PPC**- Practical Proficiency Course **DSE**- Discipline Specific Elective

AECC- Ability Enhancement Compulsory Course **SEC**- Skill Enhancement Course

GE- General Elective

SEMESTER – I

GEL:131 - COMMUNICATIVE ENGLISH

Hours per week: 02 **Credits: 02**
End examination: 60 Marks **Sessional : 40 Marks**

Preamble

The course is a unified approach to enhance language skills of learners with an aim to hone their social skills and to increase their employability. The course is designed to acquaint the learners with the necessary LSRW (Listening/ Speaking / Reading/ Writing) skills needed either for recruitment or further studies abroad for which they attempt international exams like TOEFL, IELTS and GRE. It enables the learners improve2 their communication skills which are crucial in an academic environment as well as professional and personal lives.

Course Objectives

To enable learners to develop listening skills for better comprehension of academic presentations, lectures and speeches.

To hone the speaking skills of learners by engaging them in various activities such as just a minute (JAM), group discussions, oral presentations, and role plays.

To expose learners to key Reading techniques such as Skimming and Scanning for comprehension of different texts.

To acquaint the learners with effective strategies of paragraph and essay writing, and formal correspondence such as email, letters and resume.

To provide learners with the critical impetus necessary to forge a path in an academic environment, in the professional life and in an increasingly complex, interdependent world.

UNIT I

LISTENING: Listening for gist and specific information

SPEAKING: Introducing self and others; Developing fluency through JAM

READING: Skimming for gist and Scanning for specific information

WRITING: Paragraph writing-writing coherent and cohesive paragraph (narrative and descriptive); use of appropriate Punctuation.

GRAMMAR & VOCABULARY: Articles & Prepositions;

Word Families (Verbs, Nouns, Adjectives, Adverbs; Prefixes and Suffixes)

Learning Outcomes:

After completion of this unit, the learners will be able to

Apply the requisite listening skills and comprehend at local and global level. (L4 and L2) (L5)

Introduce themselves with accurate structure in diverse social and professional contexts. (L3)

Apply relevant reading strategies for comprehension of any given text(L3)

Write a paragraph using cohesive devices maintaining coherence (L3)

Understand the Use of Articles and Prepositions, and apply appropriately for meaningful communication (L3)

Understand the relevance of various categories in word family and apply them meaningfully in context (L3)

UNIT II

LISTENING: Listening for Note taking and Summarizing

SPEAKING: Role plays and Oral Presentations.

READING: Intensive Reading-Reading for implicit meaning

WRITING: Note making and summarizing

GRAMMAR & VOCABULARY: Verb forms-Tenses; synonyms to avoid repetition in speech and writing.

Learning Outcomes:

After completion of this unit, the learners will be able to

Employ note taking and summarizing strategies to comprehend the listening text (L2)

Use strategies for successful and relevant oral presentation (L3, L4)

Demonstrate effective communication skills by applying turn-taking and role distribution techniques for meaningful and contextual Speaking (L3 and L4)

Apply various reading strategies imbibing inferential and extrapolative comprehension of any given text. (L2, L3)

Apply various note-making techniques while comprehending the reading text to present a complete and concise set of structured notes (, L3, L4, L5)

Apply the notes to draft a summary (L3)

Use correct tense forms and appropriate structures in speech and written communication (L3) Context specific use of Prefixes and Suffixes for meaningful communication (L3)

UNIT III

LISTENING: Listening for presentation strategies: introducing the topic, organization of ideas, conclusion.

SPEAKING: Aided presentations

READING: Inferring using textual clues

WRITING: Formal Letter and Email writing

GRAMMAR & VOCABULARY: Active and Passive Voice; linkers and discourse markers.

Learning Outcomes:

After completion of this unit, the learners will be able to

Notice and understand effective listening strategies to identify discourse markers in presentations. (L1, L2)
Make formal oral presentations using effective strategies such as audio – visual aids (L3)
Infer meaning and inter – relatedness of ideas (L4)
Understand relevant structures and draft formal letters in suitable format (L3, L4)
Construct relevant sentences in active and passive voice for meaningful communication (L2, L3)
Comprehend and apply available vocabulary items relevant to the context (L1, L2, L3)

UNIT IV

LISTENING: Listening for labeling-maps, graphs, tables, illustrations

SPEAKING: Aided group presentation using charts, graphs etc.

READING: Reading for identification of facts and opinions

WRITING: Information transfer (writing a brief report based on information from graph/chart/table)

GRAMMAR & VOCABULARY: Subject-verb agreement; language for comparison and contrast; Antonyms

Learning Outcomes:

After completion of this unit, the learners will be able to

a) Match visual and auditory inputs and use the information comprehensively and will adequately demonstrate important relationships or patterns between data points (L2)
b) choose and coordinate resources appropriate to context and speak intelligibly (L3, L4)
c) Develop advanced reading skills for analytical and extrapolative comprehension (L4, L5)
d) Make decisions on arrangement of ideas and transfer them from visual to verbal form using context appropriate structure. (L3, L4)
e) Demonstrate ability to use task specific grammatically correct structures (L3)

Comprehend and use expressions for negation/contradiction ((L2, L3)

UNIT V

LISTENING: Listening to discussions for opinions

SPEAKING: Group Discussion

READING: Reading for inferences

WRITING**:** Guided Essay Writing (argumentative)

GRAMMAR & VOCABULARY: Editing short texts: correcting common errors in grammar and usage; Action verbs for fluency and effective writing.

Learning Outcomes:

After completion of this unit, the learners will be able to

Apply analytical and problem-solving strategies to identify and interpret facts and opinions from a dialogue. (L3)
Able to administer group dynamics to contribute valid ideas to a discussion with clarity and precision (L3)
Demonstrate techniques to analyze contextual clues (L4)
Compare and correlate ideas and facts to produce an organized essay with adequate supporting evidences (L4, L5)
Organize the available structural/grammatical knowledge and apply them in a real time context (L3)

Comprehend meaning for new words/phrases used and apply them in a new context. (L2, L3)

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

- Think critically, analytically, creatively and communicate confidently in English in social and professional contexts with improved skills of fluency and accuracy.
- Write grammatically correct sentences employing appropriate vocabulary suitable to different contexts.
- Comprehend and analyze different academic texts.
- Make notes effectively and handle academic writing tasks such as Paragraph writing and Essay writing.
- Effectively handle formal correspondence like e-mail drafting and letter writing.

Reference Books:

1. Arosteguy, K.O. and Bright, A. and Rinard, B.J. and Poe, M. ***A Student's Guide to Academic and Professional Writing in Education***, UK, Teachers College Press,2019

2. Raymond Murphy, ***English Grammar in Use A Self-Study Reference and Practice Book for Intermediate Learners of English*** : Cambridge University Press;2019

3. Peter Watkins, ***Teaching and Developing Reading Skills***: UK, CUP, 2018
4. Deeptha Achar et al. ***Basic of Academic Writing***. (1and 2) parts New Delhi: Orient BlackSwan. (2012& 2013).

5. Kumar S and Lata P, ***Communication Skills***: New Delhi Oxford University Press, 2015

SBH 101: BIOMACROMOLECULES

Hours per week : 04 **End examination : 60 Marks**
Credits : 04 **Sessional : 40 Marks**

Preamble:
This course has been designed to enrich the students' knowledge about the macromolecules of life like carbohydrates, amino acids, fatty acids, nucleic acids. The course shall make the students' aware of the classification of all macromolecules and the structures of complex carbohydrates, proteins, structures of nucleic acids.

Course Objective:
The objectives of this course are to
1. To build the knowledge about the macromolecules of life.
2. To familiarize the classification of all macromolecules.
3. To impart knowledge on structures of complex carbohydrates, proteins and structures of nucleic acids.

UNIT-I

Classification and biological functions of carbohydrates, structure and properties ofmonosaccharides (Glucose and Fructose). Disaccharides (sucrose, maltose, lactose), polysaccharides (starch, cellulose and chitin). Glycosaminoglycans (chondroitin sulfate and Hyaluronic acid)

Learning Outcomes:
After completion of this unit, the student will be able to
- Understand the concept of carbohydrates.
- Understand the structures and properties of monosaccharides, disaccharides, polysaccharides and glycosaminoglycans.
- Understand the biological importance of monosaccharides, disaccharides, polysaccharides and glycosaminoglycans.

UNIT-II

Classification, structure and properties of amino acids, Essential and nonessential amino acids, Modified and rare amino acids, ketogenic and glucogenic amino acids, specialized roles of amino acids.

Learning Outcomes:
After completion of this unit, the student will be able to
- Sketch the chemical structures of standard amino acids
- Describe how amino acids differ in their side chains
- Understand the biological importance of essential and nonessential amino acids
- Explain the Biological importance of modified and rare amino acids.
- Understand the specialized roles of amino acids.

UNIT-III

Classification of proteins, primary structure of protein- determination of amino acid composition and sequence. Secondary structure-α-helix, β-pleated sheet, collagen triple helix. Tertiary andquaternary structures. Solid phase peptide synthesis. Glycoproteins.

Learning Outcomes:
After completion of this unit, the student will be able to
- Explain the classification of proteins
- Distinguish primary, secondary, tertiary, quarternary structures and predict how a protein's structure will be affected by a change in an amino acid and its primary structure.
- Understand the chemical synthesis of proteins
- Learn the structure and biological importance of glycoproteins.

UNIT-IV

Classification, structure, properties and functions of fatty acids, triglycerides, phospholipids, sphingolipids. Cholesterol, Eicosanoids. Structure and functions of vitamins (A,D,E,K, B complex and C).

Learning Outcomes:

After completion of this unit, the student will be able to

- Understand the structure, properties and functions of fatty acids and triglycerides.
- Describe the structure, properties and functions of phospholipids, sphingolipids and cholesterol
- Understand the structure and functions of Eicosanoids.
- Understand the structure and functions of fat-soluble vitamins

UNIT-V

Purine and pyrimidine nitrogen bases, Nucleosides and nucleotides, Structure and properties of DNA. Alternative forms of DNA -A, B, Z. Structure and properties of RNA, different types of RNA- mRNA and non-coding RNA – tRNA, rRNA, siRNA, miRNA.

Learning Outcomes:

After completion of this unit, the student will be able to

- Understand the concepts of Nitrogen bases, structural differences between nucleosides and nucleotides.
- Understand the structure and properties of DNA and different types of DNA (A, B, Z).
- Understand the structure and properties of RNA and different types of RNA (mRNA and non-coding RNA).
- Understand the differences between DNA and RNA.

Course outcomes: On completion of this course, students will be able to

- Understand the chemical structure, properties and biological functions of carbohydrates, amino acids, and proteins
- Identify the chemical structure, properties and biological functions of lipids, vitamins and nucleic acids

RECOMMENDED BOOKS:

1. Lehninger Principles of Biochemistry by Nelson D and Cox D –7th Edition. Mcmillan Pub.
2. Biochemistry by L.Stryer– 8th Edition. (Freeman-Tappan).
3. Biochemistry by D.Voet and J.G.Voet– 4th Edition. (John Weily).
4. Biochemistry by Garrett and Grisham – 6th Edition. (Cengage Learning).
5. Biochemistry Concepts and Connections by Mathews et.al. – Global Edition.
6. Principles of Biochemistry by David Rawn et.al. – 5th Edition (Pearson).
7. Essentials of Glycobiology, 3rd Edition (CSHL press).
8. Harper's Biochemistry by Robert K. Murray et.al. – 30thEdition (Langeman).
9. Biochemistry by U. Satyanarayana – 4th Edition.

SPH 105: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Hours per week	**: 04**	**End examination**	**: 60 Marks**
Credits	**: 04**	**Sessional**	**: 40 Marks**

Section A: Inorganic Chemistry-1

Preamble: The students of undergraduate program in science in Chemistry need to be conversant with the various fields off chemistry. Therefore, one module each on in general, physical and organic chemistry is introduced which helps the student familiarize with the concepts of chemistry essential for allied and interdisciplinary fields of science.

Course objective: To introduce the concepts of general chemistry. The students will be conversant with the chemistry of all the elements that is closely knitted with analytical chemistry, physical chemistry and organic chemistry.

UNIT-I

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ2, Schrödinger equation for hydrogen atom. Graphical representation of 1s, 2s, 2p, 3s, 3p and 3d orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Learning Outcomes

The student will learn about the fundamental assumptions of atomic theory and explain the composition of atoms including electronic configuration.

UNIT-II

Chemical Bonding and Molecular Structure, Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s- p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+.

Learning Outcomes

The students will learn about ionic, covalent bonding in molecules . compare/contrast the properties of molecular and ionic compounds.

Section B: Organic Chemistry-1

UNIT-III

Fundamentals of Organic Chemistry Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Learning Outcomes

The students learn about the fundamental concepts of reaction mechanism, reactive species in organic chemistry and concept of aromaticity

UNIT-IV

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Mesocompounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Aliphatic Hydrocarbons: Functional group approach for the following reactions (preparations & reactions) to be studied.

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Learning Outcomes

The student shall learn the essential concepts of chirality, configuration, isomerism in organic chemistry and nomenclature of isomers.

Students will familiarize with the elementary concept of saturated aliphatic hydrocarbons and reactions

UNIT-V

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. $KMnO_4$.

Learning Outcomes

The students will learn synthetic reactions, mechanism and properties of aromatic alcohol, aromatic and aliphatic ether, aldehydes and ketones.

Course outcomes:

1. The student will learn about the fundamental assumptions of atomic theory and explain the composition of atoms including electronic configuration.
2. The students learn about the fundamental concepts of reaction mechanism, reactive species in organic chemistry and concept of aromaticity
3. The students will learn synthetic reactions, mechanism and properties of aromatic alcohol, aromatic and aliphatic ether, aldehydes and ketones.

RECOMMENDED BOOKS:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd Ed., Wiley.
3. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry:Principles of Structure and Reactivity, Pearson Education India, 2006.
4. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
6. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
7. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
8. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
9. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

SEMESTER – I

SBH 103: FUNDAMENTALS OF STATISTICS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble:
In this course applications of correlation and regression, probability and probability distributions, Sampling techniques and testing of hypothesis for large and small samples are introduced.

Course Objectives:
To understand the difference between discrete and continuous random variables and probability.
To make the student aware of the basic concept and applications of correlation and regression.
The objective of the course is to make them understand the concept of testing of hypothesis for different samples and ability to explore certain statistical concepts in practical applications of biotechnology

UNIT-I

Probability: Definition, Addition theorem, Multiplication theorem, Conditional probability, Bayee's theorem (definitions only, no proofs)

Learning Outcomes: By the end of this Unit, the student will be able to
- Define probability.
- Describe the basic concepts of probabilitiy.
- Evaluate problems on Addition theorem of probability.
- Evaluate problems on Multiplication theorem of probability.
- Evaluate problems on Baye's theorem.

UNIT-II

Theoretical distributions: Random variables, Mean and variance, Binomial distribution. Poisson distribution, Normal distribution (simple problems on the above topics)

Learning Outcomes: By the end of this Unit, the student will be able to
- Compare discrete random variables and continuous random variables.
- Illustrate the concept of Binomial distribution.
- Explain the properties of binomial distribution.
- Evaluate problems on poisson distribution.
- Explain normal distribution and its properties.

UNIT-III

Correlation and regression, rank correlation, curve fitting, method of least squares**,** fitting of other curves straight line, parabola, $y=ax^b$, $y=ae^{bx}$

Learning Outcomes: By the end of this Unit, the student will be able to
- Evaluate correlation coefficient and rank correlation coefficient for the given data.
- Explain the need of correlation and regression.
- Explain curve fitting with the help of method of least squares.
- Evaluate fitting of straight line.
- Explain fitting of parabola and other curves.

UNIT-IV

Sampling: objectives of sampling, sampling distribution, testing of hypothesis, null hypothesis,level of significance, Test of significance for large samples, comparison of large samples. Test of significance of means of two large samples.

Learning Outcomes: By the end of this Unit, the student will be able to
- Explain the various types of sampling procedures.

SEMESTER – I

SBH 103: FUNDAMENTALS OF STATISTICS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

- Summarize different types of samplings.
- Explain test of significance for large samples.
- Evaluate problems on testing of hypothesis.
- Evaluate of test the significance of means of two large samples.

UNIT-V

Sampling of variables – small samples, students 't' distribution, properties of t-distribution. Significance test of sample mean, significance test of difference between sample means. Chi – square test – properties of Chi square distribution – 'F' distribution, ANOVA (one-way classification)

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

- Explain the method of small samples.
- Explain the properties of t-distribution.
- Evaluate problems on Chi-square test.
- Explain the properties of chi-square distribution.
- Explain the concept of ANOVA for one way classification

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

- Explain the significance of testing large samples.
- Evaluate the properties of chi-square and t- distribution
- Analyze the correlation and regression data

RECOMMEDED BOOKS:

1. Engineering Mathematics by BS Grewal, 44th Edition, Khanna Publications.
2. Engineering Mathematics by BV Ramana, Tata McGraw-Hill.
3. Fundamentals of Biostatistics-Khan and Khanum
4. Biostatistics by Daniel. (Wiley)
5. Biostatistics by S.C.Gupta
6. Problems and Solutions in Mathematical statistics Gupta Vikas Gupta S.C., Gupta Sanjeev Kumar

SEMESTER – I

SBH 105: FUNDAMENTALS OF COMPUTERS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

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 MS-Word, Power Point and Excel features

UNIT – I

Introduction: Characteristics, evolution and generations of computer. Notebook computers, personal computers, workstations, mainframe systems, super computers, client-server systems. Basic computer organization: I/O unit, storage unit, Arithmetic Logic Unit, Control Unit, Central Processing Unit, the system concept.

UNIT – II

Hardware and software: Difference between hardware and software. Secondary Storage Devices: Magnetic Tape, Magnetic Disk, Optical Disk. Magneto Optical Disk, Mass Storage Devices and other related concepts. Concept of assembler, interpreter, linker, loader and compiler.

UNIT – III

Computer software: Types of software, logical systems architecture, acquiring software, software developmental steps, software engineering. Computer Languages: Machine language, assembly language, high level language, some high level languages, characteristics of good programming language. Operating Systems: What is an Operating System, process management, MS-DOS, Windows, Unix, Linux and Macintosh.

UNIT – IV

Data Communications and Computer Networks: Basic Elements of a Communication System, Data Representation, Data Transmission Modes, Data Transmission Speed, Data Transmission Media, Digital and Analog Data Transmission.

UNIT – V

The Internet: Brief History, basic Services, overview of LAN, MAN and WAN architecture, internet search tools, WWW browsers, internet search engines, uses of internet, client-server protocol architecture, basic concepts of HTML, HTTP and FTP.

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

- Able to understand fundamental hardware components that make up a computer's hardware and the role of each of these components

SEMESTER – I

SBH 105: FUNDAMENTALS OF COMPUTERS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

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

RECOMMENDED BOOKS

1. Computer Fundamentals - Pradeep K.Sinha: BPB Publications.
2. Computer Fundamentals- Rajaraman V.
3. Introduction to Computers -Peter Norton.
4. Fundamentals of Information technology Alexis Leon, Methew Leon, Vikas publications.
5. Internet – Margaret Levine Young – The Complete Reference – Millennium Edition – TMH. Edition – 1999.
6. Harley Hahn, The Internet – Complete Reference – Second Edition – TMH.
7. Microsoft Office 2007: A Visual Approach To Learning Computer Skills- Nita Rutkosky, Denise Seguin, Andrey Rutkosky Roggenkamp - BPB Publications.

SEMESTER – I

SBH 107: FUNDAMENTALS OF BIOPHYSICS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: Biophysics is an interdisciplinary science that applies approaches and methods traditionally used in physics to study biological phenomena. Biophysics covers all scales of biological organization, from molecular to organismic and populations.

Course Objectives: The course is designed to provide a broad exposure to all basic biophysical techniques used in current Modern Biology research. The goal is to impart basic conceptual understanding of principles of these techniques and emphasize the biochemical utility of same & underlying biophysics. Student is expected to have clear understanding of all analytical techniques such that the barrier to implement same is abated to a great extent.

UNIT I

Radiation Biophysics
Ionising radiation, Interaction of radiation with matter, Measurement of Radiation, Radioactive isotopes. Types of Radioactivity-Natural, Artificial and induced Radioactivity and radioactive decay law. Measurement of Radioactivity -Geiger Muller counter, proportional counter and scintillation counter. Biological effects of radiation and radiation protection and therapy.

UNIT II

Transport process: Light scattering, Diffusion –factors effecting diffusion, Fick's law, diffusion of electrolytes, accelerated diffusion and biological significance sedimentation, osmosis, viscosity, chromatography and electrophoresis and optical activity .Biophysical phenomena in biochemical studies-pH meter - principle, electrode system and factors effecting in its measurement.

UNIT III

Physical Techniques in structure determination
Ultraviolet and Visible spectroscopy, fluorescence and phosphorescence methods, Infrared spectroscopy- bending, near, mid and far infrared region. Raman spectra- principle and instrumentation. NMR, ESR Instrumentation.

UNIT IV

Microscopies
Optical microscope, Electron microscopy, emerging trends in microscopy. X ray diffraction-diffraction of x rays, structure determination, phase determination procedures. Laser-characteristics, population inversion, stimulated and spontaneous and relation (no derivation) and Holography

UNIT V

Biomolecular structures, Bioenergetics and Biological systems
Biomolecular structures-Concepts of classical physics and limitations, quantum principles of atomic structure. Bioenergetics-Thermodynamics-reversible thermodynamics and irreversible thermodynamics. Photo bioenergetics and chemo bioenergetics. Biological systems: Neuro biophysics-Molecular transport across cell membrane and nerve impulse generation.

SEMESTER – I

SBH 107: FUNDAMENTALS OF BIOPHYSICS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

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

- Combine previously acquired knowledge of biophysical techniques to understand biochemical processes at molecular level.
- Comprehend advanced microscopy including live cell imaging, correlative light and electron microscopy, confocal microscopy and underlying biophysics

RECOMMENDED BOOKS:

1. Essentials of Biophysics: P.Narayanan.New Age India Intl.
2. Handbook of Radiobiology by KT Jaypee Brothers, Medical Publishers Pvt. Ltd.
3. An Introduction to radiation protection by A Martin & SA Harbison, 4th Edition, Springer Publishers.
4. Laser Tissue Interactions: Fundamentals and Applications by MH Niemz, Springer Publishers.
5. Understanding biophotonics- Fundamentals, Advances and Applications by K Tsia, 1st Edition, CRC press.

SEMESTER – I

SBH 111: BIOMACROMOLECULES LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Preamble:
This course has been designed to provide the hands-on experience to the students and enrich the students' knowledge about the qualitative and quantitative analysis and separation of biomolecules.

Course Objective:

The objective of this course is to provide hands on experience to under graduate students on qualitative and quantitative analysis of biomolecules and analysis of biomolecules by spectroscopy.

1. Qualitative analysis of amino acids
2. Qualitative analysis of carbohydrates
3. Determination of isoelectric point of glycine
4. Estimation of proteins by Lowry method
5. Estimation of reducing sugar by DNS method
6. Ultra violet absorption spectra of proteins / nucleic acids

Course Outcomes: On completion of this course, students should be able to

- Identify and quantify the biomolecules.
- Understand the principle, procedure and application of various estimation techniques.
- Understand the principle and biochemical analysis by spectroscopy.

RECOMMENDED BOOKS:

1. Modern experimental Biochemistry by Rodney Boyer – 3rd Edition (Benjamin Cummings)
2. Biochemical methods By Sadasivam and Manikam – 3rd Edition (New Age International Pvt. Ltd Publishers)
3. An introduction to practical biochemistry by D.T. Plummer – 2nd Edition (McGraw Hill)
4. Biochemistry - a laboratory courses by J.M.Beckar – 2nd Edition (Academic Press)
5. Introductory practical Biochemistry by S.K.Sawhney and Randhir Singh – 2nd Ed. (Narosa)

SEMESTER – I

SPH 125: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Preamble: The students of undergraduate program in science in Chemistry need to be conversant with the various basic methodologies of chemistry. Therefore, one module each on in inorganic, physical and organic chemistry is introduced which helps the student familiarize with the techniques essential for developing the foundation of practical chemistry

Course objective: To make student develop the fundamental skill required for quantitative and qualitative analysis in inorganic and organic chemistry.

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)

2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given).

   (a) Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography.

   (b) Identify and separate the sugars present in the given mixture by paper chromatography.

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

- learn about the quantitative analysis concepts of redox chemistry
- familiarize with the concept of qualitative element detection in organic chemistry essential for functional group analysis.
- have an elementary idea of the techniques of planar chromatography

RECOMMENDED BOOKS:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th Edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

SEMESTER – I

SBH 113: FUNDAMENTALS OF STATISTICS LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Course Objectives: The objective of the course is to make them understand the concept of testing of hypothesis for different samples and ability to explore certain statistical concepts in practical applications of biotechnology

1. Bisection method, method of false position
2. Gauss elimination method,
3. Jacob's iteration method,
4. Gauss-Siedel Iteration method.
5. Newton's forward formula, Newton's backward formula,
6. Lagrange formulae for unequal intervals,
7. Numerical Integration; Simpson's $1/3^{rd}$ rule, Trapezoidal rule, Simpson's $3/8^{th}$ rule.
8. Measures of central tendency: Mean median and mode.
9. Measures of Dispersion, mean deviation, standard deviation,
10. Introduction of moments, skewness and Kurtosis

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

- Evaluate various methods through which statistics can be made easier
- Discriminate various measures that can be used for central tendency and dispersion.

RECOMMENDED BOOKS:

1. Fundamentals Of Mathematical Statistics by S. C. Gupta and V. K. Kapoor
2. Biostatistics – A Foundation for Analysis of Health Sciences by Wayne Daniel
3. Methods in Biostatistics by B. K. Mahajan
4. Biostatistics by K. Vishwerhwara Rao
5. Statistics (Theory and Practice) by B.N. Gupta

SEMESTER – I

SBH 115: FUNDAMENTALS OF COMPUTERS LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Course Objectives:

- To give hands on training on MS-Word
- To give hands on training on MS-Power Point and MS-Excel

MS-WORD

Starting WORD – Creating new documents – Opening existing documents – Designing a document – Editing – Copying within a document and from one document to another – Moving – Saving – Quitting and restarting – Formatting – Headers, Footers and Footnotes – Tabs, Tables andSorting – Typing symbols and special characters – Bulleted list – Spelling checker – Auto correct – Fonts – Macros – Mail merge.

MS-EXCEL

Creating a new worksheet – Selecting cells – Mouse and keyboard navigation – Entering and editing text – Text boxes an text notes – Undoing and repeating actions – Entering and formatting numbers – Entering and editing formulas – Lookup tables – Rearranging worksheets – Formatting: changing column widths and row heights – Changing fonts and sizes– Alignment – Changing colors and shades – Inserting and removing page breaks.

MS-POWER POINT

Introduction to PowerPoint - Different PowerPoint Views-Saving Presentation as a Slide Show-Presentation Creation-Presentation Development-Navigation and Printing-Presentation Development-Creating Presentation Using Templates-Creating Outlines-Data Imports-Design Application- Presentation Design-Creating Shapes-Using Smart Art and WordArt- Rich Media Tools-Inserting Pictures-Inserting Videos-Inserting Audio-Creating Photo Album

Course Outcomes: The students will be able to

- Create a document in Microsoft Word with formatting that complies with the APA guidelines.
- Write functions in Microsoft Excel to perform basic calculations and to convert number to text and text to number.
- Create a presentation in Microsoft PowerPoint that is interactive and legible content

RECOMMENDED BOOK

1. Working with Microsoft Office – by Ron Mansfield (Tata McGraw-Hill).

SEMESTER – I

SBH 117: BIOPHYSICS LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Course Objectives: The course is designed to provide a broad exposure to few biophysical techniques used in current biology research. The goal is to impart basic conceptual understanding of principles of these techniques and analyze various spectra underlying biophysics.

1. Plateau characteristics of radioactive source
2. Intensity variation of radioactive material
3. Wavelength of colors using spectrometer
4. Determination of wavelength of LASER
5. Optical activity
6. X-ray diffraction – determination of interplanar spacing from X-ray spectra
7. Analysis of infrared spectra - Identification of various groups
8. Analysis of UV spectra -Identification wavelength corresponding to absorption

Course Outcomes: Students will be able to

- Determine the wavelength of colors
- Analyze the spectra generated by UV and Infrared rays

RECOMMENDED BOOKS:

1. Radiation Biophysics, Second Edition - by Edward L. Alpen
2. Physical Chemistry: Principles and Applications in Biological Sciences by Tinoco. I. et al..
3. Physics of the Life Sciences by Newman, J.
4. Drenth, J. (2010) Principles of Protein X-ray Crystallography, Springer

SEMESTER – II

SFC 102: ENVIRONMENTAL SCIENCE

Hours per week: 02 **End examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: The course enables the students to adapt eco-centric thinking and actions rather than human-centric thinking on natural resources, their utilization and conservation. The course also focuses on the importance of ecosystems, biodiversity and their degradation led to pollution. This course helps in finding solutions through application of control measures to combat pollution and legal measures to achieve sustainable development.

Course Objectives

1. To impart knowledge on natural resources and its associated problems.
2. To familiarize learners about ecosystem, biodiversity, and their conservation.
3. To introduce learners about environment pollution.
4. To acquaint learners on different social issues such as conservation of water, green building concept.
5. To make learners understand about the present population scenario, its impacts and role of informational technology on environment and human health.
6. To make learners understand about the importance of field visit.

UNIT-I

The Multidisciplinary nature of environmental studies–Definition, Scope and Importance, Need for Public awareness. Natural Resources: Classification – Renewable and Non-Renewable Resources. Renewable Resources: Forest, Water and Energy Resources Non Renewable Resources: Mineral, Food and Land resources (Uses, reasons for over-utilization and effects)

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

- List different natural resources and their uses.
- Relate how the over-exploitation of natural resources impact human life
- Find the role of an individual in the conservation of natural resources.
- Recall the demand of potable water in a community.
- Explain the equitable use of natural resources for sustainable lifestyles.

UNIT-II

Eco-system: Structure of an Ecosystem, Producers, consumers and de-composers. Structure of Terrestrial Ecosystems (Forest ecosystem, Grassland ecosystem and Desert ecosystem) and Aquatic Ecosystems (Pond ecosystem and ocean ecosystem). Function of an ecosystem -food chains, food web and ecological pyramids - energy flow in the ecosystem. Environmental Pollution: Causes, effects and control measures of Air, Water, soil pollution, Thermal pollution and nuclear hazards. Municipal solid waste management.

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

- Demonstrate how ecosystem functions
- Summarize the structure and function of terrestrial and aquatic ecosystems
- Explain the values and threats to biodiversity
- Identify the importance of conservation of biodiversity

UNIT-III

Environmental problems: Global Environmental Problems, Green house effect, Ozone layer depletion, acid rains and Climate change. National Environmental Problems: Deforestation – Causes and Effects, Environmental Problems associated with dams. Mining and Environmental effects.

SEMESTER – II

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

- Identify causes, effects, and control measures of pollution (air, water & soil).
- Choose different types of pollutants
- Experiment with the pollution related case studies.
- Analyze the role of an individual in prevention of pollution.

UNIT-IV

Social Issues and the Environment: Environmental ethics, Issues and possible solutions. Waste land reclamation, Consumerism and waste products. Environmental Legislation: Environment Protection Act, Air Act, Water Act, Wildlife Protection act and Forest conservation act.

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

- Understand the social issues concerned to the environment.
- Identify various acts for environment protection
- Function of green building concept.
- Theorize different environmental legislation acts and issues involved in enforcement of legislation.

UNIT-V

Human Population and the Environment: Population growth, variation among nations, Population explosion-Family welfare programme. Environment and human health. Human rights, Value education, HIV/AIDS, Women and Child welfare, Role of information technology in environment and human health.

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

- Predict population growth and variation among nations.
- Adapt value education.
- Discuss women and child welfare.
- Justify the role of information technology in environment and human health

Course Outcomes: On completion of this course, students will be able to

- Stay updated in environmental science and technologies by applying information resources and industrial contacts
- Explain the role of information technology in environment and human health
- Hypothesize different environmental legislation acts and issues involved in enforcement of legislation

RECOMMENDED BOOKS:

1. Text Book of Environmental studies for Undergraduate courses by Bharucha Erach Published by V.G.C
2. Environmental Science: A Global Concern by William P. Cunningham and Baraba Woodworth Saigo.
3. A text book of Environmental Science by P.C.Joshi
4. A text book of Environmental Science by ArvindKumar
5. A text book of Environmental Science by S.C.Santra
6. Ecology & Environment by P.D.Sharma

SEMESTER – II

SBH 102: GENERAL MICROBIOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble:
This course has been designed to introduce the field of microbiology by studying different kinds of microorganisms with special emphasis on microbial diversity. By studying this course, the student develops knowledge on the techniques used to isolate and identify the microorganisms from natural habitats. Moreover, this course imparts knowledge about the morphological, and physiological features among diverse microbial species and different kinds of methods to control microbes. Furthermore, the general microbiology course inculcates the student's about the virus classification, structure, and cultivation of viruses in laboratory.

Course Objectives: The objectives of this course is to

1. To familiarize with the historical foundations in the field of microbiology and to understand the classification system of bacteria and archaea.
2. To impart knowledge on microscopy techniques and to gain knowledge on the sterilizing agents.
3. and concepts of culture dependent and independent techniques
4. To familiarize with the polyphasic approaches employed to characterize the microorganisms and bacterial growth kinetics
5. To impart knowledge about vegetative thalli structures and reproductive structures of algae and fungi.
6. To understand the clinical manifestations of protozoans and to know about the viral structures

UNIT- I

Introduction to microbiology - Historical Foundations of Microbiology; Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Beijerinck, Winogradsky, Edward Jenner, Ivanowski; Golden era of microbiology. Whittaker's and Carl Woese's three kingdom classification systems, Bergey's classification of bacteria & Achaea

Learning Outcomes:
After completion of this unit, the student will be able to

- Learn different historical foundations imparted in the field of microbiology.
- Learn different era's that led to the evolution of microbiology field.
- Learn various contributions from the prominent scientists in the field of microbiology
- Learn the concept of Whittaker's five kingdom and Carl Woese's domain system
- Gain knowledge about the hierarchical position of bacteria and archaea.

UNIT-II

Microscopy - Principles and applications of light, phase, fluorescent and electron microscopy, confocal microscopy; Ultra structure of microorganisms (bacteria, algae, fungi and protozoa) and Acellular microorganisms (Viruses, Viroids, Prions); Preparation and staining of specimens; Fixation, Dyes, simple and differential staining; Sterilization - physical, chemical and radiation methods.

Learning Outcomes:
After completion of this unit, the student will be able to

- Learn the concepts of electromagnetic radiation, magnification, resolution and numerical aperture to know about the principles of microscopy
- Learn the importance of stains and dyes for viewing the specimen under bright field microscopy
- Learn the concept of fluorescence and fluorochromes in CSLM and Epi fluorescence microscopy
- Learn the specimen preparation and fixation methods in electron microscopy
- Learn the importance of structural components present on the cell surface of microorganisms.

SEMESTER – II

UNIT-III

Isolation of pure cultures- Culture dependent techniques (spread plate, streak plate and pour plate methods) Characterization and Identification of bacteria based on morphology, biochemical characteristics, Phage typing and ribotyping; culture independent technique; Types of nutrientmedia for bacterial growth, microbial growth – principles & kinetics.

Learning Outcomes:

After completion of this unit, the student will be able to

- Learn the concepts of isolation of bacteria and pure culture methods.
- Learn the importance of biochemical characteristics and polyphasic taxonomical approach in characterizing the bacteria.
- Learn the importance of culture independent technique in characterizing the microbiome.
- Learn the types of various complex and defined media for culturing microorganisms.
- Learn the five different phases of microbial growth and its kinetics.

UNIT-IV

General characteristics of algae and blue green algae, thallus organization, pigments, flagella,eyespot food reserves; General characteristics of fungi, fungal cells and vegetative growth, multihyphal systems, Types of culture media for cultivation of algae and fungi, Economic importance of algae & fungi.

Learning Outcomes:

After completion of this unit, the student will be able to

- Understand the general features of blue green algae and its significance
- Learn the classification of algae based on pigments
- Learn the thallus organization, types of flagella, eyespot function and diversity in algal food reserves.
- Learn about the general characteristic features of fungal mycelia and haustoria.
- Learn the various nutrient media used for culturing of algae and fungi.
- Learn the economic importance of algae and fungi.

UNIT-V

General characteristics with special reference to Plasmodium, Entamoeba, Leishmania; Virus taxonomy, ICTV regulations, Baltimore system of virus classification, virus structure, and cultivation of virus-Embryonated egg, animal cell culture methods; TMV, lytic and lysogenic cycle (T4 and λ phages).

Learning Outcomes:

After completion of this unit, the student will be able to

- Learn about the characteristic features of *Plasmodium*, *Entamoeba*, *Leishmania*
- Learn about the clinical manifestations of *Plasmodium*, *Entamoeba*, *Leishmania*
- Learn the regulations issued and nomenclature system followed by ICTV.
- Learn the characteristics used to classify the viruses and virus structures
- Learn the laboratory cultivation methods of viruses.
- Learn about the multiplicity of infection in phage particles.

Course Outcomes: On completion of this course, students should be able to

- Describe the main steps and processes used to classify microorganisms
- Discover new useful microorganisms and store them reliably for later use
- Evaluate which molecular techniques are applicable to isolate, identify and culture different types of microbes

RECOMMENDED BOOKS:

1. Textbook of Microbiology by Ananthanarayan and Paniker's, 10th Edition.
2. Microbiology - Principles and Explorations by Black, 9th Edition, John Wiley & Sons.
3. Prescott's Microbiology, 11th Edition, McGraw-Hill Publishers.

4. Microbiology: An Introduction (2016) by Tortora *et al.*, 12th Edition Pearson publishers
5. Sherris Medical Microbiology, (2018) by Kenneth J. Ryan *et al.*,7th Edition McGraw-Hill Education
6. Brock Biology of Microorganisms (2015) by Michael T. Madigan (15th Edition), Pearson publishers
7. Algae (2008) by James E. Graham (2nd Edition), Benjamin Cummings
8. The Fungi by Sarah C. Watkinson, Academic Press; 3rdEdition (2016)
9. Fungi: Experimental Methods in Biology (2019) by Ramesh Maheshwari, 2ndEdition, CRC Press
10. Human Virology by Flint, 4th Edition, ASM Press.
11. Textbook of Microbiology and Immunology by Parija, 3rd Edition.
12. Understanding Viruses by Teri Shors, 3rd Edition, Jones and Bartlett Publishers.

SEMESTER – II

SPH 106: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: The students of undergraduate program in science need to be conversant with the various aspects of energetic and chemical equilibria. Functional group chemistry forms the foundation for training a undergraduate students as organic chemist.

Course objective: To introduce the concept of chemical reaction equiribrium and reaction energetics in general and physical chemistry to the undergraduate students.

The students will learn the essential functional groups in organic chemistry, their reactions, and properties.

Section A: Physical Chemistry-1

UNIT-I

Chemical Energetics:

Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics.

Chemical Equilibrium:

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Le Chatelier's principle. Relationship between Kp, and Kc

Learning Outcomes:

- The student will learn about the essential concepts of thermo-chemistry and chemical thermodynamics The student will learn the calculation of bond energy, bond dissociation energy and resonance energy from thermo-chemical data.
- The students will learn Le Chatelier's principle and applications.

UNIT-II

Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts**.**

Learning Outcomes:

- The students will learn the elementary concepts of ionic chemical equilibrium with respect to acid – base, salt hydrolysis and solubility of ionic substances.

Section B: Organic Chemistry-2

UNIT-III

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzenesulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene).

Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl Halides
Preparation: from alkenes and alcohols.
Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation.
Williamson'sether synthesis: Elimination vs substitution.

Learning Outcomes:

- The students will learn the concept of Functional group approach for aromatic hydrocarbon and alkyl halide.

UNIT-IV

Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.
Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group)and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

Alcohols: Preparation: Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.
Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, Conc. HNO_3). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Learning Outcomes:

- The student shall learn the elementary reactions and properties , mechanism of aryl halides and alcohol . The students will learn differentiation between, primary, secondary and tertiary alcohol.

UNIT-V

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts.
Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.
Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde)
Preparation: from acid chlorides and from nitriles.
Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Learning Outcomes:
The students will learn about reactions and properties of aromatic alcohols, ethers, aldehydes and ketones

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

- learn the elementary reactions and properties, mechanism of aryl halides and alcohol
- learn about reactions and properties of aromatic alcohols, ethers, aldehydes and ketones
- learn the concept of Functional group approach for aromatic hydrocarbon and alkyl halide.
- learn the elementary concepts of ionic chemical equilibrium with respect to acid – base, salt hydrolysis and solubility of ionic substances

RECOMMENDED BOOKS:

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
6. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
7. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).

SEMESTER – II

SBH 104: CLASSICAL GENETICS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: This course is designed for students to learn the basics of inheritance of genetic material. It covers the fundamental discoveries made to understand the inheritance. It talks in detail about how the genomes of organisms changed during evolution. The experiments that proved both quantitative and qualitative changes in DNA is discussed.

Course Objectives

1. To make students learn the concepts of early experiments and concepts of heredity.
2. To make students understand the extensions and deviations of Mendel's laws.
3. It enables the students to learn gene mapping and its importance.
4. Students will be able to understand how changes in DNA and chromosomes lead to evolution.
5. To empower students with the concepts of quantitative genetics and pedigree analysis.

Unit- I

Mendelism & Chromosome Theory – Mendel's principles, applications of Mendel's principles, Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance, Inheritance patterns in Human.

Learning Outcomes: After completion of this unit, the student will be able to

- Learn the concept of inheritance.
- Understand the basics of principles of inheritance.

Unit II

Extension of Mendelism – Sex-linked, Autosomal and cytoplasmic inheritance, extranuclear inheritance Mitochondrial and chloroplast inheritance. Deviation from Mendel's Dihybrid phenotype,. Allelic Variation & Gene function – Multiple allele, Genetic interaction, Epiststic interactions, Non-Epistatic inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete & incomplete), Expressivity, Pleiotropism, Modifier/Modifying genes.

Learning Outcomes: After completion of this unit, the student will be able to

- Learn the deviations of Mendel's laws
- Understand the basics of extensions of Mendel's laws.

Unit- III

Linkage & Crossing over - Linkage, Sutton's view on linkage, Morgan's view on linkage, Bateson & Punnet's Coupling & Repulsion hypothesis Chromosome theory of Linkage, kinds of linkage, linkage groups. Determination of linkage groups, determination of map distance, determination of gene order, cytological mapping.Types of Crossing over, mechanism of Meiotic Crossing over, theories about the mechanism of Crossing over, cytological detection of Crossing over, significance of Crossing over.

Learning Outcomes: After completion of this unit, the student will be able to

- Explain basic concepts, principles and methods linkage analysis
- Describe the main features recombination and its mechanisms.
- Understand how to detect crossing over phenomenon of chromosomes.

Unit- IV

Chromosomal variation in Number & Structure – Euploidy, Non-disjunction & Aneuploidy, Aneuploid segregation in plants, Aneuploidy in Human, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Polytene chromosome in Diptera, Deletion, Duplication, Inversion, Translocation, Position Effect, Centromeric & Non-centromeric breaks in chromosomes, chromosomal rearrangements in Human being, Chromosomal aberrations & evolution.

Learning Outcomes: After completion of this unit, the student will be able to

- Define what is mutation.

SEMESTER – II

SBH 104: CLASSICAL GENETICS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

- Kinds of mutations
- How mutations lead to evolution.

Unit- V

Pedigree analysis –Pedigrees of Sex-linked & Autosomal (dominant & recessive), Mitochondrial, Incomplete dominance & Penetrance. Formulating & Testing Genetic Hypothesis –problems of Sex-linkage, problems of genes with Multiple alleles, problems of gene interactions, Chi-square, t- test.

Learning Outcomes: After completion of this unit, the student will be able to

- Understand how to draw pedigree charts of different inheritance patterns
- Problem solving skills of genetic hypothesis testing

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

- Understand the concept of inheritance
- Realize how to draw pedigree charts of different inheritance patterns
- Explain the main features recombination and its mechanisms.
- Understand how to detect crossing over phenomenon of chromosomes

RECOMMENDED BOOKS:

1. Principles of Genetics by Gardner, Simmons & Snustad, 8th Edition, Wiley.
2. Genetics by MW Strickberger, 3rd Edition, McMillan.
3. Principles of Development by Lewis Wolpert, 5th Edition, Oxford University press.
4. Principles of Heredity by Robert Tymarin A, 7th Edition, Tata McGraw-Hill.
5. Genetics by PK Gupta, Rastogi Publications.

SEMESTER – II

SBH 106: PLANT DIVERSITY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble:
The students of undergraduate program in science need to be conversant with the basic characters of plant life. Therefore, general characters of Gymnosperms and Angiosperms is introduced which helps the student familiarize with the essentials for developing the foundation of plant diversity.

Course Objectives:

1. To introduce the concept of classification of plant life.
2. To impart knowledge on the life history of basic plant diversity.
3. To familiarize students about the Plant Taxonomy.

UNIT-I

Algae : General account, ecology and distribution of Algae, thallus organization and reproduction in Algae. Fritsch classification of Algae (up to classes only). Economic importance of Algae.

Fungi: General characteristics and outline classification (Ainsworth). Structure, reproduction economic importance of Fungi.

Lichens-General characters, distribution, types, structure, reproduction and economic importance. General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

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

- Describe the classification of Algae with examples and explain life cycles of different algal forms.
- Describe the classification of Fungi with examples and explain life cycles of different Fungi.

UNIT-II

Bryophytes : General characteristics , Adaptations to land habit; Classification (up to classes); Range of thallus organization. Life cycles of *Marchantia* and *Funaria*. Evolution of Sporophyte in Bryophytes.

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

- Describe the classification of Bryophytes with examples and explain thallus organization of different Bryophytes.
- Describe the life cycles of different Bryophytes.

UNIT-III: Pteridophytes:
General characters, classification (up to Classes), Characteristics of Early land plants-Cooksonia and Rhynia. Structure, reproduction, and life history of Lycopodium, and Marsilea. Evolution of stele in Pteridophytes.

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

- Describe the classification of Pteridophytes with examples and explain the characteristics of early terrestrial plants.
- Describe the life history of different Pteridophytes.

UNIT-IV: Gymnosperms:
General characters, classification (up to classes), Morphology, anatomy, reproduction and life history of Pinus and Gnetum. Economic importance with reference to wood, essential oils and drugs.

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

- Describe the classification of Gymnosperms with examples and explain their structural organization.
- Describe the economic importance of different products yielded from Gymnosperms.

UNIT V: Angiosperms:
General characters of Angiosperms including primitive angiosperms (Amentiferae, Ranales, Magnoliales). Salient features of the systems of classification of angiosperms proposed by Bentham & Hooker and Engler & Prantl. Diversity of Flowering Plants: Diagnostic features and economic importance of the following families: Ranunculaceae, Brassicaceae, Malvaceae, Leguminosae and Poaceae.

SEMESTER – II

SBH 106: PLANT DIVERSITY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Learning Outcomes:

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

- Describe the general characters and classification of Angiosperms with examples.
- Describe the diversity of Angiosperms.

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

- Learn the concept of classification of plant life.
- Gain knowledge on the life history of basic plant diversity.
- Classify and understand about the Plant Taxonomy

RECOMMENDED BOOKS:

1. Singh.V., P.C.Pande & D.K.Jain, 2006. A Text book of Botany, Rastogi Publications, Meerut
2. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
3. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
4. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
5. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
6. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5 th edition.
7. Pandey B.P. 1989. A text book of plant pathology, pathogen and plant diseases. S. Chand and Company Ltd., New Delhi.

SEMESTER – II

SBH 108: ANIMAL DIVERSITY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble:
The students of undergraduate program in science need to be conversant with the basic characters of animal life. Therefore, general characters of vertebrates and invertebrates is introduced which helps the student familiarize with the essentials for developing the foundation of animal diversity.

Course Objectives:

1. To introduce the concept of classification of animal life.
2. To impart knowledge on life cycle of infectious parasites.
3. To familiarize students about the comparative anatomy of different vertebrate body systems.

UNIT I: Non-Chordates - Protozoa:
Outline classification of Non-Chordates up to subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes. General features of Protozoa. Brief life cycles of Pathogenic protozoans Entamoeba, Plasmodium, Leishmania, Trypanosoma.

Learning Outcomes:
By the end of this Unit, the student will be able to:
• Describe the classification of Protozoa with examples and explain life cycles of different pathogenic protozoans.

UNIT II: Non-Chordates - Parasitic helminths:
General characteristics of poriferans and coelenterates. General characteristics of Platyhelminths and Aschehelminths. Brief life cycles of Parasitic helminths-Taenia solium, Schistosoma, Ascaris, Anchylostoma.

Learning Outcomes:
By the end of this Unit, the student will be able to:
• Describe the classification of non-chordates with examples and explain life cycles of different helminth parasites.

UNIT III: Non-Chordates – General characters:
General features of Annelida and Arhtropoda. Metameric segmentation in annelids. Metamorphosis in insects. General features of Mollusca. Shell Diversity; Torsion in gastropoda. General features Echinodermata. Larval forms. General characteristics of Hemichordata.

Learning Outcomes:
By the end of this Unit, the student will be able to:
• Describe the classification of non-chordates with examples and explain Molluscan shell diversity and different invertebrate larval forms.

UNIT IV: Chordata:
General characteristics of Proto-chordates. Phylogenetic evolution of Chordates. General characteristics of Chordata and outline of classification. General features of Pisces, Ambhibia, Reptilia, Aves and Mammalia. Parental care, Paedogenesis in Amphibia. Flight adaptations and migration of birds. Dentition in Mammalia.

Learning Outcomes:
By the end of this Unit, the student will be able to:
• Describe the classification of chordates with examples and explain parental care in Amphibia, flight adaptations and migration of birds.

UNIT V: Comparative anatomy of vertebrates:
Comparative anatomy of digestive, respiratory, urinogenital system, Brain and Autonomic Nervous system in Mammals.

Learning Outcomes:
By the end of this Unit, the student will be able to:
• Describe the anatomy of functional systems in Mammals.
• Compare the anatomical features of different mammalian body systems.

SEMESTER – II

SBH 108: ANIMAL DIVERSITY

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

- Understand the concept of classification of animal life.
- Gain knowledge on life cycle of infectious parasites.
- Generate the comparative anatomy of different vertebrate body systems.

RECOMMENDED BOOKS:

1. Invertebrate Zoology by P S Verma and E L Jordon
2. Vertebrate Zoology by P S Verma and E L Jordon
3. A Textbook of Vertebrate Zoology by S.N. Prasad
4. Modern Textbook Of Zoology Vertebrates by R L Kotpal
5. Modern Text Book Of Zoology: Invertebrates by R L Kotpal
6. Comparative Anatomy of the Vertebrates by Kent G. C.
7. Comparative Anatomy of Vertebrates by R. K. Saxena, Sumitra Saxena

SEMESTER – II

SBH 112: MICROBIOLOGY LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Preamble:
This paper has been designed to enrich students in learning the good laboratory practices and understand the principle and applications of important instruments used in Microbiology laboratory.

Course Objectives:

The objective of this laboratory course is to develop a detailed knowledge on instruments used in Microbiology laboratory and also provide practical skills in operation of basic microbiological instruments and learn the basic techniques of staining and preparation of temporary mounts.

1. Microbiology Good Laboratory Practices and Biosafety.

2. Principle and applications of important instruments used in microbiology lab (biological safety cabinets, autoclave, bacteriological incubator, BOD incubator, hot air oven, light microscope, pH meter and colony counter) used in the microbiology laboratory.

3. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts

4. Study of *Spirogyra* and *Chlamydomonas, Volvox* using temporary Mounts

5. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

Course outcomes: By the end of the course, the student will be able to:
- Learn good laboratory practices and biosafety aspects
- Acquire a detailed knowledge on instruments used in Microbiology laboratory
- Perform basic experiments in staining and specimen mount preparation

RECOMMENDED BOOKS:

1. Laboratory Exercises in Microbiology (2016) by John Harley 8th Edition, McGraw-Hill Education

2. Microbiology: A Laboratory Manual (2016) by James G. Cappuccino 11th Edition Pearson publishers

3. Microbiology: Laboratory Theory and Application (2015) 4th Edition by Michael J. Leboffe, Morton Publishing Company

SEMESTER – II

SPH 124: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY LAB

Hours per week: 04 **End examination: 40 Marks**

Credits: 02 **Sessional: 60 Marks**

Preamble: The students of undergraduate program in science in Chemistry need to be conversant with the various basic methodologies of chemistry. Therefore, one module each on in inorganic, physical and organic chemistry is introduced which helps the student familiarize with the techniques essential for developing the foundation of practical chemistry

Course objective: To make student develop the fundamental skill required for quantitative and qualitative analysis in inorganic and organic chemistry.

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of H.

Ionic equilibria pH Measurements:

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH meter.

b) Preparation of buffer solutions:
   (i) Sodium acetate-acetic acid
   (ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallization, determination of melting point and calculation of quantitative yields to be done.

   (a) Bromination of Phenol/Aniline
   (b) Benzoylation of amines/phenols
   (c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde / ketone

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

- familiarize the concept of qualitative element detection in organic chemistry essential for functional group analysis.
- learn about the quantitative analysis concepts of redox chemistry

SEMESTER – II

RECOMMENDED BOOKS:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbookof Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

SEMESTER – II

SBH 114: CLASSICAL GENETICS LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Course Objectives: The objectives of this course are to take students through basics of genetics and classical genetics covering prokaryotic genetics to higher eukaryotic domains. On covering all classical concepts of Mendelian genetics across these life-forms, students will be exposed to concepts of population genetics, quantitative genetics encompassing complex traits, and clinical genetics.

1. Permanent and temporary mount of mitosis
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of - Barr Body - *Rhoeo* translocation.
5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicine treatment.

Course Outcomes: On successful completion of this course, student will be able to
• Describe fundamental molecular principles of genetics
• Understand relationship between phenotype and genotype in human genetic traits
• Describe the basics of genetic mapping
• Understand how gene expression is regulated.

RECOMMENDED BOOKS:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. 8th edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. 5th edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. 9th edition, Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. 3rd edition, Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. 9th edition.

SEMESTER – II

SBH 116: PLANT DIVERSITY LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Preamble:
This lab course is designed to introduce the students the practical knowledge of plant diversity. The concept of basic structural organization of early plant life is at the reach of students through this lab.

Course Objectives:

1. To introduce the concept of early plant life.
2. To impart knowledge on structural organization of vegetative and reproductive parts Algae and Fungi.
3. To familiarize students about the comparative anatomy by mounting different plant tissues .

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory
2. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
3. Study and section cutting and lactophenol mount of plant disease materials studied in theory.
4. Study of various types of lichens.
5. Study of external features & anatomy of vegetative and reproductive parts of *Marchantia* and *Funaria*
6. Collection of algae, fungi, plant diseases materials and bryophytes available locally.

Course Outcomes: By the end of this lab, the student will be able to:
• Understand the diversity of early plant life and observe the distinguished characters of few examples under different plant groups.
• Attain knowledge on the existence of plant groups at different localities at different seasons.

RECOMMENDED BOOKS:

1. Agrios, G.N. 1997 Plant Pathology, 4 thedition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4th edition, John Wiley and Sons (Asia) Singapore.
3. Bold, H.C. & Wayne, M.J. 1996 (2nd Ed.) Introduction to Algae.
4. Kumar, H.D. 1999. Introductory Phycology.Aff. East-West Press Pvt Ltd., Delhi.
5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
6. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
7. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.
8. Van den Hoek, C.; Mann, D.J. &Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.
9. Vander-Poorteri 2009 Introduction to Bryophytes. COP.
10. Webster, J. and Weber, R. 2007 Introduction to Fungi. 3rd edition, Cambridge University Press, Cambridge.
11. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kluwer Publishers,

SEMESTER – II
SBH 118: ANIMAL DIVERSITY LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Preamble:
This lab course is designed to introduce the students the practical knowledge of Invertebrate animal diversity. The concept of structural organization of microscopic invertebrate organisms is at the reach of students through this lab.

Course Objectives:

1. To introduce the practical knowledge of Invertebrate animal phyla.
2. To impart experience on observing the microscopic Invertebrates.
3. To familiarize students about the comparative anatomy of different invertebrate body systems.

1. Identification and Classification of any of the following :

Porifera*:* *Scypha, Leucosolenia, Euspongia, Hylonema, EuplectellaCnidaria: Medrepora, Millepora, Physalia, Porpita, Valella, Aurelia, Metridium*
Platyhelminthes: *Taenia, Fasciola,*
Aschelminthes*:* *Ascaris, Ancylostoma, Enterobius*Annelida: *Pheretima, Hirudinaria, Chaetopterus, Nereis, Aphrodite*
Arthropoda: *Julus, Scolopendra, Peripatus, Carcinus, Limulus, Lepisma, Dragonfly, Musca, Acheta* **Mollusca:** *Pila, Unio, Mytilus, Loligo, Sepia, Octopus, Solen*
Echinodermata: *Asterias, Ophiothrix, Echinus, Holothuria, Astrophyton*
Hemichordata: *Balanoglossus*

2. Identification of the following slides and mention at least two points:
Amoeba, Paramoecium, Ceratium, Plasmodium, Opalina, L.S. Sponge, Spicules of sponges, L.S. Hydra, Obelia, Bougainvillia, Larvae of Fasciola, Seta of Earthworm, Radula.

3. Ecological Note – On any of the specimens in Exercise No 1 Models of dissection of Earthworm, Cockroach Earthworm: Digestive, Nervous System, Cockroach: Digestive Reproductive, Nervous System.

Course Outcomes: By the end of the practical course, the students will be able to
• Appreciate the diversity of Invertebrate animals and observe the distinguished characters of few examples under Invertebrate phyla.
• Recognize the diversity of microscopic Invertebrates and observe the distinguished characters of few examples and functional organs under Invertebrate phyla.
• Understand anatomical organization of two representatives under Annelida and Arthropoda.

RECOMMENDED BOOKS:

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002)
2. The Invertebrates: A New Synthesis. 3rd edition. Blackwell Science.
3. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. 2nd edition. E.L.B.S. and Nelson.

SEMESTER – III

SBH 201: BIOANALYTICAL TECHNIQUES

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: The bioanalytical techniques predominately embrace a broad cross-section of modern analytical techniques and principle and usage of instruments like HPLC, XRD, NMR, GC-MS, ORD…etc. The course will help to build the knowledge about the bioanalytical techniques used to analyze various biomolecules.

Course objectives: The objective of the course is to build the knowledge of students about the biochemical techniques used in various areas of biology. To make the learners aware of the principle, operation and applications of various techniques used to analyze biomolecules.

UNIT-I

Principles and applications of chromatographic techniques- Paper chromatography, thin layer chromatography, gel filtration, ion-exchange chromatography, affinity chromatography, GC, HPLC and GC-MS.

Learning outcomes: After completion of this unit, the student will be able to

- Explain the various chromatographic techniques and their applications in various fields of biology.
- Understand separation and purification of various biomolecules using these techniques.

UNIT-II

Principles and concepts of electrophoretic techniques- native PAGE, SDS-PAGE, Agarose gel electrophoresis, capillary electrophoresis, isoelectric focusing (IEF), two dimensional, pulse field and diagonal electrophoresis.

Learning Outcomes: After completion of this unit, the student will be able to

- Understand separation of proteins based on mass and charge.
- Usage of separation techniques of DNA based on conformation and size
- Application of different separation techniques based on research question.

UNIT-III

Principles and applications of Optical Rotatory Dispersion (ORD), Circular Dichroism (CD), Nuclear Magnetic Resonance spectroscopy (NMR), Electron Spin Resonance spectroscopy (ESR), Fluorescence spectroscopy. X-ray diffraction.

Learning Outcomes: After completion of this unit, the student will be able to

- Understand the characterization of biomolecules based on spectroscopic techniques.
- Comprehend how 3-dimensional structure of a protein can be predicted using various techniques.

UNIT-IV

Principles and applications of preparative centrifugation: Differential centrifugation, density gradient centrifugation, rate zonal centrifugation and isopycnic centrifugation. Types of rotors. Analytical centrifugation: sedimentation coefficient, boundary sedimentation, band sedimentation.

Learning Outcomes: After completion of this unit, the student will be able to

- Gain knowledge about the centrifugation principles and operations.
- Comprehend how various biomolecules are purified or separated using centrifuges

UNIT-V

Radioactive and non-radioactive tracer techniques and their applications in biological sciences. Detection and measurement of radioactivity. Principles of electrochemical techniques-operation and applications of pH, oxygen, ion-selective and gas sensing electrodes. Biosensors- principle,

design and applications.

SEMESTER – IV

Learning Outcomes: After completion of this unit, the student will be able to

- Acquaint with the role of radioactive tracer techniques and apply them in various fields of biology
- Comprehend the principle, operation and applications of various electrodes and biosensors.

Course Outcomes: At the completion of this course, students should be able to:

- Understand the principles and basic theory behind several popular Bioanalytical techniques
- Utilize these techniques successfully in practical situations.
- Comprehend the principle, operation and applications of various electrodes and biosensors

RECOMMENDED BOOKS:

1. Practical Biochemistry by Keith Wilson & Walker, 5th edition, Cambridge University Press.
2. A Biologists guide to Principles and techniques of practical Biochemistry by BD Williams (Edward Arnold).
3. Principles and Techniques of Biochemistry and Molecular Biology by K Wilson & J Walker, 7th Edition, Cambridge University Press.
4. Biophysical chemistry principles and techniques by Upadyay & Nath, Himalaya publishing House.
5. Instrumental methods of chemical analysis by Chatwal & Anand, 5th edition, Himalaya Publishers.
6. Modern Experimental Biochemistry by Rodney F Boyer, 3rd Edition.
7. Fundamentals of Biostatistics by Khan & Khanum, Ukaaz publications.
8. Biostatistics by Daniel, 10th edition, Wiley Publishers.
9. Physical Chemistry: Science of Biology by Atkins, Freeman & Company.

SEMESTER – III

SBH 203: ENZYMOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: Flow of free energy in biological systems among various tropic levels occurs through several metabolic pathways. These pathways involve exothermic reactions necessitating energy consumption for the progress of a reaction. Life forms deal such uphill task with the help of enzymes. Therefore, it is interesting to study how enzymes work and what are the different types of enzymes. In this regard, this course deals with classification of enzymes based on their specificity, kinetics, mechanisms of action of enzymes. Effortless learning of enzymology could be done, if pursued in logical and application-oriented manner.

Course Objectives:

1. An understanding of coupled reactions, difference between exergonic and endergonic reactions.
2. An appreciation of how the enzymes could bring down the activation energy barrier
3. Mechanism of action of enzymes and their application in industry and medicine.

UNIT-I

Basic Concepts: Nomenclature and classification of enzymes, Enzyme specificity, Factors effecting enzyme activity: enzyme concentration, substrate concentration, pH, temperature and metal ions. Enzyme assay and units of enzyme activity. Coenzymes and metalloenzymes.

Learning Outcomes:

After completion of this unit, the student will be able to

• Understand what rate of enzyme catalyzed reaction (enzyme activity) is, its units and concept of enzyme specificity
• Distinguish between various classes of enzymes and the changes brought by them.
• Effect of different enzyme, substrate concentrations on the enzyme activity
• Understand what the active site of enzyme is and discuss various factors effecting enzyme activity

UNIT-II

Enzyme Kinetics: Michaelis-Menten equation and Steady state assumption theory, Significance of Km, Vmax and Kcat, Lineweaver-Burk plot. Enzyme inhibition: irreversible, reversible, competitive, non-competitive and uncompetitive inhibition.

Learning Outcomes:

After completion of this unit, the student will be able to

• Understand that the process of single substrate reaction follows 1st order reaction initially and becomes independent of substrate concentration.
• Describe the derivation of Michalis-Menten equation, to know about Vmax and Km of single substrate reactions.
• Learn about the turnover number (Kcat), which is the number of times active site of the enzyme converts substrate to product per unit time.
• Understand about various enzymes inhibitors segregate them into 3 categories and deduce their mechanism of action.

UNIT-III

Active site determination / investigation: Mechanism of enzyme action of Carboxypeptidase-A and Ribonuclease-A. Multienzyme system (PDH complex). Enzyme regulation: Allosteric enzymes, zymogen activation and isoenzymes.

Learning Outcomes:

After completion of this unit, the student will be able to

- What is enzyme's active site.
- Mechanism of enzyme action of the c-terminal peptidase enzymes specific example is carboxypeptidase-A

SEMESTER – III

SBH 203: ENZYMOLOGY

Hours per week: 04 **End examination: 60 Marks**

- Mechanism of action of acid-base hydrolases enzymes model of study: Ribonuclease-A
- How do multienzyme complexes work and their importance in biological systems.
- Regulation of enzyme activity. Mechanism of allosteric regulation of enzymes.
- Activation of proenzyme or zymogen. The importance of the presence of zymogen in biological systems.

UNIT-IV

Techniques of enzyme immobilization: adsorption, entrapment, covalent binding and cross-linking. Properties and applications of immobilized enzymes, Application of enzymes in medicine and industry.

Learning Outcomes:

After completion of this unit, the student will be able to

- Why do we need to immobilize enzymes?
- Methods for enzyme immobilization.
- The changes in the properties if enzyme after immobilization.
- Application of immobilized enzymes in medicine, food, and other industries.

UNIT-V

Overview of Abzymes – Types and strategies for designing abzymes. Ribozymes – Types and mechanism of action. Enzyme engineering by site-directed-mutagenesis.

Learning Outcomes:

After completion of this unit, the student will be able to

- Understand about catalytic monoclonal antibodies and their uses in finding reaction mechanisms, enzyme structure and catalysis
- Understand that a ribonucleic acid (RNA) enzyme used in catalysis is called as Ribozyme
- Understanding how to alter an amino acid from the active or specific site of the protein, using site directed mutagenesis and its applications in enzymology.

Course Outcomes: On completion of this course, students should be able to

- Gain clear understanding in isolation, purification and characterization of enzymes
- Understand enzyme engineering technologies
- Employ the knowledge of enzyme immobilization technology in medicine and industry
- Alter an amino acid from the active or specific site of the protein, using site directed mutagenesis and its applications in enzymology

RECOMMENDED BOOKS:

1. Enzymology: Biochemistry, Biotechnology and Clinical chemistry by T Palmer & P Bonner, 2nd edition, Horwood series.
2. Lehninger Principles of Biochemistry by Nelson D & Cox D, 5th edition, WH Freeman and Co.
3. Biochemistry by L Stryer, 8th Edition, WH Freeman publishers.
4. Textbook of Biochemistry by ES West & WR Todd, 4th Edition, McMillan Publishers.
5. Harper's Biochemistry by Robert K Murray, 28th Edition, McGraw-Hill Lange Publishers.
6. Biochemistry by D Voet & JG Voet, 4th Edition, John Wiley Publishers.
7. Biochemistry by Mathews, 2nd edition, Pearson Publishers.
8. Biochemical engineering fundamentals by Bailey &Ollis, 2nd Edition, McGraw-Hill Lange Publishers.

SEMESTER – III

SBH 205: CELL BIOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: An introductory course suitable for students interested in pursuing Cell Biology specialization/honors. This course focuses on the molecular aspects of modern cell biology. Topics covered include the nucleus membrane structure and function; organelle biogenesis; cytoskeleton and cell adhesion; the cell cycle; and cancer.

Course Objectives:

This course is designed to prepare students for a career in research in molecular and cellular biology and its applications

A broader training in the skills and techniques of contemporary research in molecular and cellular biology

Prepare for a career in the biosciences industry or academic research

UNIT-I

History of cell biology, Evolution of the cell: endosymbiotic theory, tree of life**.** Structural organization of prokaryotic and eukaryotic cell. Ultra-structure of nucleus, mitochondria, endoplasmic reticulum, golgi complex.

Learning Outcomes:

After completion of this unit, the student will be able to

- Diagram the structure of the nuclear envelope and describe its functions
- Compare the mechanisms for importing specific proteins into the nucleus and into mitochondria.
- Compare the general mechanisms that allow some newly synthesized proteins to be released into the cytoplasm, whereas others are directed into other cellular compartments
- Explain how the orientations of transmembrane proteins are determined as they are integrated into a membrane
- Describe the different mechanisms by which secretory vesicles fuse with the plasma membrane

UNIT-II

Chemical composition, structure and functions of cell wall and plasmodesmata. Biochemistry and significance of vacuoles. Ultra structure of chloroplast. Lysosomes and Peroxisomes

Learning Outcomes:

After completion of this unit, the student will be able to

- Describe the functions of lysosomes and how vesicles are targeted to them
- Compare the mechanisms by which proteins are targeted for degradation by either proteosomes or lysosomes.
- Describe the synthesis of glycoproteins and the functions of their carbohydrate side chains.
- Explain how cells regulate the directional flow of secreted components from theendoplasmic reticulum (ER) to the Golgi apparatus to the plasma membrane.
- What problems would a cell have if it could not produce lysosomes?

UNIT-III

Extracellular matrix – Collagen, Elastin, Fibrillin, Fibronectin, Laminin, Proteoglycans, Integrins. Cytoskeleton – microtubules and microfilaments. Cell-cell interactions - Gap junction, Tight Junction, Desmosomes. Exocytosis and Endocytosis.

Learning Outcomes:

After completion of this unit, the student will be able to

- Distinguish between receptor-mediated endocytosis and phagocytosis
- Compare the characteristics and functions of microfilaments, microtubules, and intermediate filaments.
- Compare treadmilling of actin filaments with dynamic instability of microtubules.
- Explain how the growth and branching of actin microfilaments is controlled
- Describe the general functions of directional microtubule motor proteins and how they work.

SEMESTER – III

SBH 205: CELL BIOLOGY

Hours per week: 04 **End examination: 60 Marks**

UNIT-IV

Different membrane models, Ultra structure of plasma membrane. Membrane asymmetry. Fluidity of membranes. Membrane biogenesis. Membrane channels and pumps. Membrane transport mechanisms.

Learning Outcomes:

After completion of this unit, the student will be able to

- Explain how membrane lipid and protein components and their structural asymmetries are important for membrane functions in cells
- Compare the different ways in which proteins associate with cellular membranes.
- Predict how variation in the lipid composition of a membrane will affect its fluidity and the mobility of integral membrane proteins.
- Explain how diffusion rates are related to molecular size and hydrophobicity
- Compare the mechanisms of facilitated diffusion and active transport for moving ions and molecules across cell membranes through protein transporters

UNIT-V

Cell division by mitosis/meiosis. Cell cycle and its regulation. Abnormal cell division: cancer - hallmarks of cancer and role of oncogenes and tumour suppressor genes in cancer development - Programmed cell death (Apoptosis).

Learning Outcomes:

After completion of this unit, the student will be able to

- Describe how a cell determines whether it is ready to replicate DNA and then enter mitosis
- Explain the role of centrosome duplication and cytoskeletal changes during cell division
- Discuss how cell cycle, chromosome condensation, and transcription are related
- Explain how the cell regulates the timing of events in the mitotic cycle.
- Describe the mechanism of programmed cell death (apoptosis) and its importance for animal homeostasis
- Explain how defects in control of the cell-cycle or programmed cell death can lead to cancer.

Course Outcomes: On completion of this course, students should be able to

- Acquire basic knowledge on cell structure and function, transport in a cell, protein trafficking in the cell,
- Understand the cell-cell communication, cell division, and cell death.

RECOMMEDED BOOKS:

1. Molecular Biology of the Cell by B Alberts *et.al.,* 5th Edition, Garland publications incorporation.
2. Principles of Development by Lewis Wolpert, 4th Edition, Oxford University press.
3. Molecular Cell Biology by Harvey Lodish*et.al.,* 7th Edition, W.H. Freeman and Co.,
4. Cell and Molecular Biology by DeRoberties&DeRoberties, 8th Edition, S Chand & Co.
5. The Cell: A molecular approach by GM Cooper & RE Hausman, 6th Edition, Ingram Publishers
6. Molecular Cell Biology by J Darnell, 4th Edition, Scientific American Books.
7. Harper's Biochemistry by RK Murray *et.al.,* 30th Edition, McGraw-Hill Lange Publishers.
8. Biochemistry of Signal Transduction and Regulation by G Krauss, 5th Revised Edition, Wiley-VCH publishers.

SEMESTER – III

SBH 207: METABOLISM

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: This course has been designed to enrich the students' knowledge about the metabolism of biomolecules. The course shall make the students' aware of the significance of metabolism and its regulation in living organisms.

Course Objectives:

1. To build the knowledge about the metabolic significance of bioenergetics and energy compounds in various catabolic and anabolic pathways.
2. To impart knowledge on various metabolic pathways and their integration in carbohydrate metabolism.
3. To familiarize the significance and knowledge on lipid metabolism and its regulation.
4. To understand the nitrogen balance and metabolic pathways of few amino acids.
5. To understand the mechanisms of purine and pyrimidine metabolism.
6. To apprehend the disorders of various metabolic pathways.

UNIT- I

Principles of Bioenergetics – Free energy concept, enthalpy, entropy, redox potential, phosphate group transfer potential. Coupled reactions, High-energy compounds in biological systems. Substrate level phosphorylation, Electron transport -oxidative phosphorylation

Learning Outcomes:

After completion of this unit, the student will be able to

- Explain the principles of thermodynamics.
- Explain the significance of enthalpy, entropy and free energy.
- Understand the importance of coupled reactions in metabolic pathways.
- Understand the role of high energy compounds in biological systems.
- Explain the mechanisms of oxidative and substrate level phosphorylation reactions and their role in energy synthesis.

UNIT- II

Glycolysis and its regulation. Alcoholic and homolactic fermentation. TCA cycle and its regulation-amphibolic nature of TCA cycle, anapleurotic reactions. Significance of gluconeogenesis, HMP shunt and glyoxalate cycle. Glycogen metabolism-glycogenesis, glycogenolysis and glycogen storage diseases.

Learning Outcomes:

After completion of this unit, the student will be able to

- Understand the aerobic and anaerobic energy yielding pathways.
- Understand the amphibolic nature of TCA cycle.
- Understand the significance of gluconeogenesis, HMP shunt and Glyoxylate cycle.
- Explain the pathways of glycogenesis and glycogenolysis with regulation.
- Understand the clinical significance of glycogen storage disorders.

UNIT-III

Synthesis and degradation of saturated and unsaturated fatty acids. Ketone bodies. Synthesis of triglycerides, phospholipids, cholesterol and sphingolipids. Lipid storage disorders.

Learning Outcomes:

After completion of this unit, the student will be able to

- Understand the synthesis and degradation of saturated and unsaturated fatty acids.
- Understand the synthesis, utilization, and significance of Ketone bodies.
- Explain the pathways for the synthesis of triacylglycerides, phospholipids, and cholesterol.
- Explain the synthesis of lipids and their storage disorders

UNIT-IV

Protein turnover, transamination, deamination and urea cycle. Biosynthesis and degradation of phenylalanine and valine. Inborn errors of amino acid metabolism.

Learning Outcomes:

After completion of this unit, the student will be able to

- Understand the concept of protein turnover.
- Understand the importance of transamination and deamination.
- Understand the biosynthesis and degradation of aromatic and branched chain amino acids.
- Understand the inborn errors of amino acid metabolism.

UNIT- V

Synthesis and regulation of purine nucleotides by *denovo* pathway. Salvage of purine nucleotides. Synthesis and regulation of pyramidine nucleotides. Formation of deoxyribonucleotides and their regulation. Degradation of purines and pyrimidine nucleotides. Disorders of nucleotide metabolism- Lesch-nyhan syndrome, Gout and Severe combined immunodeficiency disorder (SCID).

Learning Outcomes:

After completion of this unit, the student will be able to

- Understand the synthesis and regulation of purine and pyrimidine nucleotides.
- Understand the degradation of purine and pyrimidine nucleotides.
- Explain the formation of deoxyribonucleotides and regulation.
- Understand the disorders of nucleic acid metabolism

Course Outcomes: On completion of this course, students will be able to:

- Gain fundamental knowledge in metabolic pathways
- Understand the energy pathways of metabolism
- Appreciate the integration of metabolism.

RECOMMENDED BOOKS:

1. Lehninger Principles of Biochemistry by Nelson, D and Cox, D. –7th Edition. Mcmillan.
2. Biochemistry by L. Stryer– 8th Edition. (Freeman-Tappan).
3. Biochemistry by D.Voet and J.G.Voet– 4th Edition. (John weily).
4. Biochemistry by Garrett and Grisham 6th Edition. (Cengage Learning)
5. Principles of Biochemistry by David Rawn etal., 5th Edition (Pearson)
6. Harper's Biochemistry by Robert K. Murray et al., – 30thEdition. (Langeman).
7. Biochemistry by U.Satyanarayana—4thEdition.

SEMESTER – III

SBH 209: FOOD AND NUTRITION

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: Food and nutrition plays a major role in promotion of health and well being of an individual. A good and balanced diet habit improves the quality of life while poor diet may lead to morbidity and diseases. This course is related to food management and nutrition is related to promotion of health. The course helps in understanding food production and processing, psychological factors influencing food choice, digestion and its effects on nutritional aspects.

Course Objectives:

- To apply analytical principles of food and nutrients in diet formulation.
- To devise research strategies for empowering and promoting healthy living in the community.
- To acquire skills in the field of food science and nutrition

UNIT-I

Animal and vegetative foods – Essential nutrients and their classification, biochemical functions of macronutrients, Carbohydrates – dietary needs, Proteins – determination of biological values of proteins, nitrogen balance studies, specific dynamic action, improvement of protein quality by supplementation and fortification. Lipids – dietary needs of lipids, essential fatty acids.

Learning Outcomes: After completion of this unit, the student will be able to

- Describe the knowledge regarding various nutritional classification of food grouping system
- Understand the biochemical functions and nutritional importance of biomolecules.

UNIT -II

Fermented foods and their nutritive role, Clinical nutrition – role of diet and nutrition in prevention of atherosclerosis and obesity, role of leptin in regulation of body mass. Starvation – Protein sparing treatment during fasting, Protein calorie malnutrition – Kwashiorkar and Marasmus, Nutritional requirements for pregnant and lactating women and aged people.

Learning Outcomes: After completion of this unit, the student will be able to

- Understand the nutritional role of fermented foods
- Appraise the importance of clinical nutrition
- Recognize the nutritional requirements for different groups of people

UNIT-III

Biological effects of non nutrients, dietary fibre - physiological role. Biological effects of food contaminants – Hexachlorobenzene, arsenic, DDT, cadmium, mercury, lead, aflatoxins, food additives - saccharin and sodium nitrite. Food allergy – role of allergens, diagnosis and management of food allergy. Measurement of energy expenditure: BMR, RMR, thermic effect of feeding and physical activity. Calorific values of foods.

Learning Outcomes: After completion of this unit, the student will be able to

- Develop skills to assess the total energy requirements, balance and its concepts depending on the individual specific needs.
- Identify body composition and its changes though life cycle and the techniques of measuring body composition.
- Understand the concept of food allergy

UNIT-IV

Applications and role of enzymes in food industry: Amylases, Proteases, Lipases, Glucose isomerase, lactase, pectinase and renin in food industry. Food processing and loss of nutrients during processing and cooking.

Learning Outcomes: After completion of this unit, the student will be able to

- Evaluate the importance of enzymes in food industry
- Emphasizing the role of food processing in food industry

SEMESTER – III

SBH 209: FOOD AND NUTRITION

UNIT-V

Regulatory aspects of food biotechnology; Future strategies for development of biotechnology-enhanced functional foods for human nutrition. Food safety, evaluation of food quality and quality assurance (PFA, FSSAI, HACCP, ISO and FSO systems).

Learning Outcomes: After completion of this unit, the student will be able to

- Assess the food safety and quality
- Emphasizing the regulatory aspects of food biotechnology

Course Outcomes: On completion of this course, students will be able to

- Emphasize the regulatory aspects of food biotechnology
- Evaluate the importance of enzymes in food industry
- Understand the nutritional role of fermented foods
- Understand the biochemical functions and nutritional importance of biomolecules

RECOMMEDED BOOKS:

1. Text book of Human Nutrition by Mehtab SBamji, 3rd Edition, Oxford and IBH publishing Pvt. Ltd.
2. Food Processing Principles & Applications by Ramaswamy & Marcotte, Taylor and Francis- CRC Publications.
3. Food Chemistry by Meyer LH, Affiliated East and west Press Ltd., Bombay,1987.
4. FSSAI Training manual.
5. Nutrition Science by B Srilakshmi, 2nd Edition, New Age International Publishers Pvt. Ltd.
6. Food Science by B Srilakshmi, 2nd Edition, New Age International Publishers Pvt. Ltd.
7. Food facts and Principles by N Shakuntala Manay & M Shadakshara Swamy, New Age International Publishers Pvt. Ltd., 1987.
8. Food Microbiology by Frazier, 4th Edition, WC McGraw-Hill Incorporation.
9. Advanced Text book on Food and Nutrition, Vol-I &Vol-II, The Bangalore Press.

SEMESTER – III

SBH 211: BASICS OF FORENSIC SCIENCE

Hours per week: 02 **End examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: Forensic science is the application of science to the criminal justice. Almost all the academic and experimental branches in humanity, arts, commerce, science, medicine, and engineering are used to study forensic science. All acquired knowledge must be fitted within the proposed scenario which includes crime scene, victim, and the culprit is possible. Forensic science has evolved as a subject, to investigate the crime scene, analyze the subtle clues, and pin down the kingpin using various scientific methods judiciary.

Course Objectives:

1. An understanding of basic concept of forensic science.
2. Introduction of forensic branches
3. Overview of forensic laboratories and organization.

UNIT-I

Introduction of forensic science. History, development and Scope of Forensic Science. Forensic science laboratories and its organization. Branches of forensic science. principles of forensic science. Frye case and Daubert standard. Ethics in forensic sciences.

Learning Outcomes:
After completion of this unit, the student will be able to

- What is forensic science and its history
- Branches of forensic science.
- Setup of Forensic science laboratories and its organization.

UNIT-II

Analysis of toxicity of Insecticides & Pesticides, Tranquillizers & Sedatives, Hypnotics Stimulants, Narcotics and Opiates. Chemical evidence for explosives. Plant and Metallic Poisons. Identification of common poisons from viscera, tissues and body fluids

Learning Outcomes:
After completion of this unit, the student will be able to

- Chemical analysis of substances of forensic importance.
- Chemicals used in criminal activities and their classification.
- Careful collection of samples of forensic importance.

UNIT- III

Techniques for the determination of blood groups of Blood Stains. Detection and analysis of Seminal and other body fluids. Red cells Enzymes, Serum Proteins of forensic significance. Principle, scope and limitations of lie detection (Polygraphy), Narco analysis, voice sampling,finger prints. Overview of cyber crimes- hacking, spamming, phishing and stalking.

Learning Outcomes:
After completion of this unit, the student will be able to

- Blood groups and analysis of blood
- In depth analysis of all types of body fluids.
- Theory and principle of polygraphy, narco, voice analysis fingerprints
- Criminality of cyber misuse.

SEMESTER – III

Course Outcomes: On completion of this course, students will be able to

- Understand the concept of forensic science and its branches
- Analyze the blood groups, body fluids, polygraphy…etc.,
- Analyze the importance of chemical compounds used in forensic science

RECOMMEDED BOOKS:

1. A Handbook of Forensic Medicine and Toxicology: Question Answer Format with Illustrations by Dr. Madona Joseph and Dr. Harpreet Kaur
2. The Essentials of Forensic Medicine and Toxicology by K.S. Narayan Reddy, O.P. Murty
3. Textbook of Forensic Medicine and Toxicology by Anil Aggrawal
4. Parikhs textbook of medical jurisprudence forensic medicine and toxicology for classrooms and courtrooms by Subrahmanyam B.V.
5. Cyber Forensics by Dejey and Murugan

SEMESTER – III

SBH 213: BIOANALYTICAL TECHNIQUES LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Course Objectives

The objectives of this course is to provide hands on experience to under graduate students on qualitative analysis and quantitative analysis of biomolecules by various methods.

1. Qualitative analysis of amino acids
2. Qualitative analysis of carbohydrates
3. Determination of isoelectric point of glycine.
4. Estimation of protein by Lowry's method.
5. Estimation of glycine by Sorenson's formal titration
6. Estimation of cholesterol by Zak's method.
7. Estimation of carbohydrate by Anthrone method
8. Estimation of ascorbic acid by 2, 6-dichlorophenol indophenol method

Course Outcomes: On completion of this practical course, students will be able to:

- Quantify the biomolecules.
- Understand the principle of various biochemical estimation techniques for analyzing biological macromolecules.

RECOMMENDED BOOKS:

1. Modern experimental Biochemistry by Rodney Boyer, 3rd Edition, Benjamin Cummings.
2. Biochemical methods by Sadasivam and Manikam, 2nd Edition, Wiley Eastern limited.
3. An introduction to practical biochemistry by DT Plummer, 2nd Edition, Mc Graw Hill.
4. Laboratory manual in Biochemistry by J Jayaraman, 2nd Edition, Wiley Eastern limited.
5. Biochemistry - A laboratory courses by JM Beckar, 2nd Edition, Academic Press.
6. Introductory practical Biochemistry by SK Sawhney & Randhir Singh, 2nd Edition, Narosa

SBH 215: ENZYMOLOGY LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Preamble : Enzymology is the study of enzymes, their structure and function. Enzymes are highly specific towards their substrates. Their specificity is due to their sequence and structural conformation. Sensitive to various physical and biochemical factors. This course enables the learner to be acquainted with laboratory skills in assaying, quantifying various enzymes. Further, enhances the ability of understanding the kinetics aspects of enzymes.

Course objectives:

- To train students in the practical aspects of Enzymology so that they can perform quantification and assay procedures.
- To conduct the experiments on enzymes to study their kinetic behavior at various temperatures, pH etc with respect to the kinetic parameters such as Km and Vmax

1. Assay of salivary amylase
2. Assay of potato acid-phosphatase
3. Effect of pH on enzyme activity
4. Effect of temperature on enzyme activity
5. Effect of incubation time on enzyme activity
6. Effect of substrate concentration on enzyme activity

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

- Gain hands-on experience in conducting various enzyme assays and analysis
- Perform enzyme kinetics related experiments.

RECOMMENDED BOOKS:

1. Modern experimental Biochemistry by Rodney Boyer – 3rd Edition (Benjamin Cummings).
2. Biochemical methods By Sadasivam and Manikam – 3rd Edition (New Age International Pvt. Ltd. Publishers).
3. An introduction to practical biochemistry by D.T.Plummer – 2nd Edition (McGraw Hill).
4. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5. Biochemistry - a laboratory courses by J.M.Beckar – 2nd Edition (Academic Press).
6. Introductory practical Biochemistry by S.K.Sawhney and Randhir Singh – 2nd Edition

SEMESTER – III

SBH 217: CELL BIOLOGY LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Preamble: This course has been designed to train students with basic techniques of cell biology and the role of microbes in the daily life as well as in the various fields of science, Imparts basic training in cell biology for the students.

Course Objectives:

- Is to provide practical skills on basic microscopic examination techniques.
- Is to isolate subcellular organelles by various centrifugation techniques.
- Is to identify different stages of mitotic and meiotic cell division process.

1. Microscopic examination of thallus in Algae.
2. Microscopic examination of fruiting bodies of Fungi.
3. Identification of different stages of mitosis (onion root tips) by squash method.
4. Identification of different Meiotic stages by smear method (in onion flower buds).
5. Isolation of subcellular organelles by centrifugal techniques (Nucleus / Mitochondria / Chloroplast)
6. Microscopic examination of nucleus by Feulgen staining method

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

- Learn how to make slides for cytological examinations and will equip themselves with the basic cytology aspects to be performed in the laboratory.
- Understand all aspects of microbiology as it is required for Biotechnology course.

RECOMMENDED BOOKS:

1. Handbook of Microbiological Media by Atlas RL.
2. Manual of Clinical Microbiology by Lennettee EH.
3. Manual of Clinical Microbiology by Murray PR.
4. A Laboratory manual of Microbiology: Microbes in action.
5. Molecular Biology of the Cell by B Albert*set.al.*
6. Handling of Chromosomes by Darlington & Lacor.

SEMESTER – IV

SBH 202: MOLECULAR BIOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: This Course introduces you the structure and function of the molecules, including DNA and RNA, which allow genes to be expressed and be maintained from one generation to the next.

Course Objective: The objectives of this course are to make students understand how molecular machines are constructed and regulated so that they can accurately copy, repair, and interpret genomic information in prokaryotes and eukaryotic cells. Further, to appreciate the subject of molecular biology as a dynamic and ever-changing experimental science.

UNIT-I

Structure of Nucleic acid and genome organisation: DNA as genetic material, Structure of DNA, Types of DNA. Genome organization in prokaryotes and eukaryotes; chromosome structure, chromosome organization. Heterochromatin and euchromatin. C - Value and C – value paradox,DNA re-association kinetics (Cot curve analysis)-DNA melting, Tm-value Mitochondrial, chloroplast and plastid genomes.

Learning Outcomes:

- Students should be able to acquire basic knowledge on molecular architecture of prokaryotic and eukaryotic genomes.

UNIT-II

DNA replication, damage, repair and recombination: Classical experiments in DNA replication. Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature and bi-directional DNA replication, Enzymes and accessory proteins in replication. The replication complex. Replication of chromosomal ends. Mutagens. Types of DNA damage – nonsense, missense, silent, point and frame shift mutations. Different mechanisms of DNA repair. Homologous recombination: models and mechanism

Learning Outcomes:

Students should be able to learn various molecular events that lead to duplication of DNA. Also, the mechanisms by which DNA could be damaged and repairs itself will be also studied

UNIT-III

Transcription and Post-transcription events: Transcription mechanism in prokaryotes and eukaryotes. Types of RNA polymerases and promoter-polymerase interactions, transcription factors. Transcription termination. Post-transcriptional processing, 5'- capping,3'-end processing and polyadenylation and splicing. mRNA transport, stability and degradation. RNA editing –insertion, deletion-guide RNA and base substitution. Inhibitors of transcription and applications of antibiotics.

Learning Outcomes:

Students should be able to learn the basic mechanism and methods to measure rate of gene expression

UNIT-IV

Translational and Post-translational modifications: Ribosomes – structure, composition and assembly. Genetic code – codon-degeneracy -codon bias, start and termination codons, Wobble

hypothesis. Mechanism of translation in prokaryotes and eukaryotes. Cap dependent and Cap independent initiation in eukaryotes, Elongation-translocation-transpeptidation and termination of translation. Co-and post translational modifications of proteins, Protein targeting.

Learning Outcomes:

Students should be able to learn how expressed genes can be translated into proteins following a central dogma

UNIT-V

Gene regulation: Regulation of gene expression in prokaryotes; Repressors, activators, positive and negative regulation. Operon concept. Gene regulation in eukaryotes -regulatory RNA and RNA interference mechanism, miRNA. Cis-trans elements – silencers, insulators, enhancers. Introduction to epigenetics- DNA and histone modifications and chromatin remodeling

Learning Outcomes:

- Students should be able to understand molecular mechanisms behind different modes of gene regulation in bacteria and eukaryotes

Course Outcomes: On completion of this course, students will be able to

- develop basic knowledge on molecular architecture of prokaryotic and eukaryotic genomes
- understand various molecular events that lead to duplication of DNA
- learn the basic mechanism and methods to measure rate of gene expression and functional product formation
- identify molecular mechanisms behind different modes of gene regulation in bacteria and eukaryotes

RECOMMENDED BOOKS:

1. Biochemistry by L Stryer, 8th Edition, WH Freeman publishers.
2. Lewin's Genes XI by JE Krebs, ES Goldstein & ST Kilpatrick, Student Edition, Jones & Bartlett publishers.
3. Freifelder’s Essentials of Molecular Biology by GM Malacinski, 4 th Edition, Jones & Bartlett.
4. Cell and Molecular Biology by DeRoberties&DeRoberties, 8 th Edition, S Chand & Co.
5. Molecular Biology of the Gene by JD Watson et.al., 7th Edition, Benjamin-Cummings Pub. Co.

SEMESTER – IV

SBH 204: GENETIC ENGINEERING

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: This course has been designed to enrich students' ability to understand modern areas of biology. Students would learn how engineers apply their understanding of DNA to manipulate specific genes to produce desired traits, and how engineers have used this practice to address current problems facing humanity.

Course Objectives:

1) To enlighten the knowledge of the students on rDNA technology.
2) To teach students the various approaches in conducting genetic engineering and their application in biotechnology industry

UNIT-I

Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing.

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

- Understand the isolation of DNA and cDNA synthesis
- Appreciate the different enzymes used in genetic engineering

UNIT-II

Plasmids, Bacteriophages, M13 mp vectors, PUC19 and Bluescript vectors, phagemids, Lambda vectors, Insertion and Replacement vectors, Cosmids. Artificial chromosome vectors (YACs; BACs), Mammalian expression and replicating vectors, plant-based vectors, Ti and Ri plasmids as vectors, yeast vectors, shuttle vectors.

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

- have a clear idea about different vectors used in genetic engineering
- be able to distinguish viral and bacterial vectors

UNIT-III

Principles of PCR: primer design, fidelity of thermostable enzymes, DNA polymerases. Types of PCR – multiplex, nested, reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR. Cloning of PCR products; T-vectors, proofreading enzyme, PCR based site-specific mutagenesis. PCR in molecular diagnostics, viral and bacterial detection. Sequencing methods: enzymatic DNA sequencing: chemical sequencing of DNA, automated DNA sequencing, RNA sequencing.

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

- have clarity on PCR and its variants
- perceive the concept of PCR and its applications in various fields
- understand various gene sequencing techniques

SEMESTER – IV

UNIT-IV

Insertion of foreign DNA into host cells: transformation, electroporation, transfection. Construction of libraries, isolation of mRNA and total RNA, reverse transcriptase and cDNA synthesis, cDNA and genomic libraries. Construction of microarrays – genomic arrays, cDNA arrays and oligo arrays.

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

- understand various gene transfer techniques
- be able to distinguish genomic and cDNA library construction
- understand the principle of molecular probes

UNIT-V

Gene silencing techniques: introduction to siRNA, siRNA technology, Micro RNA, construction of siRNA vectors, principle and application of gene silencing. Gene knockouts and gene therapy, creation of transgenic plants, debate over GM crops, introduction to methods of genetic manipulation in different model systems e.g. fruit flies (Drosophila), worms (Caenorhabditis elegans), frogs (Xenopus), fish (zebra fish) and chick.

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

- understand various gene silencing techniques
- explain the importance of knockouts and gene therapy
- envisage the usage of different model organisms in various gene manipulation techniques

Course Outcomes: On completion of this course, students will be able to

- Understand the impact of genetic engineering in modern society
- Gain strong theoretical knowledge of this recombinantDNA technology.
- Envisage the usage of different model organisms in various gene manipulation techniques

RECOMMENDED BOOKS:

1. From genes to clones by Winneker, 3rd Edition, VCH Publishers.
2. Molecular Biotechnology: Principles and applications of recombinant DNA technology by BR Glick, JJ Pasternak & CL Patten, 4th Edition, ASM Press.
3. Gene cloning and DNA an a lysis an introduction by TA Brown, 5th Edition, Blackwell Pub.
4. Genomes by TA Brown, 3rd Edition, Garland Science p ublishers.
5. Principles of Gene Manipulation by Old & Primrose, 7th Edition, Blackwell Publishers.
6. Recombinant DNA: Genes and Genomes - A Short Course by Watson, 3rd Edition, Cold Spring Harbor Laboratory Press.
7. Lewin's GENES XI by JE Krebs, ES Goldstein & ST Kilpatrick, 11thEdition, Jones and Bartlett

SEMESTER – IV

SBH 206: IMMUNOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: This course deals about the structure and organization of different components of the immune system. The course makes the student understand about the biological function of various cells and organs of the sentinel system and their critical role in orchestrating an appropriate response in resisting the unwanted hostile intruders. The course also helps to understand the principles and significance of various immunoassays.

Course objectives:

a. Course helps students to get knowledge about different cells, organs and other components of the immune system
b. Student will understand the immune response manifested by different components.
c. Students will learn about the response of immune system in different pathological conditions and learns about different techniques based on antigen and antibody interactions

UNIT-I

Introduction to Immune system - Innate immunity and Adaptive immunity. Immunological barriers. Pattern recognition receptors. Toll like receptors in innate immunity. Cells of the immune system - lymphocytes, macrophages, neutrophils, NK, NKT cells and Innate lymphoid cells. Organization and Structure of lymphoid organs. Antigens, Immunogens, Adjuvants, Haptens. Factors contributing to antigenicity. Superantigens. B and T cell epitopes.

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

- Learn about different cells of the immune system
- Differentiate various lymphoid organs
- Understand the requirements of antigenicity

UNIT-II

B cell ontogeny - B cell development, maturation, activation and memory. BCR. Types of B cells Classification, fine structure and functions of antibodies. Antigenic determinants-isotypes, allotypes and idiotypes. The generation of antibody diversity. Effector cell mechanisms of humoral response.

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

- Understand the ontogeny of B cell
- Analyze the functions of different classes of antibodies and antibody diversity
- Evaluate the biological function and regulation of complement system

UNIT-III

T cell ontogeny - Development, maturation, activation and memory. TCR. Types of T cells. MHC restriction. Recognition of antigen by B-Cell and T-Cell receptors. MHC & HLA-Types, structure and properties. Organization of MHC genes. MHC-Multiple allelism disease Susceptibility, linkage and disequilibrium. Antigen processing and presentation. Cell mediated immune responses. Regulation of immune response.

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

- Understand the ontogeny of T cell
- Evaluate the significance of MHC in antigen processing and presentation

SEMESTER – IV

UNIT-IV

Complement system - Classical, alternate and mannose binding lectin pathways, biological functions and regulation. Cytokines and receptors-Properties, biological functions and signalling pathways. Inflammation-Mechanism of inflammatory response, Inflammasome activation.

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

- Appreciate the biological functions of cytokines
- Understand the importance of complement system and their regulation

UNIT-V

Immunological techniques: principles of antigen and antibody interactions - Affinity, Avidity, Antibody valency, agglutination, precipitation. Gel diffusion methods - Single and double immunodiffusion. Complement fixation test. ELISA. ELISPOT. Immunoelectrophoresis. Western blot. RIA. FACS. Immunostaining.

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

- Learn different immunological techniques
- Realize the importance of antigen and antibody interactions and techniques involved for their identification

Course Outcomes: On completion of this course, students will be able to

• Provide sequential and conceptual thinking and paradigms of cellular and molecular basis of immune system and their applications

• Evaluate the usefulness of immunology in different fields like medicine, industry…etc.,

• Apply their knowledge and design molecular diagnostic kits for detection of diseases.

RECOMMENDED BOOKS:

1. Immunology a short course by E Benjamin & S Leskowitz, Wiley Liss NY.
2. Fundamental Immunology by WE Paul, 4th Edition, Garland Science publishers.
3. Immunology by Roitt et al., 8th Edition, Elsevier.
4. Immunology by Kuby et al., 5th Edition, WH Freeman and Co.
5. Principles of Microbiology and Immunology by Davis et al., Harper International Publishers.
6. Immunology-understanding of immune system by Klans D Elgret, Wiley-Liss Publishers, NY.
7. Cellular and Molecular Immunology by AK Abbas & AH Lichtman, 9th Edition, Elsevier.

SEMESTER – IV

SBH 208: BIOPROCESS ENGINEERING

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: The significance of this course is to provide students with sound theoretical knowledge and principles relevant to Bioprocess Engineering. As per the course content, one can understand the diversity of microorganisms and search for strains from the natural environment, which are able to produce novel or unusual products of high commercial value. The main task of the industrial biotechnologist is to develop procedures for obtaining new microbial metabolites by rapid and reliable isolation and screening procedures. Understanding various principles of fermentation processes, selection of media, reactor designs, scale-up and downstream processing is primary and essential in large-scale production of various biologically active principles or products. At the outset, the learner can understand about the process and product development having market viability using microorganisms and able to excel in research or in industrial arena.

Course Objectives:

1. To educate students about the fundamental concepts of bioprocess engineering and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.
2. To develop skills about the screening and maintenance of industrially useful microorganisms, the sterilization kinetics, fermentation processes, reactor design, product development and recovery.
3. To improve the base knowledge and to bring awareness on various industrial processes.

UNIT-I

Isolation, screening: primary and secondary screening of microorganisms and preservation of microbes, Strain improvement by mutations (Physical and Chemical methods). Media for industrial fermentation, sterilization of air and media.

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

- Isolate and screen the microorganisms from the soil, air or water and preserve the selected strains.
- Improve the wild strains at genetic level to make industrial applications
- Acquire knowledge about the various media used for industrial processes for large scale production of the products using microorganisms

UNIT-II

Types of fermentation process-batch, fed batch and continuous cultures. Bioreactors-design, parts and their functions. Types of Bioreactors-airlift, packed bed, fluidized and photo bioreactors, tower fermenter, continuous stirred tank bioreactor.

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

- Know the various types of fermentation process and understand the basic principles of batch, fed batch and continuous process.
- Carry out stoichiometric calculations and specify models of microbial growth.
- Gain knowledge about the design parameters and operations of the bioreactors.

UNIT-III

Single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (KLa) determination, factors depending on scale up principle and different methods of scaling up.

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

- Carry out stoichiometric calculations and specify models of microbial growth.

SEMESTER – IV

UNIT-IV

Industrial production of vitamins (Vitamin B_{12} and Riboflavin), Amino acids (lysine, glutamic acid) organic acids (citric acid, acetic acid), alcoholic beverages (beer and wine), organic solvents (ethanol, acetone, butanol), antibiotics (penicillin, streptomycin). Production of single cell proteins.

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

- Give an account of important microbial / industrial processes in beverage, pharma, food and nutraceutical industry
- Present unit operations together with the fundamental principles for basic methods in production technique for bio-based products.

UNIT-V

Downstream processing: solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra-centrifugation, liquid extraction, ion-exchange recovery of biological products. Isolation and Purification of proteins.

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

- Be familiar with different methodologies involved in the downstream processing in removing the microbial cells and solid matter from the fermentation broth and finishing of product purification.
- Understand the significance of operations during product recovery under *In-situ* and *Ex-situ* conditions.

Course Outcomes: On completion of this course the students will be able to

- Appreciate relevance of microorganisms from industrial context
- Carry out stoichiometric calculations and specify models of their growth
- Give an account of design and operations of various fermenters
- Calculate yield and production rates in a biological production process, and also interpret data

RECOMMENDED BOOKS:

1. Principle of fermentation technology by Stanbury, 2nd Edition, Elsevier.
2. Industrial Biotechnology by Creuger & Creuger, 2nd Edition, Panima publishers.
3. Industrial Microbiology: An Introduction by MJ Waites *et al.*, 1stEditon, Blackwell Science Ltd.
4. Modern Industrial Microbiology and Biotechnology by Nduka Okafor & BC Okeke, 2nd Edition, CRC Publishers.
5. Biochemical engineering fundamentals by Bailey & Ollis, 2nd Edition, Intl. Pub.
6. Molecular Biotechnology: Principles and applications of recombinant DNA technology by BR Glick, JJ Pasternak & CL Patten, 4th Edition, ASM Press.

SEMESTER – IV

SBH 210: MOLECULAR DIAGNOSTICS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: The course helps in knowing the collection of techniques used to analyze biological markers in the genome and proteome. The course also signifies on how the cells express their genes as proteins, applying molecular biology techniques to medical testing tools alias molecular diagnostic tools.

Course objectives:

1. To demonstrate students about the traditional disease diagnosis and history of diagnostic tools and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.
2. To improve the base knowledge and to bring awareness on various traditional methods for the diagnosis of genetic and metabolic disorders.
3. To develop fundamental concepts on molecular oncology and intricate mechanisms involved in it

UNIT- I

Introduction and History of diagnostics, Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples, Interpretation of results.

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

- Understand the genetic basis of diseases and related metabolic errors
- Develop skills in the collection, processing analysis of samples

UNIT- II

Traditional disease diagnosis methods and tools - diagnosis of infection caused by bacteria. *Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium.*Diagnosis of fungal infections. Major fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. Diagnosis of DNA and RNA viruses- Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and · Retroviruses.Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis.

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

- Distinguish the traditional diagnostic methods for identification of bacteria and fungi
- Develop skills in identification of viruses and protozoans using various diagnostic tools

UNIT -III

Traditional methods for the diagnosis of genetic disorders. Diseases due to genetic disorders - Identifying human disease genes. Methods available for the diagnosis of genetic diseases Sickle cell anaemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis, Down syndrome and Sex – linked inherited disorders.· Neonatal and Prenatal disease diagnostics.

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

- Differentiate the traditional diagnostic methods for identification of genetic disorders

UNIT -IV

Traditional methods for the diagnosis of metabolic disorders. Blood - formation, composition, function and pathology of blood disorders. Haemoglobinopathies, Muscle disorders (Duchene muscular dystrophy-DMD, Becker's Muscular Dystrophy-BMD, spinal muscular atrophy-SMA),

Bone disorders (Osteogenesis imperfecta, Rheumatoid arthritis), Skin disorder (Albinism), Eye disorder (Retinitis pigmentosa).

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

- Segregate the traditional diagnostic methods for identification of metabolic disorders

UNIT –V

Molecular Oncology. Cancer- Diagnosis of different types of cancers. Detection of recognized genetic aberrations in clinical samples from cancer patients; Gene and chromosomal mutations in solid tumors, microsatellite instability and loss of heterozygosity. Molecular markers in haematological malignancies.

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

- Distinguish various diagnosis methods for various types of cancers
- Understand the mutations and markers in these malignancies

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

- Understand various facets of molecular procedures and basics of molecular diagnostics
- Evaluate the therapeutics that could be employed in early diagnosis and prognosis of human diseases
- Distinguish various diagnosis methods for various types of diseases

RECOMMENDED BOOKS:

1. Glick, BR., Pasternak, JJ., & Patten, C.L. (2010). Molecular biotechnology: Principles and Applications of recombinant DNA. Washington, DC: ASM Press.
2. Coleman, WB., & Tsongalis GJ (2010). Molecular Diagnostics: for the clinical laboratorian. Totowa, NJ: Humana Press.
3. Campbell, AM & Heyear LJ (2006). Discovering Genomics, Proteomics and Bioinformatics. San Francisco: Benjamin Cummings.

SEMESTER – IV

MBA 201: FUNDAMENTALS OF ENTREPRENEURSHIP

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: Entrepreneurship is an essential element for economic progress as it manifests its fundamental importance in different ways: • By identifying, assessing, and exploiting business opportunities • By creating new firms and renewing existing ones by making them more dynamic • By driving the economy forward – through innovation, competence, job creation- and by generally improving the well-being of society

Course Objectives: This course aims to enable the students to understand the fundamentals of entrepreneurship and the entrepreneurial process, including identifying customers' problems, sources, and viability of ideas to convert them into a product/service. Students can:

- Understand Entrepreneurship and its role in society.
- Know the evolution of Entrepreneurship.
- Understand the mindset of entrepreneurs.
- Gain knowledge about business Idea Generation
- Apprehend about EDP Programmes

UNIT-I

Entrepreneur and Entrepreneurship – Description and definition of entrepreneur – Characteristics of entrepreneur – Functions of an entrepreneur – types of entrepreneurs – concept of entrepreneurship – entrepreneurial culture – entrepreneurial process – entrepreneurial competencies – entrepreneurial mobility.

UNIT-II

Evolution of Entrepreneurship**:** Genesis of entrepreneur and entrepreneurship - Theories of Entrepreneurship – Role of entrepreneurship in economic development – Barriers of entrepreneurship - Entrepreneurship and current business environment

UNIT-III

Entrepreneurial Mindset**:** Entrepreneurial Motives, Motivating factors of entrepreneurship - Growth of entrepreneurship in India – Agricultural Entrepreneurship to Industry entrepreneurship to Services entrepreneurship – corporate entrepreneurship – women entrepreneurship.

UNIT-IV

Business Idea generation**:** Sourcing of business ideas, innovative ideas, opportunity identification, scanning of the environment - finding the gaps for new business and new way of business - setting-up new ventures - acquiring existing business – franchising and Entrepreneurship.

UNIT-V

Entrepreneurship Development Programmes**:** Need and objectives of EDP – Evolution of EDPs – Phases of EDPs – Course content and curriculum of EDPs – Management Education centers and Entrepreneurship Development Programmes.

SEMESTER – IV

Course Outcomes: On successful completion of this course, students will be able to

- Familiarize the nature of entrepreneurship and the functions of an entrepreneur.
- Acquaint the student's understanding of the evolution of Entrepreneurship.
- Discover the entrepreneurial motives to become an entrepreneur
- Describe the step-by-step procedure in developing a business idea
- Examine the Entrepreneurship Development Programs of various institutions in India

RECOMMENDED BOOKS:

1. Bill Bolton, John Thompson (2014), Entrepreneurs: Talent, Temperament and Opportunity, Routledge 3rd Ed.
2. Arya Kumar (2014), Entrepreneurship: Creating and Leading an Entrepreneurial Organization, New Delhi: Pearson Publications.
3. S.Anil Kumar & S.C Purnima (2014), Entrepreneurship Development, New Delhi: New Age Publishers.
4. A Shay and V Sharma (2012), Entrepreneurship and New Venture Creation, New Delhi: Excel Books.
5. Vasant Desai (2012), Dynamics of Entreprenurial Development and Management, New Delhi: Himalaya Publishing House.
6. Poornima M. Charantimath (2012), Entrepreneurship Development – Small Business Enterprises, New Delhi:Pearson

SEMESTER – IV

SBH 212: RESEARCH METHODOLOGY

Hours per week: 02 **End examination: 00 Marks**
Credits: 02 **Sessional: 100 Marks**

Preamble: This course enables the students to learn about the specific procedures or techniques used to identify, select, process, and analyze information about a research topic. This course will make students to incline towards research and understand the importance of the methodology section to critically evaluate a study's overall validity and reliability**.**

Course Objectives:

1. To demonstrate students the fundamental concepts, components and various methods of research
2. To learn various methods, styles and formats of writing research articles
3. To improve the knowledge and bring awareness on research ethics and several indices related to scientific journals

UNIT-I

Fundamental concepts of Research. Research- meaning, characteristics and objectives. Types of research. Different methods of Research: Experimental, Descriptive, Historical, Qualitative and Quantitative methods.

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

- Understand the fundamental concept of research
- Distinguish various methods of research

UNIT-II

Components of research- Identification, design and & formulation of research problem. Hypothesis -Null Hypothesis & Alternative Hypothesis. Hypothesis Testing.

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

- Understand the components of research
- Distinguish various hypothesis related to research

UNIT-III

Scientific communication-formats of writing research articles. Methods and styles of referencing. Research Ethics. Plagiarism. Impact factor and other indices of articles and journals of scientific communication.

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

- Appreciate the various formats of scientific communication
- Differentiate various methods and styles of referencing
- Discriminate several indices related to articles and journals

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

• Understand history and methodologies of scientific research, applying these to recent published papers
• Understand and practice scientific reading, writing and presentations
• Appreciate scientific ethics through case studies

RECOMMENDED BOOKS:

1. Research Methodology : Methods And Techniques (Multi Colour Edition) by C.R. Kothari and Gaurav Garg
2. Research Methodology: A Step by Step Guide for Beginners by KUMAR
3. Research methodology & medical statistics
4. Research Methodology by Panneerselvam R

SEMESTER – IV

SBH 214: MOLECULAR BIOLOGY LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Course Objective: This course would familiarize students with facile molecular techniques involved in isolation and estimation of genetic material for achieving the desired goal.

1. Isolation of Prokaryotic genomic DNA from bacteria.
2. Isolation of Eukaryotic genomic DNA (Plant / animal).
3. Agarose gel electrophoresis
4. Estimation of DNA using Diphenylamine reagent by spectrophotometry
5. DNA Denaturation and Hyperchromic effect.
6. Isolation of RNA from yeast.
7. Estimation of RNA using Orcinol reagent by spectrophotometry.

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

- Apply landmark discoveries in developing several facile molecular techniques used in rDNA technology.
- Isolate and estimate DNA and RNA from prokaryote and eukaryotes
- Know the importance of hyperchromic shift

RECOMMENDED BOOKS:

1. Molecular Cloning: A laboratory manual by Gren & Sambrook, 4th Edition, CSHL Press.
2. Laboratory manual in Biochemistry by J Jayaraman, 2nd Edition, Wiley Eastern limited.
3. Biochemistry - A laboratory courses by JM Beckar, 2nd Edition, Academic Press.

SEMESTER – IV

SBH 216: GENETIC ENGINEERING LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Course Objective: This course would familiarize students with facile molecular techniques involved in isolation and manipulation of genetic material for achieving the desired goal.

1. Plasmid DNA isolation and DNA quantitation
2. Restriction Enzyme digestion of plasmid DNA
3. Polymerase Chain Reaction and analysis by agarose gel electrophoresis
4. Vector and Insert Ligation
5. Preparation of competent cells
6. Transformation of *E.coli* with standard plasmids, Calculation of transformation efficiency
7. Confirmation of the insert by Colony PCR

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

- Understand the extraordinary power of restriction and other enzymes in molecular cloning and genetic manipulations.
- Perform transformation and cloning of gene (s) for basic and applied research.
- Gain hands-on training in various molecular techniques for gene manipulation

RECOMMENDED BOOKS:

1. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

SEMESTER – IV

SBH 218: IMMUNOLOGY LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Preamble: The course deals with the immune system which is a very important branch of medicine and biological sciences. Immunological cells and immuno-active molecules are significant in protecting from infection through various lines of defense. The non-functioning of immune system leads to various serious disorders and diseases. This course enables the learner to be acquainted with laboratory skills in assaying, quantifying various enzymes and immunological molecules.

Course objectives:

- To train students in the practical aspects immunology so that they can perform quantification and assay procedures.
- To make students gain expertise in conducting various diagnostic tests.

1. Identification of human blood groups.
2. Total Leukocyte Count of the given blood sample.
3. Differential Leukocyte Count of the given blood sample.
4. Separation of serum from the blood sample (demonstration).
5. VDRL and WIDAL tests
6. Immunodiffusion by Ouchterlony method.
7. ELISA
8. Immunoelectrophoresis

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

- Gain hands-on experience in conducting various enzyme assays and analysis
- Conduct diagnostic experiments in identifying the cause of various diseases or disorders
- Understand the response of immune system in different pathological conditions and about different techniques based on antigen and antibody interactions

RECOMMENDED BOOKS:

1. Immunology methods manual - The comprehensive source book by Lefkowitz. I
2. Manual of clinical laboratory immunology by Rose NR.
3. The experimental foundations of modern immunology by Clark W.R.

SEMESTER – IV
SBH 220: INDUSTRIAL VISIT

Credits: 02 **Evaluation : 50 Marks**

Industrial visit is conducted for the students with the objective of providing an opportunity to combine theoretical knowledge with industrial scale application. Industrial visit provides student a practical perspective on the large-scale view beyond academics.

The student should submit a comprehensive report after the visit based on the observations, processes and methods learned during the visit relevant to the subject.

SEMESTER V

SBH 301: PLANT AND ANIMAL BIOTECHNOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: This course will develop the graduate capabilities of knowledge ability, comprehension and applications of plants in cell and tissue culture systems, and how cell and tissue culture contribute to global sustainability. It will also develop the practical skills and confidence of students to successfully culture plant cells and tissues.

Course Objectives: The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.

UNIT-I

Phytohormones, types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropropagation: advantages and disadvantages. Organogenesis and somatic embryogenesis.*In vitro* haploid production: Androgenic and Gynogenic methods. Transgenic plants:
Production methods and its applications.

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

- Learn plant tissue culture methods and usage purposes,
- Have knowledge about tissue culture methods used in plant breeding.

UNIT-II

Protoplast Isolation and fusion methods somatic hybridization, identification and selection of hybrid cells and its limitations. Cybrids, Somaclonal variations. Plant growth promoting bacteria, Nitrogen fixation.

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

- Learn protoplast isolation and somatic hybridization
- Have knowledge about hybrids, cybrids and somaclonal variations used in plant breeding.

UNIT-III

Basic techniques of animal cell and tissue culture. Different types of animal cell culture media Natural, synthetic media, cryopreservation of cells, applications of cell culture. Stem cells: Properties, types and applications.

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

- Successfully maintain cultures of animal cells and established cell lines with good viability
- Learn different types of cell culture media
- Understand the properties and types of stem cells along with its applications

UNIT-IV

Causes of infertility in male and females. super ovulation, embryo transfer. *In vitro* Fertilization methodology, Artificial insemination, Immuno contraception.

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

- Gain greater appreciation of the biological processes of mammalian reproduction that are relevant to the manipulation of fertility and the treatment of reproductive disease.
- Learn various invitro fertilization methods

UNIT-V

Production of transgenic animals -by microinjection, retroviral, vector method and embryonic stem cell method. Animal cloning – methodologies and its applications. Gene Therapy-Ex vivo and In vivo gene therapy.

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

- Gain knowledge about recent advances in animal reproduction and
- acquire exposure to application of reproductive biotechniques and technologies in livestock.

Course Outcomes: On completion of this course, students should be able to

- Benefit with fundamental knowledge in plant and animal biotechnology and their applications
- Utilize the principles, practices and application of plant and animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation, and molecular breeding of plants and animals in numerous areas.

RECOMMENDED BOOKS:

1. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications by R. Ian Freshney
2. Molecular Biotechnology by Glick.
3. Gene cloning and DNA analysis an introduction by T.A. Brown (Blackwell).
4. Biotechnology by U.Satyanarayana.
5. Biotechnology by B.D.Singh (Kalyani).
6. Plant Tissue Culture and Practice.by Bhojwani, S.S. and Razdan
7. Plant Biotechnology: The Genetic Manipulation of Plants, by Slater, A., Scott, N.W. & Fowler, M.R.
8. In Vitro Fertilization: The A.R.T. of Making Babies (Assisted Reproductive Technology) (2013) by Geoffrey Sher, Virginia Marriage Davis, Jean Stoess
9. In-Vitro Fertilization 3rd Edition (2011), by Kay Elder, Yves Ménézo, Joyce Harper, John Huntriss

SBH 303: GENOMICS AND PROTEOMICS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: The course enables the students to **s**tudy genome, including function and interaction of all the genes of an organism which is known as genomics. Proteomics is study of the entire protein complement of an organism, under a given set of conditions. The proteomic studies rely on tools that entail understanding the biochemistry of proteins and the pathways in which these proteins participate to bring about a well-orchestrated and harmonious functioning of a given cell or organism in consideration

Course Objectives: The objective of this course is to provide introductory knowledge concerning genomics, proteomics and their applications.

UNIT-I

Brief overview of prokaryotic and eukaryotic genome organization, extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.

UNIT-II

Genetic and physical maps, markers for genetic mapping, methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, hybridization techniques: northern, southern, south-western and far-western hybridization, fluorescence in situ hybridization, somatic cell hybridization, radiation hybrid maps, comparative gene mapping.

UNIT-III

Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web. Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs.

UNIT-IV

Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function- forward and reverse genetics, gene ethics.

UNIT-V

Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases, Study of protein-DNA interactions: electrophoretic mobility shift assay, DNase footprinting, methyl interference assay, chromatin immunoprecipitation, Protein chips and functional proteomics, Clinical and biomedical applications of proteomics.

Course Outcomes: By the end of the course students should be able to

- acquire knowledge and understanding of fundamentals of genomics and proteomics,
- develop knowledge about transcriptomics and metabolomics
- explain the applications all the “omics” studies in various applied areas of biology

RECOMMENDED BOOKS:

1. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
2. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.
3. Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.

SEMESTER – V

SBH 305: DEVELOPMENTAL BIOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: The developmental biology course helps the student to study the process by which animals and plants grow and develop. It also encompasses the biology of regeneration, asexual reproduction, metamorphosis, and the growth and differentiation of stem cells in the adult organism**.**

Course Objectives: The objective of this course is to make the students

- Learn how a single cell, develop into an embryo, grow, into an adult, sexually matures, and ages.
- Get a conceptual overview of how developmental patterns arise using examples from different model systems and highlighting regulatory networks involved in these processes.
- Discuss the essential aspects of developmental biology, their usage for therapeutic purposes and social implications associated with this modern technology

UNIT I

Introduction on developmental Biology- Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II

Developmental stages- zygote, blastula, gastrula, neurula: Definition, Process, types & mechanisms of Cleavage, Blastulation and Gastrulation. Morphogenetic movements– epiboly, emboly,extension, invagination, convergence, de-lamination.

UNIT III

Cell fate & commitment – potency- concept of embryonic stem cells, terminal differentiation, lineages of three germ layers, Fate Maps in early embryos. Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation.

UNIT IV

Control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT V

Neurulation, notogenesis, development of vertebrate eye. Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals. Model organisms in Developmental biology.

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

• Understand major stages in developmental biology

• Familiarize with experimental approaches, and how they are applied to specific problems in developmental biology

• control the differentiation patterns at various levels in developmental biology.

RECOMMENDED BOOKS:

1. Gilbert, S. F. Developmental Biology, XI Edition, Sinauer Associates, Inc.,
2. Lawrence Gilbert : Metamorphosis: A Problem in Developmental Biology. Springer Pubs
3. Balinsky, B.I. An introduction to Embryology, International Thomson Computer Press.
4. Kalthoff . Analysis of Biological Development, II Edition, McGraw-Hill Professional
5. Essential Developmental Biology by Jonathan Slack
6. Developmental Biology, Werner A Muller
7. Principles of Development - Lewis Wolpert

SEMESTER – V

SEM 241: ENVIRONMENTAL BIOTECHNOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Course Objectives: The course is designed to teach students the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments and to generate valuable resources for the human society.

UNIT-I

Environmental Biotechnology: Definition, Scope and role of Biotechnology in Environment Protection, Current Status of Biotechnology in Environment Protection, Future. Biotechnology for air pollution abatement and odor control: Deodorization process - bioscrubbers, biobeds, Biotrickling filters.

UNIT-II

Bioreactors for Waste –Water Treatment: Biological processes for Industrial treatment - Aerobic biological Treatments (Activated sludge process, biological filters, Rotating Biological Contactors (RBC), Anaerobic Biological treatment: Contact Digesters, Packed column reactors, Upflow Anaerobic Sludge Reactor (UASB).

UNIT – III

Biofertilizers: Use of microbes as biofertilizers and bioinsecticides to improve productivity and crop protection. Biopesticides: Bacterial (Bt pesticides), fungal (Trichoderma). Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, Algal and fungal biofertilizers (VAM). Eutrophication.

UNIT-IV

Bioremediation: Definition, need and scope of bioremediation: types of bioremediation. Environmental applications of bioremediation, Bioremediation of soil and water contaminated with oil spills, heavy metals and pesticides by soil microorganisms. Phytoremediation.-Biotechnology in cleaning up the environment by plants. Phytoremediation of heavy metal contaminated soils.

UNIT – V

Biomass based energy: Role of microbes in energy production, biogas production (Methanogenic bacteria), microbial hydrogen production, ethyl alcohol production from sugarcane and single cell protein (SCP).

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

- Gain knowledge on the scope, role and current status of environmental biotechnology.
- Know the types of biological processes for industrial treatment and the role of microbes as biofertilizers and biopesticides.
- Explain the processes and types of bioremediation, phytoremediation and role of biotechnology in production of energy**.**

RECOMMENDED BOOKS:

1. Introduction to Environmental Biotechnology by A.K. Chattarji, 2nd Edition, Prentice Hall Publishers.
2. Environmental Biotechnology – Principles and Applications by Bruce E Rittman, Perry. L. Mc. Carty, Mc Graw Hill Publishers.
3. Microbial Ecology by Ronald. A. Atlas Environmental Biotechnology, SVS Rama, Rastogi Publications.

SEMESTER – V

SBH 307: PHYSIOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

UNIT-I

Preamble: An understanding of the functional biology of plants, animals and the mechanisms that shape and modify fundamental importance for all biological activities in relation to changing environments.

Course Objectives: The objectives of this course are to understand basic principles of important physiological processes in plants (water relations, photosynthesis and to study functions of plant growth regulators in crop production) and humans (Circulatory, nervous and gastrointestinal system).

UNIT-I

Plant Physiology-Photosynthesis-Light phase reactions. Cyclic and Non-cyclic Photophosphorylations. Z scheme of Photosynthesis. Chloroplast organization. Photosystems, Energy transfer and Pigments involved in photosynthesis. Calvin cycle. CO2 fixation in C3, C4 and CAM plants. Environmental impact on photosynthesis.

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

- Explain the inextricable link between energy gain and water loss in land plants
- Distinguish different phases during photosynthesis

UNIT-II

Plant Physiology -Plant and water relations. Water potential, Photorespiration: respiration complexes, structure, function, mechanism, and regulation; cyanide resistant respiration. Plant hormones: biosynthesis, transport, regulation, and applications.

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

- Explain plant responses to environmental stimuli.
- Define hormone and explain its in general role as a signal transducer

UNIT-III

Human physiology-Composition of blood, coagulation of blood and fibrinolysis. Circulatory systems: electrical and mechanical properties of myogenic and neurogenic hearts, heart cycle, neural control of cardiovascular system. Physiology of respiration. respiratory pigments, transportof gases in blood, regulation of body pH, respiratory response to extreme conditions like hypoxia, diving and exercise.

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

- Understand the interrelationship between structure and function of each of the cardiovascular and respiratory systems
- Explain how these two systems contribute to homeostasis.

UNIT-IV

Human physiology- Structure of nerve cell, origin of membrane potential, mechanism of propagation of nerve impulse in nerve fibres. Neurotransmitters. Structure and organization of muscle cells. Biochemical changes associated with muscle contraction and relaxation.

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

- Recognize and describe the main components of the nervous systems, musculoskeletal system
- Demonstrate knowledge of how they contribute to the maintenance of homeostasis.

UNIT-V

Human physiology- Gastrointestinal system: Structure and functions of digestive glands - salivary glands, pancreas, liver, gastric and intestinal wall gland. Regulation of secretion of digestive juices. Digestion and absorption of food nutrients in different parts of the alimentary canal. Excretory system- Structure and functions of kidney. The nephron and its functions, the mechanism of urine formation and its concentration. The counter current theory, electrolyte balance, acid-base balance.

SEMESTER – V

SBH 307: PHYSIOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

UNIT-I

Regulation of renal functions.

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

- Recognize and describe the main components of the digestive and renal systems
- Demonstrate knowledge of how they contribute to the maintenance of homeostasis.
- Understand how the excretion of nitrogenous wastes is linked to the regulation of water and salt balance in animals

Course Outcomes: On completion of this course, students will be able to

- Acquire knowledge on important physiological processes in plants
- Explain the role of nutrients and growth regulators in growth and development besides the crop's response to various abiotic stresses.
- Describe the main components of the nervous systems and musculoskeletal system
- Understand how the excretion of nitrogenous wastes is linked to the regulation of water and salt balance in animals

RECOMMENDED BOOKS:

1. Introductory Plant Physiology by GR Noggle & GJ Fritz, 2nd Edition, PHI learning Pvt. Ltd., New Delhi.
2. Plant physiology and development by L.Taiz & E.Zeiger, 6th Edition, Sinauer Associates Inc.
2. Text book of Medical Physiology by AG Guyton & JE Hall, 11th Edition, Harcourt, Asia.
3. Essentials of Medical Physiology 8th Edition by Sembulingam
4. Ross and Wilson Anatomy and Physiology in Health and Illness International Edition by Anne Waugh & Allison Grant, 12th Edition.
5. Text book of Medical Biochemistry by M.N.Chaterjee & Rana Shinde, Jaypee.
6. Harper's Biochemistry by RK Murray *et.al.*, 30th Edition, McGraw-Hill Lange Publishers.

SEMESTER – V

SBH 309: DRUG DESIGNING

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

UNIT-I

Preamble: This course enables the student to learn about the inventive process of finding new medications based on the knowledge of a biological target. The drug activates or inhibits the function of a biomolecule, which in turn results in a therapeutic benefit to the patient. The designing involves prediction of binding affinity, bioavailability, metabolic half-life, side effects, etc., that should be optimized before a ligand can become a safe and efficacious drug.

Course Objectives:

- This course will give a broad overview of research and development carried out in industrial setup towards drug design and development.
- The objective of the course is to teach various approaches in making a lead molecule into a suitable drug and release into the market.

UNIT - I

Introduction to Drug Discovery and Development. Source of Drugs, Structural effects on drug action. Approaches to New Drug Discovery: Drugs Derived from Natural Products, Existing Drugs as a Source for New Drug Discovery, Screening for New Drug Leads, Modern "Rational Approach"to Drug Design.

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

- Comprehend drug discovery cycle and identify various sources of lead compounds.
- Classify the drugs and know various routes of directing the drugs to destined places in the human body.

UNIT-II

Approaches to Lead Optimization: Bioisosteric replacement, Conformation restriction, Homolgation of alkyl chain(s) or alteration of chain branching, design of aromatic ring position isomers, and alteration of ring size, Alteration of stereochemistry, or design of geometric isomers orstereo isomers, Design of fragments of the lead molecule that contain the pharmacophoric group, Alteration of interatomic distances within the pharmacophoric group or in other parts of the molecule.

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

- Identify the lead compounds through various *insilico*, *invivo* and *invitro* approaches.
- Encapsulate the design patterns of lead molecules and their groups.

UNIT-III

Enzymes as Targets of Drug Design: Enzyme kinetics, Enzyme inhibition and activation, Approaches to the Rational Design of Enzyme Inhibitors. Receptors as Targets of Drug Design: Receptor Theory, Receptor Complexes and Allosteric Modulators, Second and Third Messenger Systems, Molecular Biology of Receptors, Receptor Models and Nomenclature, Receptor Binding Assays. Lead Compound Discovery of Receptor agonists and antagonists

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

- Identify the drug targets through various *insilico*, *invivo* and *invitro* approaches.
- Summarize the expression patterns of drug targets through expression profiling techniques.

UNIT-IV

Prodrug Design and Applications: Definition, Applications, Prodrug Design Considerations, Prodrug

SEMESTER – V

SBH 309: DRUG DESIGNING

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

UNIT-I

Forms of Various Functional Groups. Drug release and activation mechanisms- Simple one-step activation, Cascade release/activation systems. Prodrugs and intellectual property rights

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

- Create the prodrugs using tools understand its release mechanism
- Understand different systems related to prodrugs and property rights related to them.

UNIT-V

Combinatorial Chemistry: Introduction-Concepts and Terms, Solid-phase Strategies, Solution Phase Strategies. Computer-Aided Drug Design: Docking and virtual screening, Molecular Dynamics and binding free energy methods

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

- Design the drugs using *insilico* tools by the knowledge gained
- Dock drug to its target and validate its efficacy.

Course Outcomes: On completion of this course, the students will be able to

- Develop an understanding of the basic theory of drug designing
- Comprehend drug discovery cycle and identify various sources of lead compounds
- Identify the lead compounds through various *insilico*, *invivo* and *invitro* approaches
- Critically analyze and interpret results of their study with respect to whole systems.

RECOMMENDED BOOKS:

1. Kerns, E.H.; Di, L. Drug-Like Properties: Concepts, Structure Design and Methods: from ADME to Toxicity Optimization, Academic Press, Oxford, 2008
2. Burger's Medicinal Chemistry and Drug Discovery, 6th Edition, Vol. 1. Principles and Practice, edited by M. E. Wolff, John Wiley & Sons: New York, 2003.
3. Principles of Medicinal Chemistry, 7th Edition, edited by T.L. Lemke, D. A. Williams, V. F. Roche, and S.W. Zito, Williams and Wilkins: Philadelphia, 2013.

SEMESTER – V

SBH 311: PLANT AND ANIMAL BIOTECHNOLOGY LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Preamble: The science of plant and animal biotechnology has tremendous potential for application in agriculture and medicine. The linkage between basic and applied research and new discoveries and innovations can find direct applications in agriculture and human health

Course Objectives: The objectives of this course are to provide hands-on training in basic experiments of plant and animal biotechnology.

1. Preparation of simple growth nutrient (Knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. Sterilization and preparation of various explants for plant tissue culture.
4. To demonstrate various steps of Micropropagation.
5. Isolation of protoplasts from Leaf.
6. Preparation of animal cell culture media
7. Preparation of suspension cultures from animal tissue
8. Enumeration of cells in culture by haemocytometer
9. Preparation of glycerol stocks

Course Outcomes: On completion of course, students will be able to

- Prepare different types of media for growth of plant and animal tissues
- Gain basic skills in plant and animal biotechnology.

RECOMMENDED BOOKS:

1. Plant cell culture - A practical approach by Dixion RA.
2. Plant tissue culture - Theory and practice by Bhojwani, S.S.
3. Biotechnology: A laboratory course by Becker, J.M.
4. Animal cell culture - A practical approach Ed. By John R.W. Masters (IRL Press).
5. Animal cell culture techniques, Ed. Martin Clyenes (Springer).
6. Culture of Animal cells; A manual of Basic techniques by R. Ian Freshney

SEMESTER – V

SBH 313: GENOMICS AND PROTEOMICS LAB

Hours per week: 04 **End examination: 40 Marks**
Credits: 02 **Sessional: 60 Marks**

Course Objectives: The objective of this course is to make the students learn about various techniques involved for isolation and purification of genome and proteome. It also enables them to design primers, clone the gene and analyze the recombinants. The course also equips the students to analyze and interpret microarray and 2D PAGE data.

1. Principles and Methods involved in nucleic acid separation
2. Designing Primers - Gene specific primers – primers based on conserved regions – Degenerate primers
3. Gene cloning – ligation and transformation - analysis of recombinant colonies
4. Molecular analysis of transgenic plants
5. RT-PCR – semi-quantitative
6. Microarray – data analysis and interpretation
7. 2D PAGE – data analysis and interpretation
8. Genome databases – any one each from bacterial, viral, fungal, plant and animal species.

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

- Acquire knowledge on designing primers and gene cloning techniques
- Analyze the data in genome databases of various organisms
- Evaluate the recombinant colonies

RECOMMENDED BOOKS:

1. Brownstein MJ and Khodursky AB. (2003). Methods in Molecular Biology. Vol. 224. Functional Genomics: Methods and Protocols. Humana Press Inc., Totowa, NJ, USA.
2. Baldi P. (2002). DNA Microarrays and Gene Expression. Cambridge University Press
3. Primrose. S. B. and Twyman. R. (2004). Principles of Genome Analysis and Genomics. Third edition University of York. 288p.
4. Grotewold E. (2003). Methods in Molecular Biology. Vol. 236. Plant Functional Genomics: Humana Press Inc., Totowa, NJ, USA.
5. Proteins and Proteomics: A Laboratory Manual https://sjfjrcheaphub.files.wordpress.com/2017/03/proteins-and-proteomics-a.pdf

SEMESTER – V

SBH 315: DISSERTATION BASED ON LITERATURE REVIEW

Credits: 06 **End Evaluation: 100 Marks**

At the end of VI semester, the student should submit a dissertation on the topic assigned to him/her. The project work should be prepared basing on the review of literature from all available resources like books, research and review articles of peer reviewed journals of high repute and online resources accessible and should give a presentation on that research work.

SEMESTER – VI

SBH 302: MEDICAL BIOTECHNOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: This course deals about different methodologies involved in the production of various health care products and helps us to understand about the process of tissue engineering. This course enlightens on hybridoma technology and basic and new generation strategies to design vaccines and specific attempts to prepare vaccines against some of the diseases challenging mankind and discusses the application of various molecular probes.

Course objectives:

1. This course helps us to understand about the production and applications of health care products and Hybridomas.
2. Gives a view on the design of vaccines and problems associated with the development of vaccines against some of the diseases.
3. This course critically examines the production of health care products and the mechanism of gene therapy
4. Gives an overview of physiology of reproductive systems and variousmethodologies developed for invitro fertilization

UNIT-I

Vaccines: Active and Passive Immunization, Designing Vaccines for Active Immunization, Whole-Organism Vaccines, Purified Macromolecule Vaccines, Recombinant-Vector Vaccines, DNA Vaccines, Multivalent Subunit Vaccines. Edible vaccine, RNA vaccine, Strategies for development of vaccines against HIV and Malaria.

Learning Outcomes: Student will be able to

- Can describe about strategies to design various vaccines and explain about the challenges faced in the design of vaccines against malaria and HIV

UNIT-II

Hybridoma technology - Production and applications of monoclonal antibodies. Antibody engineering, chimeric antibodies. DNA in the diagnosis of diseases, Disease diagnosis using Enzyme probes. DNA fingerprinting and DNA profiling and application in forensic medicine.

Learning Outcomes: Student will be able to

- Understand about the production and application of hybridomas
- Understand about the applications of DNA and enzyme probes and forensic medicine

UNIT-III

Production of recombinant health care products - Insulin, growth hormone, factor VIII, tissue plasminogen activator, Urokinase, interferons, lymphokines and Hepatitis-B vaccine. Nanomedicine -Preparation of Nano particles for target based drug delivery.

Learning Outcomes: Student will be able to

- Understand the process of production of healthcare products like insulin, growth hormone, factor VIII, tissue plasminogen activator, urokinase etc.
- Enumerate various advantages and disadvantages of nano medicine

SEMESTER – VI

UNIT-IV

Gene Therapy: Ex vivo and In vivo gene therapy. Vectors in gene therapy: Retro, Adeno, Lenti, Adeno-associated viruses. Therapy for Adenosine deaminase deficiency, Cystic fibrosis, hemophilia. Gene delivery by viral and non-viral vectors, Gene therapy for Cancer, AIDS. Antigene and antisense therapy.

Learning Outcomes: Student will be able to

- Emphasize various gene therapies and vectors used in it along with examples

UNIT-V

Physiology of reproductive system - Males and females. Oogenesis, Ovulation, Spermatogenesis. Infertility in males and females. *In vitro* fertilization methodology in humans. Sperm collection and superovulation. Embryo culture and transfer. Cryopreservation. Artificial insemination. Amniocentesis, immunocontraception.

Learning Outcomes: Student will be able to

- Understand the process involved in the physiology of male and female reproductive systems
- Evaluate the role of artificial methods used in *invitro* fertilization process

Course Outcomes: On completion of this course, students should be able to

- Understand basics of Research and Development in the fields of medical biotechnology
- Apply knowledge gained on various gene therapies in respective fields of pharmaceutical industry
- Describe basic science behind the physiology of reproductive systems with special emphasis on IVF process

RECOMMENDED BOOKS:

1. Molecular Biotechnology: Principles and applications of recombinant DNA technology by BR Glick, JJ Pasternak & CL Patten, 4th Edition, ASM Press.
2. Gene cloning and DNA analysis an introduction by TA Brown, 5th Edition, Blackwell publishers.
3. Fundamentals of Ecology by EP Odum & GW Barrett, 5th Edition, McGraw-Hill publishers.
4. Biotechnology by U Satyanarayana, 3rd Edition, Books and Allied Sciences Publishers.
5. Biotechnology and genomics by PK Gupta, Rastogi Publications.

SEMESTER – VI

SBH 304: INDUSTRIAL FERMENTATIONS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: The significance of this course is to provide students with sound theoretical knowledge and principles relevant to Industrial Fermentations. As per the course content, one can understand the diversity of microorganisms and search for strains from the natural environment, which can produce novel or unusual products of high commercial value. Understanding various principles of fermentation processes, selection of media, reactor designs, scale-up and downstream processing is primary and essential in large-scale production of various biologically active principles or products. This course also provides the knowledge about the importance of immobilization of enzymes/ cells and their applications.

Course Objectives:

1. To educate students about the fundamental concepts of industrial fermentation and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.
2. To develop skills about the screening and maintenance of industrially useful microorganisms, the sterilization kinetics, fermentation processes, reactor design, product development and recovery.
3. To improve the base knowledge and to bring awareness on various industrial processes.

UNIT-I

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, ethanol, butanol, biodiesel, starch conversion processes; Microbial polysaccharides; Microbial insecticides; anti-cancer agents.

UNIT-II

Microbial products of pharmacological interest, steriod fermentations and transformations. Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity.

UNIT-III

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra-centrifugation, liquid extraction, ion-exchange recovery of biological products.

UNIT-IV

Enzyme and cell immobilization techniques in industrial processing. Application of immobilized enzymes in medicine and industry.

UNIT-V

Enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

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

- Be familiar with different methodologies involved in the downstream processing in removing the microbial cells and solid matter from the fermentation broth and finishing of product purification.
- Give an account of important microbial / industrial processes in industrial chemicals, solvents, insecticides etc
- Understand the production of therapeutic agents
- Be familiar with industrial processes and applications in pharma, medicine etc
- Understand the transformations and metabolic engineering of biologically active molecules.

SEMESTER – VI

- Know the immobilization techniques

RECOMMENDED BOOKS:

1. Principle of fermentation technology by Stanbury, 2nd Edition, Elsevier.
2. Industrial Biotechnology by Creuger & Creuger, 2nd Edition, Panima publishers.
3. Industrial Microbiology: An Introduction by MJ Waites *et al.*, 1stEditon, Blackwell Science Ltd.
4. Modern Industrial Microbiology and Biotechnology by Nduka Okafor & BC Okeke, 2nd Edition, CRC Publishers.
5. Biochemical engineering fundamentals by Bailey & Ollis, 2nd Edition, Intl. Pub.
6. Biotechnology and genomics by PK Gupta, Rastogi Publications.

SEMESTER – VI

SBH 306: CANCER BIOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: Cancer biology is an important aspect of life sciences. It helps us to understand the biology of the most difficult to treat disease and unravel more therapeutic options. This course gives a detailed aspects of how cancer occurs, different forms of it, and different diagnostics and therapies available.

Course Objective: This course is an introduction to the molecular and cellular basis of cancer. The course will take a mechanistic view of the dysregulation of cellular processes that occurs in cancer cells, including the mechanisms of action of anti-cancer drugs and radiation treatments.

UNIT – I

Introduction to cancer-tumor, neoplasia, benign and metastatic tumor, oncogenes, tumor suppressor genes; General characteristics of cancer. Classification of cancers. TNM staging system of cancer. Carcinogens-physical, chemical- exogenous and endogenous, biological-DNA Viruses and RNA Viruses. DNA Adduct formation.

Learning outcomes:

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

- Identify different tumors
- Understand staging and classification of cancer
- Learn about various carcinogens

UNIT – II

Alterations in cell cycle regulations in cancer. Genetic Variations in Cancer. Mechanisms of genetic instability and chromosome aneuploidy in cancer. Defects in DNA repair mechanisms. Telomers and telomerase dynamics in cancer. Non coding RNAs and epigenetic elements and processes in cancer. Apoptosis-Alterarations in apoptotic mechanisms in cancer.

Learning outcomes:

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

- Describe genetic variations in cancer
- Decipher genomic instability
- Describe the role of noncoding RNAs and epigenetic elements in cancer

UNIT – III

Cancer stem cells. Role of growth factors, receptors, secondary messengers in cancer induction and progression. Angiogenesis-Mechanism, molecular mediators and endogenous inhibitors of angiogenesis. Metastasis-initiation and progression. Mechanisms of Immune response and surveillance in cancer induction and progression.

Learning outcomes:

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

- Explain the processes of angiogenesis and metastasis
- Describe the immune mechanisms in cancer cells

UNIT – IV

Cancer diagnostics: Biopsies, Histopathological techniques, Recent advances in new diagnostic tests. Tumor imaging, Detection of metastais. Immunohistochemical diagnosis. Biomarkers ofcancer

Learning outcomes:

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

- Differentiate different diagnostic tests for cancer detection

- Explain the various therapies available for cancer
- Enumerate the biomarkers of cancer

UNIT – V

Cancer Therapy: Treatment of cancers in different organs of the body-Chemotherapy, Surgery, Radiation Therapy, endocrine therapy and Immunotherapy. Drug resistance in cancer cells. Ethical and regulatory issues involved in cancer research and therapeutics.

Learning outcomes:

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

- Decipher drug resistance in cancer cells
- Differentiate various therapies for cancer
- Explore the future scope in cancer research

Course Outcomes: By the end of the course, the students have learned to understand

- the general features and classification of cancers
- Cell cycle regulation and DNA repair mechanisms in cancers
- oncogenes and cell signaling, tumor suppressors and cell cycle checkpoints
- cancer therapeutics and diagnostics
- how to identify and validate new effective anti-cancer drugs

RECOMMENDED BOOKS:

1. Rebel Cell: Cancer, Evolution and the Science of Life by Kat Arney
2. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics by Pecorino
3. Cancer by Paul Scotting
4. Principles of Cancer Biology by Kleinsmith
5. Introduction to Cancer Biology by Robin Hesketh
6. The Biology of Cancer by Robert Weinberg

SEMESTER – VI

SBH 308: BIOSAFETY, IPR AND ETHICS

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing.

Course Objectives: The objectives of this course are
• To provide basic knowledge on intellectual property rights and their implications in biological research and product development
• To become familiar with India's IPR Policy
• To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products
• To become familiar with ethical issues in biological research.

UNIT-I
Biosafety: Definition of bio-safety, Biotechnology and bio-safety with special emphasis on Indian concerns. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP). Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions

UNIT-II
National and international regulations: International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies

UNIT-III
Bioethics: Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening.

UNIT-IV
Introduction to IPR: IPR, forms of IPR, Copy right, Trademarks, Geographical indications, Industrial designs and Intellectual property protection. WIPO, EPO. Type of patents. Indian patent act and foreign patents. Infringement of intellectual property rights.

UNIT-V
Concept related to patents novelty, non-obviousness, utility, anticipation, prior art etc. Searching a patent, Drafting of a patent, Filing of a patent, Revocation of patent, Infringement and Litigation with case studies on patent, Commercialization and Licensing, Moral Issues in Patenting Biotechnological inventions, Case studies: Basmati, Haldi.

Course Outcomes: On completion of this course, students will be able to:
• Understand the rationale for and against IPR and especially patents
• Understand why India has adopted an IPR Policy and be familiar with broad outline of patent regulations
• Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents
• Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations
• Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

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RECOMMENDED BOOKS:

1. Principles of Intellectual Property by NS Gopalakrishnan & TG Agitha, Eastern Book Co., Lucknow.
2. Kerly's Law of Trade Marks and Trade Names by Thomson, Sweet & Maxweel, 14th Edition.
3. Indian Patents Law – Legal & BusinessImplications by Ajit Parulekar & Sarita D' Souza, McMillan India Ltd.
4. Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications by BL
   Wadehra, Universal law Publishing Pvt. Ltd., India.
5. Law of Copyright and Industrial Designs by P Narayanan, Eastern law House, Delhi.
6. Bioethics: An Anthology by H Kuhse & MA Malden, Blackwell.

SEMESTER – VI

SBH 310: STEM CELL BIOLOGY

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble:
This course offers an opportunity the students to understand the basics of stem cells, genetic manipulation of stem cells and their applications to various diseases affecting mankind.

Course objectives:

1. To teach students the importance and availability of stem cells in the body
2. To make students understand how stem cells function, divide and respond to various factors
3. To teach students how pluripotent stem cells can be produced in the laboratory and their applications
4. To teach students the applications of stem cells in transplantation and regenerative medicine
5. To make students understand how to handle, culture and preserve stem cells and the ethical issues behind the use of stem cells

UNIT-I

Introduction to stem cells. Types-Embryonic, adult stem cells. Properties, potency, Differences and similarities in adult and embryonic stem cells. Stem cell niches. Stem cells localized in different tissues- Hematopoietic and Umbilical cord blood stem cells., mesenchymal, skin, intestinal, neural, cardiac and skeletal stem cells.

Learning outcome:

By the end of this unit, students would

1. be able to differentiate the different types of stem cells that exist
2. understand differences between adult and embryonic cells
3. understand stem cells localized in different tissues of the body

UNIT-II

Isolation and characterization of stem cells. Stem cell markers and their roles in signalling cascades of LIF, Wnt, TGF-beta, PI3/Akt pathways. Mechanisms of self-renewal. Epigenetics in stem cells development. Transcriptional control of gene expression in ESC: role of miRNAs, LincRNAs and RNA binding proteins. Cell cycle regulation in stem cells.

Learning outcome:

By the end of this unit, students would

1. develop an understanding on how stem cells can be isolated
2. appreciate the different markers that distinguish stem cells
3. perceive gene regulation and cell cycle in stem cells

UNIT-III

Tissue derivation from different germ layers. Differentiation of stem cells. Induced pluripotency of stem cells, Markers and factors involved in induced pluripotency. Production of induced pluripotent stem cells-earlier attempts and recent advancements. Applications of iPSCs

Learning outcome:

By the end of this unit, students would

1. appreciate the concept of induced pluripotency
2. comprehend the attempts and advancements in production of iPSCs
3. analyse the applications of iPSCs

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UNIT-IV

Tissue engineering. Autologous and Allogenic Stem Cell Transplantation, Stem cells in gene therapy. Applications of stem cells in regenerative medicine-neurodegenerative diseases, stroke, cardiac disorders, cancer, and diabetes. Cancer stem cells.

Learning outcome:

By the end of this unit, students would

1. conceptualize tissue engineering and transplantation
2. understand the concept of regenerative medicine
   comprehend stem cells application

UNIT-V

Cryopreservation of stem cells. Stem cell banking. Clinical trials in stem cell research. Challenges and promises of stem cell applications in medicine and research. Ethical and regulatory issues involving stem cell research.

Learning outcome:

By the end of this unit, students would

1. understand the principle of stem cell cryopreservation and banking
2. appreciate the use of stem cells in medicine and research
3. debate the ethical and regulatory issues of stem cells

Course Outcomes: At the end of course, students should be able to

- Understand major ideas in stem cell biology
- Familiarize with experimental approaches, and how they are applied to specific problems in stem cell biology
- Carry out and interpret experiments in stem cell biology

RECOMMENDED BOOKS:

1. Essentials of Stem Cell Biology by R Lanza & A Atala, 3rd Edition, Academic Press.
2. Stem Cells: Basics and Applications by KK Deb & SM Totey, Reprint 2009, Tata McGraw-Hill Education, .
3. Stem Cells: From Mechanisms to Technologies by MK Stachowiak & E Tzanakaki, World Scientific publishers
4. Principles of Tissue Engineering by R Lanza *et al.*, 4th Edition, Academic Press.
5. Stem Cell Anthology: From Stem Cell Biology, Tissue Engineering, Cloning, Regenerative
6. Medicine and biology by BM Carlson, Academic press.
7. Stem Cells: From Basic Research to Therapy, Volume I by F Calegari & C Waskow, 1st Edition, CRC Press.

SEMESTER – VI

SBH 312: HUMAN INFECTIOUS DISEASES

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Course Objectives: This course will provide a perspective and exposure to medical aspects of bacteriology, virology, mycology, parasitology and infectious diseases along with concepts of symptoms, pathogenesis, transmission, prophylaxis and control, a conceptual understanding of host – pathogen interactions using well characterized systems as examples. The student should have a good grasp of disease-causing microbes and their interactions with host.

UNIT-I

General introduction: Definitions and methods of Sterilization, disinfection, antisepsis and quarantine. Mechanisms of action different chemical disinfectants. Mode of transmission of Infections Microbial Diseases: spread of disease in populations, reservoirs of infection- human, animal, and non-living reservoirs.

UNIT-II

Bacterial infections: Pathophysiology of Tuberculosis-Causative agent, molecular basis of host specificity, infection and pathogenicity. Diagnostics, Therapeutics, inhibitors and vaccines against tuberculosis. Drug resistance. Pathology of other bacterial diseases-Typhoid, Diphtheria, Pertussis, Tetanus, Typhoid and Pneumonia.

UNIT –III

Overview of diseases caused by Viruses

Mechanisms of viral pathogenesis-Virus entry into the target tissue. Lytic, nonolytic and oncogenic infections. The role of Antigenic shift and antigenic drift in viral infections. Pathophysiology of AIDS, Challenges posed by HIV. Diagnostics and therapeutics of AIDS. Brief pathology of - Hepatitis, Covid-19, influenza, rabies, chikungunya and polio.

UNIT-IV

Overview of diseases caused by Parasites

Host parasite interactions. Malaria-History, causative agents, Vectors, life cycle of Plasmodium. Diagnostics, drugs and inhibitors, resistance, vaccine development with regard to malaria. Pathology of leishmaniasis and amoebiasis.

UNIT -V

Fungal infections: General characteristics, classification, medical importance. of major fungal groups, fungal cell structure, fungal morphology, fungal replication, general information on fungal pathogenesis. Systemic and Opportunistic Mycoses.

Course Outcomes: On completion of this course, students will be able to:

- Compare and contrast different infectious diseases, including properties of different types of pathogens, and mechanisms of pathogenesis
- Summarize role of host in infectious disease, including natural barriers to infection, innate and acquired immune responses to infection, and inflammation
- Compare and contrast experimental approaches for identifying virulence genes and advantages/disadvantages of each approach for specific pathogens

RECOMMENDED BOOKS:

1. Zoonoses: Infectious Diseases Transmissible from Animals to Humans (ASM Books) by Rolf Bauerfeind, Alexander Von Graevenitz, et al.
2. Bacterial Infection: Close Encounters at the Host Pathogen Interface by Peter K. Vogt (Editor), Michael J. Mahan
3. Zoonoses Infectious Diseases of Animal Transmissible to Humans by Chandra Shekhar
4. Human Virology by Leslie Collier, John Oxford, et al.
5. Fungal Infections Diagnosis And Treatment by Sardana K.

SEMESTER – VI

SBH 314: PROTEIN ENGINEERING

Hours per week: 04 **End examination: 60 Marks**
Credits: 04 **Sessional: 40 Marks**

Preamble: Protein engineering is a valuable tool for the creation of novel or improved proteins for practical and therapeutic uses and provides new insights into protein structure and function.

Course Objectives: The aim of this course is to introduce methods and strategies commonly used in rational protein designing to understand the protein's structure-function correlation and for therapeutic applications.

UNIT-I
Introduction to Protein engineering – definition, applications; Features or characteristics ofproteins that can be engineered (definition and methods of study) – affinity and specificity; Spectroscopic properties, Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities.

UNIT-II
Stability of protein structure- Methods of measuring stability of a protein - Spectroscopic methods to study physicochemical properties of proteins: far-UV and near-UV CD; Fluorescence; UV absorbance; ORD.

UNIT-III
Applications - Forces stabilizing proteins – Van der waals, electrostatic, hydrogen bonding and weakly polar interactions, hydrophobic effects; Entropy – enthalpy compensation; Experimental methods of protein engineering: directed evolution like gene site saturation mutagenesis.

UNIT-IV
Hydrodynamic properties – viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy – emphasis on parameters that can be measured / obtained from NMR and their interpretation.

UNIT-V
Protein engineering Applications for biosensors, vaccine development, engineering proteins for the degradation of recalcitrant compounds, Engineering antibody affinity by yeast surface display; Protein engineering with unnatural amino acids and its applications, Peptidomimetics and its use in drug discovery.

Course Outcomes: On completion of this course, students will be able to:

- Analyze structure and construction of proteins by computer-based methods
- Describe structure and classification of proteins
- Analyze purity and stability of proteins and explain how to store them in best way
- Explain how proteins can be used for different industrial and academic purposes such as structure determination, organic synthesis and drug design.

RECOMMENDED BOOKS:

1. Protein Engineering for Industrial Biotechnology by L Alberghina, 2005 Edition, Harwood academic press.
2. Protein Engineering Handbook by S Lutz and UT Bornscheuer, Volume III, Wiley–VCH press.
3. Gene Structure and Transcription by T Beebe & T Burke, Oxford University Press
4. Protein Engineering (Nucleic Acids and Molecular Biology) by C Kohrer& UL Raj Bhandaray, 1st Edition, Spinger,
5. Protein Engineering: Principles and Practice by JL Cleland & CS Craik, 1st Edition, Wiley-Liss publishers.

6. Molecular Biology of the Cell by B Alberts*et al*., 5th Edition, Garland publications incorporation.
7. Concepts in Biotechnology by D Balasubramanian *et al.*, Revised edition, Universities press.

SEMESTER – VI

SBH 390: PROJECT WORK

Credits: 06 **End examination: 150 Marks**

The student should submit a project report by the end of the VI semester based on the results of his/her research work done on a topic relevant to Biotechnology and should give a seminar on that work. The research work may be carried out in Universities/Institutes/ Research labs/Industries.