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

INTEGRATED MASTER OF SCIENCE

Biotechnology

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

Website: www.gitam.edu

INTEGRATED M.Sc. BIOTECHNOLOGY
REGULATIONS

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

1. ADMISSION

1.1 Admission into Integrated M.Sc. in Biotechnology program of GITAM (Deemed to be University) is governed by GITAM admission regulations.

2. ELIGIBILITY CRITERIA

2.1. A pass in 10+2 or equivalent examination 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).

2.2. Admissions into Integrated M.Sc. programme will be based on an all India entrance test conducted by GITAM (Deemed to be University) and the rule of reservation, wherever applicable.

3. CHOICE BASED CREDIT SYSTEM

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

- Student Centered Learning
- Cafeteria approach
- Inter-disciplinary learning
- Learning goals/ objectives and outcomes are specified leading to what a student should be able to do at the end of the program.

4. STRUCTURE OF THE PROGRAM

4.1 The Program Consists of

Ability Enhancement Compulsory Core course (AECC)

i) Core Courses (Compulsory).

ii) Discipline centric electives which

a) are supportive to the discipline
b) give expanded scope of the subject
c) give inter disciplinary exposure
d) nurture the student skills

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

iv) Practical Proficiency Courses

a) Laboratory
b) Project work

4.2 Each course is assigned a certain number of credits depending upon the number of contact hours (Lectures/Tutorials/Practical) per week.

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

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

4.4 The curriculum of the ten semesters Integrated M.Sc. program is designed to have a total of **242** credits for the award of Integrated M.Sc. Degree.

5. MEDIUM OF INSTRUCTION

The medium of instruction (Including examinations and project reports) shall be in English.

6. REGISTRATION

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

7. ATTENDANCE REQUIREMENTS

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

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

8. EVALUATION

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

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

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

8.4 Project work & Seminar are assessed for maximum marks of 300 marks respectively. A student has to obtain a minimum of 40% to secure pass grade. Details of Assessment Procedure are furnished below in Table 1.

Table 1: Assessment Procedure

S. No.	Component of assessment	Marks allotted	Type of Assessment	Scheme of Examination
1	Theory	40	Continuous evaluation	(i) Three mid semester examinations shall be conducted for 15 marks each. The performance in best two shall be taken into consideration. (ii) 5 marks are allocated for quiz. (iii) 5 marks are allocated for assignment.
		60	Semester-end examination	The semester-end examination shall be for a maximum of 60 marks.
	Total	**100**		
2	Theory (SEC)	100	Continuous evaluation	Hundred (100) marks for continuous evaluation.
2	Practicals	100	Continuous evaluation	Sixty (60) marks for continuous evaluation is 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.
				Forty (40) marks (30 marks for experiment(s) and 10 marks for practical viva-voce.) for one test towards the end of the semester conducted by the concerned lab teacher and external examiner appointed by the Head of Department.
	Total	**100**		
3	Project work (X Semester)	300	Project evaluation	(i) 200 marks for evaluation of the project work dissertation submitted by the candidate. (ii) 100 marks are allocated for the project viva-voce. (iii) The project work evaluation and the viva-voce shall be conducted by one external examiner outside the University and the internal examiner appointed by the Head of the Department.

9. RETOTALING & REVALUATION (Upto VI semester)

9.1 Retotaling of the theory answer script of the semester-end examination is permitted on request by the student by paying the prescribed fee within one week after the announcement of the results.

9.2 Revaluation of the theory answer scripts of the semester-end examination is permitted on request by the student by paying the prescribed fee within one week after the announcement of the result.

10. PROVISION FOR ANSWER BOOK VERIFICATION & CHALLENGE EVALUATION (Upto VI semester)

10.1 If a student is not satisfied with his/her grade after revaluation, the student can apply for, answer book verification on payment of prescribed fee for each course within one week after announcement of revaluation results.

10.2 After verification, if a student is not satisfied with revaluation marks/grade awarded, he/she can apply for challenge valuation within one week after announcement of answer book verification result/ two weeks after the announcement of revaluation results, which will be valued by the two examiners i.e., one Internal and one External examiner in the presence of the student on payment of prescribed fee. The challenge valuation fee will be returned, if the student is succeeded in the appeal with a change for a better grade.

11. SUPPLEMENTARY EXAMINATIONS & SPECIAL EXAMINATIONS

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

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

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

12. PROMOTION TO THE NEXT YEAR OF STUDY

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

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

13. BETTERMENT OF GRADES

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

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

14. REPEAT CONTINUOUS EVALUATION

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

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

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

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

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

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

15. GRADING SYSTEM

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

Table 2: Grades & Grade Points

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

15.2 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.

16. GRADE POINT AVERAGE

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

$$GPA = \frac{\Sigma [CxG]}{\Sigma C}$$

Where

C = number of credits for the course,

G = grade points obtained by the student in the course.

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

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

Table 3: CGPA required for award of Class

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

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

17. ELIGIBILITY FOR AWARD OF THE INTEGRATED M.Sc. DEGREE

17.1 Duration of the programme: A student is ordinarily expected to complete the Integrated M. Sc. programme in ten semesters of five years. However a student may complete the programme in not more than seven years including study period.

17.2 However, a student who completes three years and four years of study and who earns required number of credits, as decided by Academic Council and Board of Management and desires to discontinue the programme shall be eligible for the award of B.Sc. and B.Sc. (Hons.) degree respectively.

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

17.4 A student shall be eligible for award of the Integrated M. Sc. degree if he/she fulfils 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.

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

18. 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.

INTEGRATED M.Sc. BIOTECHNOLOGY

SCHEME OF INSTRUCTION AND EVALUATION

(w.e.f Academic year 2019-20)

Course Code	Name of the Course	Category	Instruction Hours/Week		No. of Credits	Scheme of Examination		
						Duration of Exam (Hrs.)	Maximum Marks (100)	
			L	P			Continuous evaluation	Semester-end examination
I Semester								
SBT 101	Plant and Animal sciences	PC	4	-	4	3	40	60
SBT 103	Biomolecules-I	PC	4	-	4	3	40	60
SBT 105	Numerical and statistical methods	PF	4	-	4	3	40	60
SPH 105	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	PC	4	-	4	3	40	60
SFC 103	English Language Skills	PF	4	-	4	3	40	60
SBT 121	Biochemical Analysis Lab	PP	-	6	3	3	60	40
SBT 123	Numerical and statistical methods Lab	PP	-	6	3	3	60	40
SPH 125	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab	PP	-	6	3	3	60	40
Total					**29**		**800**	
II Semester								
SBT 102	Biomolecules-II	PC	4	-	4	3	40	60
SBT 104	Cell Biology	PC	4	-	4	3	40	60
SBT 106	Fundamentals of Statistics	PF	4	-	4	3	40	60
SBT 108	Introduction to UNIX Programming	PF	4	-	4	3	40	60
SPH 106	Chemical Energetics, Equilibria& Functional Organic Chemistry	PC	4	-	4	3	40	60
SBT 122	Cell Biology Lab	PP	-	6	3	3	60	40
SBT 124	UNIX Lab	PP	-	6	3	3	60	40
SPH 124	Chemical Energetics, Equilibria & Functional Organic Chemistry Lab	PP	-	6	3	3	60	40
Total					**29**		**800**	

Course Code	Name of the Course	Category	Instruction Hours/Week		No. of Credits	Scheme of Examination		
						Duration of Exam (Hrs.)	Maximum Marks (100)	
			L	P			Continuous evaluation	Semester-end examination
III Semester								
SBT 201	Genetics and Evolution	PC	4	-	4	3	40	60
SBT 203	Microbiology	PC	4	-	4	3	40	60
SBT 205	Environmental Science	PC	4	-	4	3	40	60
SBT 207	C-Programming	PF	4	-	4	3	40	60
SPH 205	Solutions, phase equilibrium, conductance, electro chemistry & functional group Organic Chemistry-II	PC	4	-	4	3	40	60
SBT 221	Microbiology Lab	PP	-	6	3	3	60	40
SBT 223	C-Programming Lab	PP	-	6	3	3	60	40
SPH 225	Solutions, phase equilibrium, conductance, electro chemistry & functional group Organic Chemistry-II Lab	PP	-	6	3	3	60	40
Total					**29**		**800**	
IV Semester								
SBT 202	Biochemical Techniques	PC	4	-	4	3	40	60
SBT 204	Biophysics	PF	4	-	4	3	40	60
SBT 206	Object Oriented Programming in C++	PC	4	-	4	3	40	60
SPH 206	Coordination chemistry, states of matter & chemical kinetics	PC	4	-	4	3	40	60
SFC 104	Functional English	PF	4	-	4	3	40	60
SBT 222	Biochemical Techniques Lab	PP	-	6	3	3	60	40
SBT 224	Object Oriented Programming Lab	PP	-	6	3	3	60	40
SPH 224	Coordination chemistry, states of matter & chemical kinetics Lab	PP	-	6	3	3	60	40
Total					**29**		**800**	

Course Code	Name of the Course	Category	Instruction Hours/Week		No. of Credits	Scheme of Examination		
						Duration of Exam (Hrs.)	Maximum Marks (100)	
			L	P			Continuous evaluation	Semester-end examination
V Semester								
SBT 301	Metabolism-I	PC	4	-	4	3	40	60
SBT 303	Metabolism-II	PC	4	-	4	3	40	60
SBT 305	Enzymology and Enzyme Technology	PC	4	-	4	3	40	60
SPH 383	Green chemistry	PC	4	-	4	3	40	60
SBT 321	Enzymology Lab	PP	-	6	3	3	60	40
SPH 341	Green Chemistry Lab	PP	-	6	3	3	60	40
SBT 391	Viva-voce	PP	-	-	1	-	50	
Total					**23**		**650**	
VI Semester								
SBT 302	Molecular Biology	PC	4	-	4	3	40	60
SBT 304	Immunology-I	PC	4	-	4	3	40	60
SBT 306	Physiology	PC	4	-	4	3	40	60
SPH 382	Industrial Chemicals and Environment	PC	4	-	4	3	40	60
SBT 322	Molecular Biology Lab	PP	-	6	3	3	60	40
SPH 340	Industrial chemicals and environment Lab	PP	-	6	3	3	60	40
SBT 392	Viva-voce	PP	-	-	1	-	50	
Total					**23**		**650**	

Course Code	Name of the Course	Category	Instruction Hours/Week		No. of Credits	Scheme of Examination		
						Duration of Exam (Hrs.)	Maximum Marks (100)	
			L	P			Continuous evaluation	Semester-end examination
VII Semester								
SBT 401	Genetic Engineering	PC	4	-	4	3	40	60
SBT 403	Plant Biotechnology	PC	4	-	4	3	40	60
SBT 405	Animal Biotechnology	PC	4	-	4	3	40	60
SBT 407	Immunology-II	PC	4	-	4	3	40	60
Open Elective I		OE	3	-	3	3	40	60
SBT 421	Genetic Engineering and Immunology Lab	PP	-	6	3	3	60	40
SBT 423	Plant and Animal Biotechnology Lab	PP	-	6	3	3	60	40
SBT 491	Viva-voce	PP	-	-	1		50	
Total					**26**		**750**	
VIII Semester								
SBT 402	Bioprocess Engineering and Technology	PC	4	-	4	3	40	60
SBT 404	Medical Biotechnology	PC	4	-	4	3	40	60
SBT 406	Bioinformatics	PC	4	-	4	3	40	60
Program Elective I (Choose any one)		PE	4	-	4	3	40	60
SBT 442	Cancer Biology							
SBT 444	Stem cell Biology							
SBT 446	Protein Engineering							
SBT 448	Drug designing and Development							
SBT 422	Industrial Biotechnology Lab	PP	-	6	3	3	60	40
SBT 424	Bioinformatics Lab	PP	-	6	3	3	60	40
SBT 492	Viva-voce	PP	-	-	1		50	
Total					**23**		**650**	

Course Code	Name of the Course	Category	Instruction Hours/Week		No. of Credits	Scheme of Examination		
			L	P		Duration of Exam (Hrs.)	Maximum Marks (100) Continuous evaluation	Semester-end examination
IX Semester								
SBT 501	Food Biotechnology	PC	4	-	4	3	40	60
SBT 503	Aquaculture and Marine Biotechnology	PC	4	-	4	3	40	60
SBT 505	Virology	PC	4	-	4	3	40	60
Program Elective II (Choose any one)		PE	4	-	4	3	40	60
SBT 541	Pharmaceutical Biotechnology							
SBT 543	Nanobiotechnology							
SBT 545	Molecular Modeling							
SBT 547	Biosafety, Bioethics & IPR							
SBT 521	Food Biotechnology Lab	PP	-	6	3	3	60	40
SBT 523	Aquaculture and Marine Biotechnology Lab	PP	-	6	3	3	60	40
SBT 591	Viva-voce	PP	-	-	1		50	
Total					**23**		**650**	
X Semester								
SBT 592	Project work	PP	-		**8**		200	
	Seminar						100	
Total					**8**		**300**	
Grand Total for Ten Semesters					**242**		**6850**	

PC-Program Core **PF-Program Foundation** **PP-Practical Proficiency**
PE-Program Elective **OE-Open Elective**

Open elective I & II should be selected from the list of open elective subjects offered by the University.
One program elective (Elective I) should be selected from the papers SBT 442, SBT 444, SBT 446 and SBT 448.
One program elective (Elective II) should be selected from the papers SBT 541, SBT 543, SBT 545 and SBT 547.

*** Open Electives offered by the Department:**

S. No.	Course code	Title of the paper	Semester in which the course offered	Course offered to students of
01	SOE 831	Fundamentals of Biotechnology	VII Semester	All programs other than M.Sc. Biotechnology
02	SOE 833	Fundamentals of Plant Biotechnology	VII Semester	All programs other than M.Sc. Biotechnology

* Students who are having these papers/content of this paper in their curriculum are not allowed to opt for the respective electives.

INTEGRATED M.Sc. BIOTECHNOLOGY
SYLLABUS

I SEMESTER

SBT 101: PLANT AND ANIMAL SCIENCES

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

Preamble:

A fundamental problem in biology is how the complex set of multicellular structures that characterize an adult animal is generated from the fertilized egg. Recent advances at the molecular level, particularly with respect to the genetic control of development, have been explosive. These advances represent the beginning of a major movement in the biological sciences toward the understanding of the molecular mechanisms underlying developmental decisions and the resulting morphogenetic processes.

Course Objectives:

It is important to understand how a single cell, develop into an embryo, grow, into an adult, sexually matures, and ages. In view of above, this course will provide a conceptual overview of cellular system and functioning, and also discuss how developmental patterns arise using examples from different model systems and highlighting regulatory networks involved in these processes.

UNIT-I

Principles and methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants and animals.

Learning Outcomes:

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

- Learn about the Taxonomy and systematics that provide the foundation for studying the great diversity of the living world and its evolutionary history.

UNIT-II

Anatomy: Meristematic and permanent tissues of plants, Shoot and root apex organization, Special and secretory tissues of plants, Types of tissue systems, Anatomical features of dicotyledonous and monocotyledonous plants, Secondary and anomalous growth in plants**.**
Morphogenesis: Evolution of morphogenetic pattern, Organogenesis of root, stem and leaf, Organogenesis of bud, flower and inflorescence, effect of light, temperature and precipitation on morphogenesis

Learning Outcomes:

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

- Know how the organism takes on a three dimensional shape with all the cells types in the right place to form structures and carry out functions.

UNIT-III

Embryology**:** Micro and Mega sporangium, Female and Male gametophyte, Fertilization, Endosperm Types, Embryogenesis and types of embryos, Apomixis, Polyembryony and parthenocarpy

Learning Outcomes:

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

- Describe the fertilization and the stages of seed development.

UNIT-IV

Basic concepts of development: Potency, commitment, specification (autonomous, regulative and syncytial), induction competence, determination and differentiation, morphogenetic gradients, cell fate and cell lineages, genomic equivalence and cytoplasmic determinants, imprinting.

Learning Outcomes:

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

- Describe the kinds of changes that can occur in cells in response to positional signals (change gene expression, divide, differentiate) and explain with examples how changes in cell shape and cell death can influence morphogenesis.

UNIT-V

Early embryonic development of vertebrates and invertebrates: embryo cleavage formation of blastula and gastrulation; axes and germ layers; morphogenesis - cell adhesion, cleavage, neural tube formation, cell migration.

Learning Outcomes:

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

- Describe the process of organogenesis; Identify the anatomical axes formed in vertebrates

RECOMMENDED BOOKS:

1. Plant Cell Morphogenesis by Zarsky, Viktor, Cvrckova & Fatima.
2. Plant Morphogenesis by Edmund Ware Sinnott.
3. Plant Organogenesis by De Smet.
4. Plant Anatomy by A Fann.
5. Developmental Biology by Scott F Gilbert&Michael JF Barresi, 11th Edition.
6. Essential Developmental Biology by Jonathan MW Slack.

SBT 103: BIOMOLECULES-I

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 classification, structure, properties, and functions of biomolecules. The course shall make the students' aware of the significance of various biomolecules necessary to maintain the living organisms

Course Objectives:

The objectives of this course are to build the knowledge of undergraduate students about the classification, structure, properties, functions and interactions of different biomolecules. The course shall make the students awareof significance of various biomolecules necessary to maintain the living organisms.

UNIT-I

Properties and importance of water, intra and intermolecular forces, non covalent interactions-electrostatic, hydrogen bonding, Vanderwaals interactions, hydrophobic and hydrophilic interactions, Disulphide bridges, pH, pK, acid base reactions and buffers.

Learning Outcomes:

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

- Understand the chemical structure and properties of water.
- Understand the role of non-covalent interactions in biomolecules.
- Understand the role of pH and buffers in biological system.

UNIT-II

Classification, properties and biological significance of carbohydrates, structure and functions of monosaccharides, disaccharides, polysaccharides (starch, glycogen, cellulose and chitin) and glycosaminoglycans (chondroitin sulfate and Hyaluronic acid).Carbohydrate microarray and applications.

Learning Outcomes:

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

- Understand the chemical structure and properties of carbohydrates.
- Understand the biological functions of carbohydrates.

UNIT-III

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:

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

- Understand the chemical structure, properties and biological functions of amino acids.
- Understand the biological functions of ketogenic and glucogenic amino acids Understand the specialized roles of amino acids.

UNIT-IV

Protein isolation and purification. Primary structure of protein- Determination of amino acid composition and sequence. Secondary structure-α-helix, β-pleated sheet, collagen triple helix, β-bends and structural motifs. Tertiary and quaternary structures. Solid phase peptide synthesis. Glycoproteins

Learning Outcomes:

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

- Understand the chemical structure, properties and biological functions of proteins.
- Understand the chemical synthesis of proteins.

UNIT-V

Classification, structure, properties and functions of Fatty acids, Triglycerides, Phospholipids, Sphingolipids, Terpenes, Cholesterol and Eicosanoids- Prostaglandins, Prostacyclins, Thromboxanes and Leukotrienes.

Learning Outcomes:

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

- Understand the chemical structure and properties of lipids.
- Understand the biological functions of lipids.

RECOMMENDED BOOKS:

1. Lehninger Principles of Biochemistry by Nelson D & Cox D, 7th Edition McMillan Pub.
2. Biochemistry by L Stryer, 8th Edition (Freeman-Tappan).
3. Biochemistry by D Voet & JG Voet, 4th Edition (John Weily).
4. Biochemistry by Garrett & 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.*, 30th Edition (Langeman).
9. Biochemistry by U Satyanarayana, 4th Edition.

SBT 105: NUMERICAL AND STATISTICAL METHODS

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

Credits : 04 **Sessional :40 Marks**

Preamble:

This course is introduced to learn fundamental topics such as matrices, numerical methods, interpolation, numerical integration, graphical representation of statistical data, measures of central tendency, and measures of dispersion in mathematics for undergraduate level.

Course Objectives:
To understand various types of matrices, operations on matrices and applications of matrices. To evaluate root of an equation using numerical techniques and understand the concept of numerical integration using various methods. To learn the basic concepts in applications of statistics and graphical presentation of data. To understand the concept of measures of central tendency

UNIT-I

Matrices: Definition, singular, non singular, symmetric, skew symmetric matrices, Multiplication of matrices, Transpose, inverse of a matrix, solving system of equations by Crammer's rule.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- List the difference between various types of matrices.
- Evaluate Matrix multiplication, transpose of a matrix and inverse of a matrix.
- Discuss the methods to solve system of equations.
- Evaluate the system of equations by Cramer's rule.
- Explain difference between symmetric and skew symmetric matrices.

UNIT-II

Numerical methods: Bisection method, method of false position, Gauss elimination method, Jacob's iteration method, Gauss-Siedel Iteration method.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Explain method to find positive root of an equation using bisection method.
- Illustrate the concept of finding root of an equation using Method of false position.
- Evaluate the problems using Gauss elimination method.
- Evaluate the problems using Jacobi's iteration method.
- Evaluate the problems using Gauss-Siedal iteration method.

UNIT-III

Numerical methods: Interpolation, Newton's forward formula, Newton's backward formula, Lagrange formulae for unequal intervals, Numerical Integration – Simpson's $1/3^{rd}$ rule, Trapezoidal rule, Simpson's $3/8^{th}$ rule (Statements only, no proofs)

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Apply Newton's forward formula to estimate the function value for equal intervals.
- Explain the Newton's backward formula to estimate the function using the tabular values.
- Evaluate problems on Lagrange formula for unequal intervals.
- Outline the different types of numerical integration methods.
- Use Simpson's rule and trapezoidal rule to explain numerical integration.

UNIT-IV

Statistical methods: Collection, classification of data, Graphical representation, Histogram, frequency polygon, Ogive, Measures of central tendency: Mean median and mode.

Learning Outcomes:

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

- Explain the need of statistics in real world.
- Summarize different types of graphical representation of statistical data.
- Explain histogram, frequency polygon, and ogive graphically.
- Evaluate mean, median and mode for given ungrouped data and also for grouped data.
- Explain difference between mean, median and mode.

UNIT-V

Statistical methods: Measures of Dispersion, Range, mean deviation, quartile deviation, standard deviation, introduction of moments, Skewness and Kurtosis (definitions only, no proofs)

Learning Outcomes:

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

- Explain properties of measures of dispersion.
- Explain advantages of measures of dispersion.
- Evaluate range, mean deviation, quartile deviation for ungrouped data.
- Apply standard deviation formula for grouped data.
- Evaluate Skewness and Kurtosis for any given data.

RECOMMENDED BOOKS:

1. Engineering Mathematics by BS Grewal, 44th Edition, Khanna Publications.
2. Engineering Mathematics by BV Ramana, Tata McGraw-Hill.

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

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

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 Objectives:

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.

Section A: Inorganic Chemistry-1

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 ψ^2, Schrödinger equation for hydrogen atom. Graphical representation of 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* 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:

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

- 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:

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

- Learn about ionic, covalent bonding in molecules. compare/contrast the properties of molecular and ionic compounds.

UNIT-III

Section B: Organic Chemistry-1

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:

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

- 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 Meso compounds). 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'ssynthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Learning Outcomes:

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

- Learn the essential concepts of chirality, configuration, isomerism in organic chemistry and nomenclature of isomers.
- Disseminate with the elementary concept of saturated aliphatic hydrocarbons an 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. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti- Markownikoff's addition), Hydration, Ozonolysis.

Alkynes: (Upto 5 Carbons) *Preparation:* Acetylene from CaC2and conversion into higheralkynes; 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. KMnO4.

Learning Outcomes:

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

- Learn synthetic reactions, mechanism and properties of aromatic alcohol, aromatic and aliphatic ether, aldehydes and ketones.

RECOMMENDED BOOKS:

1. Concise Inorganic Chemistry by Lee JD, ELBS, 1991.
2. Basic Inorganic Chemistry by Cotton FA, Wilkinson G & Gaus PL, 3rd Edition, Wiley.
3. Inorganic Chemistry: Principles of Structure and Reactivity by Huheey JE, Keiter EA, Keiter RL & Medhi OK, Pearson Education India, 2006.
4. Fundamentals of Organic Chemistry by McMurry JE, 7th Edition, Cengage Learning India Edition, 2013.
5. A Guidebook to Mechanism in Organic Chemistry by Sykes P, Orient Longman, New Delhi,1988.
6. Stereochemistry of Carbon Compounds by Eliel EL, Tata McGraw-Hill education, 2000.
7. Organic Chemistry by Finar IL, Volume I & II, ELBS.
8. Organic Chemistry by Morrison RT & Boyd RN Pearson, 2010.
9. Advanced Organic Chemistry by Bahl A & Bahl BS, S Chand, 2010.

SFC 103: ENGLISH LANGUAGE SKILLS

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

Preamble:

English Language Skills is the foundation course for the first semester students which will help them to learn and understand the basics of English language. It will also provide an opportunity to the students to use language in different contexts. It enhances writing and speaking skills of the students.

Course Objectives:

The main objective of the course is to acquaint the students with proper vocabulary, grammar rules in writing and speaking and paragraph writing by following the principles of the language. To read the given text (lessons) in front of the others and answer the questions by reading the paragraph and passage.

A TEXT WITH COMMUNICATIVE APPROACH

Creative English for Communication‖ by N Krishnaswamy & T Sri Raman, McMillan India Ltd. (2005 version).
(Section-I Communicate - Units 1-6 only)

UNIT-I

Textual Lessons - 1 & 2
Synonyms & Antonyms, One word substitutes, Words often confused, Phrasal Verbs

Learning Outcomes:

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

- Understand the contextual use of the language after reading the text and practice the exercises
- Find out the synonyms for various words and use them in the right context.
- Find out the antonyms for various words and use them effectively
- Use one-word substitutions to replace the lengthy sentences and expression.

UNIT-II

Textual Lesson - 3
Foreign Phrases, Tenses, Concord

Learning Outcomes:

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

- Understand the contextual use of the language after reading the text and practice the exercises.
- Find out the meanings for various foreign expressions and use them in the contexts.
- Learn the structures of the sentences in different times.
- Differentiate the subject and verb and use the right verb for the right subject.

UNIT-III

Textual Lesson - 4
Idiomatic expressions, Proverbs, Correction of sentences, Scientific terms,

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

- Understand the contextual use of the language after reading the text and practice the exercises
- Find out the meanings for various Idiomatic expressions and use them in the contexts.
- Identify proverbs in day to day life and use them for effective communication.
- Analyze the sentence to mark the mistakes and correct the sentences

UNIT-IV

Textual Lesson - 5
Paragraph Writing, Essay Writing, Dialogue Writing, Reading Comprehension

Learning Outcomes:

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

- Understand the contextual use of the language after reading the text and practice the exercises
- Know the rules of the paragraph writing and following them in their writing.
- Learn the principles of essay writing and implement them in their writing.
- Learn the techniques to comprehend the passage and answer the questions given.

UNIT-V

Textual Lesson - 6
Description, Story writing, Note Making, Precis Writing

Learning Outcomes:

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

- Understand the contextual use of the language after reading the text and practice the exercises
- Learn the rules for the descriptive writing and use them in their assignments.
- Identify different formats for note making and insert the transfer the information in to them. Identify irrelevant and unnecessary sentences and phrases and draft the short and meaningful passage.

RECOMMENDED BOOKS:

Part – 1 (Communicate - Units 1 to 6 only) of Creative English for Communication by NK Swamy & T Sriraman, Reprint 2005, Macmillan publishers.

SUPPLEMENTARY READING:

1. Current English for Colleges by N.K. Swamy & T Sri Raman, McMillan publishers.
2. Examine your English by Margaret Maison, Orient Blackswan publishers.

SBT 121: BIOCHEMICAL ANALYSIS LAB

Hours per week	**: 06**	**End examination:**	**40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

The biochemical analysis lab predominately embraces cross-section of qualitative analysis and estimations of biomolecules using various methods. The course will help to build the knowledge about the biochemical techniques used to analyze various biomolecules.

Course Objectives:

The objective of this course is to provide hands on experience to undergraduate students on qualitative and quantitative analysis of biomolecules by chromatography techniques 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 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

Learning Outcomes:

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

- Quantify the biomolecules.
- Estimate the biomolecules using various methods.

RECOMMENDED BOOKS:

1.Modern experimental Biochemistry by Rodney Boyer, 3rd Edition, Benjamin Cummings.
2.Biochemical methods by Sadasivam & Manikam, 2nd Edition, Wiley Eastern limited.
3.An introduction to practical biochemistry by DT Plummer, 2nd Edition, McGraw-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 publishing house.

SBT 123: NUMERICAL AND STATISTICAL METHODS LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

Numerical and statistical methods Lab is introduced to solve the problems which are related to matrices, numerical methods, interpolation, numerical integration, graphical representation of statistical data, measures of central tendency, and measures of dispersion.

Course Objectives:

The objective of the course is to make students evaluate problems using operations on matrices and root of an equation using numerical techniques. It enhances the ability to interpolate the function value or function within the table values using interpolation formulae. Make students to evaluate problems using numerical integration using various methods and express graphical presentation of data. To evaluate problems on measures of central tendency and dispersion.

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

Learning Outcomes:

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

- Find solution of an equation using Bisection method and Regula-Falsi method.
- Evaluate the system of linear equations using Gauss elimination method, Jacobi's iteration method and Gauss-Seidal iteration method.
- Solve problems on interpolation for given equal intervals.
- Solve problems on interpolation for given unequal intervals.
- Calculate problems on numerical integration.
- Apply measures of central tendency and measures of dispersion on various statistical data.
- Evaluate Moments, Skewness and Kurtosis for the given data.

RECOMMENDED BOOKS:

1. Engineering Mathematics by BS Grewal, 44^{th} Edition, Khanna Publications.
2. Engineering Mathematics by BV Ramana, Tata McGraw-Hill.

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

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**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 Objectives:

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 KMnO4.
3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.
4. Estimation of Fe (II) ions by titrating it with K2Cr2O7 using internal indicator.
5. Estimation of Cu (II) ions iodometrically using Na2S2O3.

Learning Outcomes:

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

- Learn about the quantitative analysis concepts of redox chemistry.

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 2 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.

Learning Outcomes:

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

- Disseminate the concept of qualitative element detection in organic chemistry essential for functional group analysis.
- Learn the elementary idea of the techniques of planar chromatography.

RECOMMENDED BOOKS:

1. *Vogel's Qualitative Inorganic Analysis* by Svehla G, Pearson Education, 2012.
2. *Vogel's Quantitative Chemical Analysis* by Mendham J, Pearson, 2009.
3. *Textbook of Practical Organic Chemistry* by Vogel AI, Tatchell AR, Furnis BS, Hannaford AJ & Smith PWG, Prentice-Hall, 5th Edition, 1996.
4. *Practical Organic Chemistry* by Mann FG & Saunders BC, Orient-Longman, 1960.

Note: Out of the above listed experiments eight experiments will be conducted.

II SEMESTER

SBT 102: BIOMOLECULES-II

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 classification, structure, properties, and functions of biomolecules. The course shall make the students' aware of the significance of various biomolecules necessary to maintain the living organisms

Course Objectives:

The objectives of this course are to build the knowledge of undergraduate students about the classification, structure, properties, functions and interactions of different biomolecules and Mechanism of action of steroid, protein and amino acid derived hormones. The course shall make the students aware of significance of various biomolecules and hormones necessary to maintain the living organisms.

UNIT-I

Source, structure, biological role and deficiency disorders of fat soluble vitamins (A,D,E and K) and water soluble vitamins (Riboflavin, Niacin, Thiamine, Pyridoxine, Biotin, Folic acid, Pantothenic acid, Cobalamine, and Ascorbic acid).

Learning Outcomes:

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

- Understand the chemical structure and properties of vitamins.
- Understand the biological role and deficiency disorders of vitamins.

UNIT-II

Structure and properties of DNA. Alternative forms of DNA -A, B, Z. Circular DNA and DNA supercoiling, triple and quadruple helix structures of DNA. Structure and properties of RNA, different types of RNA- mRNA and non-coding RNA – tRNA, rRNA, scRNA, snRNA, siRNA, miRNA, exRNA and piRNA

Learning Outcomes:

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

- Understand the chemical structure and properties of DNA and RNA.
- Understand the biological functions of nucleic acids.

UNIT-III

Classification and properties of porphyrins, structure and function of heme and chlorophyll, Biological significance of cytochromes and carotenoids.

Learning Outcomes:

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

- Understand the chemical structure, properties and biological role of porphyrins.
- Understand the chemical structure, properties and biological role of cytochromes.
- Understand the chemical structure, properties and biological role of carotenoids.

UNIT-IV

Mechanism of action of steroid, protein and amino acid derived hormones. Signal transduction. Secondary messenger concept- cAMP, cGMP, Calcium, Phosphotidylinositide, nitric oxide, G proteins, HRE.Membrane receptor tyrosine kinases and growth factor signaling cascades.

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

- Understand the Mechanism of action of steroid, protein and amino acid derived hormones.
- Understand the signal transduction and secondary messenger concept.
- Understand the role of secondary messengers in signaling cascades.

UNIT-V
Structure, function and pathophysiology of pituitary, thyroid, pancreatic, adrenal and gonadal hormones.

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

- Understand the Structure, function and pathophysiology of hormones.

RECOMMENDED BOOKS:

1. Lehninger Principles of Biochemistry by Nelson D & Cox D, 7th Edition, McMillan Pub.
2. Biochemistry by L Stryer, 8th Edition, (Freeman-Tappan).
3. Biochemistry by D Voet & JG Voet, 4th Edition, (John weily).
4. Biochemistry by Garrett & 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.*, 30th Edition (Langeman).
9. Biochemistry by U Satyanarayana, 4th Edition.

SBT 104: CELL BIOLOGY

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

Preamble:

The course provides knowledge on the basic structures and cell biology-related mechanisms in an eukaryotic cell.

Course Objectives:

The objective of this course is to familiarize the students with the cell biology at molecular level and to understand basic concepts of cell division.

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

- Acquire basic knowledge on cell structure and function of the eukaryotic cell and its organelles

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

- Acquire basic knowledge on cell structure and function of the eukaryotic cell and its organelles

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

- Acquire basic knowledge on how cells interact with other cells and the extracellular matrix allowing formation and maintenance of tissues

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

- Understand the biochemical and biophysical properties of membrane constituents which contribute to the structure and organization of membranes and how ions and solutes are transported across membranes

UNIT-V

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

Learning Outcomes:

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

- Acquire basic knowledge on cellular components underlying mitotic 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 *et.al.*, 4thEdition, 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 GKrauss, 5th Revised Edition, Wiley-VCH publishers.

SBT 106: 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.
- 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.

RECOMMEDED BOOKS:

1. Engineering Mathematics by BS Grewal, 44th Edition, Khanna Publications.
2. Engineering Mathematics by BV Ramana, Tata McGraw-Hill.

SBT 108: INTRODUCTION TO UNIX PROGRAMMING

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

Preamble:

UNIX is popular multi user operating system in the world. We learn UNIX tools and concepts. We can write shell programming in UNIX programming languages. It is aimed to give security of files and directories of UNIX operating system.

Course Objectives:

To make the student to learn ownership and permissions of the files and directories and train them to acquaint about Vi- a standard UNIX text editor. The course will also help in writing shell script programs.

UNIT-I

Getting started: The operating system-The UNIX operating system-knowing your machine-A briefing session.

The UNIX Architecture and Command Usage: UNIX architecture-Features of UNIX-Locating commands-Internal and external commands-command structure- Flexibility of Command Usage.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Describe UNIX operating system and machine-briefing session (L2).
- Illustrate the UNIX architecture (L3).
- Use internal and external commands (L3).

UNIT-II

General-purpose utilities-cal, date, echo, printf, bc, mailx, passwd, who, uname, tty-The file System.

The file system: The file – File name- parent-child relationship, The Home Directory, pwd, cd, mkdir, rmdir, ls-Absolute Pathnames-Relative Pathnames, ls-The UNIX file System.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Use cal and other commands in UNIX (L3).
- Describe file system in UNIX (L2).
- Illustrate parhname, relative pathnames and UNIX file systems (L3).

UNIT-III

Handling ordinary files: cat, cp, rm, mv, more, lp, file, wc, od, cmp, comm, diff, zip and unzip.

Basic file attributes: ls –l, File Ownership, Permissions- chmod, Directory Permissions, Changing file ownership.

Learning Outcomes:

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

- Describe ordinary files (L2).
- Identify the need of diff, zip and unzip commands in UNIX (L1).
- Illustrate Basic file attributes in UNIX (L3).

UNIT-IV

The vi EDITOR: vi Basics-Input Mode-Entering and Replacing Text-Saving Test and quitting-Editing Text.

The Shell: The shell's Interpretive Cycle-Shell Offerings-Pattern Matching-The wild-cards-Escaping and Quoting-Redirection-Pipes-tee-Command substitution-Shell Variables.
More File Attributes: file systems and Inodes-Hard links-Symbolic Links and ln-umask-The Directory-find.

Simple Filters: head, tail, cut, paste, sort, uniq, tr.
Filter using regular expressions: grep-sEd.

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

- Use vi Editor and other editors in UNIX (L3).
- Explain the need of the shell, redirection, pipes, tee and other commands in UNIX (L2).
- Describe file system, links, Directory, find (L2).
- Identify the need head, tail, cut, paste, sort, uniq, tr, grep, sed commands in UNIX (L1).

UNIT-V

Essential Shell Programming: Shell Scripts, read-The if Conditional-The case Conditional-expr-while looping-for looping.

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

- Construct programs using Shell Script (L3).
- Use read, if, case statements in UNIX (L3).
- Describe while, for looping in UNIX (L2).

RECOMMEDED BOOKS:

1. UNIX Concepts and Applications by Sumitabha Das, 4th Edition, McGraw-Hill Education.
2. UNIX and Shell Programming by BM Harwani, 2013 reprint, Oxford University Press.
3. The UNIX Programming Environment by BW Kernighan & R Pike, 1st Edition, Pearson Education.

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 Objectives:
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:
By the end of this Unit, the student will be able to:
- Learn about the essential concepts of thermo-chemistry and chemical thermodynamics.
- Learn the calculation of bond energy, bond dissociation energy and resonance energy from thermo-chemical data.
- 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:
By the end of this Unit, the student will be able to:
- 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 andsulphonation. 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:
By the end of this Unit, the student will be able to:

- 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°, 2°and 3°alcohols: using Grignard reagent, Esterhydrolysis, 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:
By the end of this Unit, the student will be able to:

- 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): (Formaldehye, acetaldehyde, acetone andbenzaldehyde)

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:

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

- Learn about reactions and properties of aromatic alcohols, ethers, aldehydes and ketones.

RECOMMENDED BOOKS:

1. Organic Chemistry by Graham Solomon TW, Fryhle CB & Dnyder SA, John Wiley & Sons (2014).
2. Fundamentals of Organic Chemistry by McMurry JE, 7th Edition, Cengage Learning India Edition, 2013.
3. A Guidebook to Mechanism in Organic Chemistry by Sykes P, Orient Longman, New Delhi (1988).
4. Organic Chemistry by Finar IL, Volume I & II, ELBS.
5. Organic Chemistry by Morrison RT & Boyd RN, Pearson, 2010.
6. Advanced Organic Chemistry by Bahl A & Bahl BS, S Chand, 2010.
7. Physical Chemistry by Barrow GM, Tata McGraw-Hill (2007).

SBT 122: CELL BIOLOGY LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

This lab course blends cell biology and other sub-fields with training in lab techniques and research methods.

Course Objectives:
The objectives of this course are to provide the knowledge about the basic cytological techniques.

Microscopic examination of thallus in Algae.

Microscopic examination of fruiting bodies of Fungi.

Microtomy - Cross sections of plant stem, root and leaf.

Identification of different stages of mitosis (onion root tips) by squash method.

Identification of different Meiotic stages by smear method (in onion flower buds).

Isolation of subcellular organelles by centrifugal techniques (Nucleus / Mitochondria / Chloroplast)

Microscopic examination of nucleus by Feulgen staining method

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

- Acquire basic hands-on skills of various microscopic and cytological techniques.

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 Alberts *et.al.*
6. Handling of Chromosomes by Darlington & Lacor.

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

Hours per week : 06 **End examination: 40 Marks**

Credits : 03 **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:
Student will be familiarized with the practical applications of thermo-chemistry and ionic equilibrium.

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 (KNO3, NH4Cl).
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.

Learning Outcomes:

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

- Learn determination of heat of neutralization and enthalpy.
- Learn to apply concept of ionic equilibrium for determination of pH.
- Learn to prepare the solution of buffer and determination of its pH.

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.
   Recrystallisation, 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

Learning Outcomes:

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

- Disseminate the concept of measurement of melting point, boiling point and re-crystallization essential for organic synthetic chemistry.

RECOMMENDED BOOKS:

1. *Textbook of Practical Organic Chemistry* by Vogel AI, Tatchell AR, Furnis BS, Hannaford AJ & Smith PWG, Prentice-Hall, 5th Edition, 1996.
2. *Practical Organic Chemistry* by Mann FG & Saunders BC, Orient-Longman, 1960.
3. *Senior Practical Physical Chemistry* by Khosla BD, Garg VC & Gulati A, R Chand & Co., New Delhi (2011).

Note: Out of the above listed experiments eight experiments will be conducted.

SBT 124: UNIX LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

UNIX is popular multi user operating system in the world. The lab will enhance the skills to write shell programming in UNIX programming languages. It is aimed to give security of files and directories of UNIX operating system.

Course Objectives:
The objective of the course is to give an overview of the UNIX Operating System, its Architecture, Directory Structure and Command Usage.

1. Practice the commands encountered in the syllabus.
2. Write a shell script to read variables and perform all arithmetic operations.
3. Write a shell script to illustrate relational operators.
4. Write a shell script to compare two strings.
5. Write a shell script to find the length of a given string.
6. The marks obtained by a student in 5 different subjects are input through the keyboard. The student gets a rank as per the following rules:
7. Percentage above or equal to 60 – First
   Percentage between 50 and 59 – Second
   Percentage between 40 and 49 – Third
8. Percentage less than 40 – Fail.
9. Write a shell script to display file permissions along with their names.
10. Write a shell script to print date, no of users and personal status.
11. Write a shell script that prints today's date information in this order:
12. TIME, DAY OF WEEK, DAY NUMBER, MONTH, YEAR
    like 20:10:42 Mon 29 Jun 1970.
13. Write a shell script to find the greatest of three numbers.
14. Write a shell script to read 5 employees information and display the following details in a pay slip using looping constructs.
15. PAYSLIP DETAILS

a. HOUSE RENT ALLOWANCE

b. DEARNESS ALLOWANCE

c. PROVIDENT FUND.

16. Write a shell script to display all even in a given set of numbers (using for).
17. Write shell script to enter a number between 1 and 4 and print it in words.
18. Write a shell script to reverse a number (using while).

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

- Able to develop and understand UNIX commands (L3).
- Understand various UNIX commands (L2).
- Able to develop and implement shell script programs (L3).
- Construct applications using control structure and shell commands (L6).

RECOMMENDED BOOKS:

1. UNIX Concepts and Applications by Sumitabha Das, 4th Edition, McGraw-Hill Education.
2. UNIX and Shell Programming by BM Harwani, 2013 reprint, Oxford University Press.

III SEMESTER

SBT 201: GENETICS AND EVOLUTION

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

Preamble:

This course has been designed to make students understand the basic principles of genetics and inheritance. The course gives the concept of "evolution" in a biological context and discusses the evidence for the truth of evolution. It discusses the complexities of the genetics underlying traits, the origin of genetic variation, and how "complex" traits are studied genetically.

Course Objectives:

The objective of the course is to make students understand the basics of genetics and classical concepts of Mendelian genetics across life-forms. It enables the students to learn extensions of Mendelian genetics and gene mapping. To empower students with the concepts of population genetics, quantitative genetics and genetics of evolution.

UNIT-I

Principles of Mendelian inheritance - Law of purity of gametes, independent assortment, dominance and dominance relations, multiple alleles, interaction of genes and lethality, environment effects on phenotypic expression, Sex linkage and sex determination, human genetic disorders, Pedigree analysis.

Learning Outcomes:

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

- Understand fundamental principles of genetics.
- Understand the concepts of sex determination and sex linked inheritance

UNIT-II

Linkage and crossing over. Cytological basis of crossing over, Molecular mechanism of crossing over. Linkage groups, recombination and gene mapping. Interference and coincidence. Maternal effects and cytoplamic heredity. Extra chromosomal inheritance - episomes, mitochondria and chloroplast. Mutations - types, molecular basis of mutations in relation to UV light and chemical mutagens, Detection of mutations - CLB method and attached method.

Learning Outcomes:

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

- Learn the concept of linkage and gain knowledge about the organelle inheritance.
- Understand the basics of mutations and the detection methods.

UNIT-III

Developmental genetics-basic concepts, development of drosophila body plan - setting up the body axes and segment identity. Patterning the vertebrate body plan - axes, germ layers and somites.

Learning Outcomes:

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

- Explain basic concepts, principles and methods in developmental biology.
- Describe the main features of embryonic development and mechanisms that specify body axes and germ layers.
- Understand how genetic control mechanisms determine the skeletal pattern along the body axis.

UNIT-IV

Origin of life, theories of organic evolution - Lamarckism, Darwinism, germplasm theory, theory of mutation, modern synthetic theory. Evolution above species level - micro, macro and mega evolution. Isolation, types and mechanisms. Speciation.

Learning Outcomes:

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

- Understand Evolution, theories of evolution, Selection and Migration

UNIT-V

Life's beginning - An overview of chemogeny, biogeny and the RNA World. Evidences of evolution - Paleontological evidences and Molecular evidences. Process of evolutionary change. Population genetics - Gene pool and gene frequency, Hardy-Weinberg Law and its application in calculating gene frequencies in a population, QTLs, genetic polymorphism

Learning Outcomes:

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

- Understand Genome evolution, population variation and speciation.
- Know about molecular phylogenetics.

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. Developmental Biology by Scott F Gilbert, 10th Edition, Sinauer Associates.
5. Principles of Heredity by Robert Tymarin A, 7th Edition, Tata McGraw-Hill.
6. Genetics by PK Gupta, Rastogi Publications.
7. Evolution by Brian K Hall & Benedikt Hallgrimsson, 5th Edition, Jones & Bartlett Learning.
8. Evolution by Marl Ridley, 3rd Edition, John Wiley & Sons.
9. Organic Evolution by Rastogi, 13th Edition, Medtech Publisher.

SBT 203: MICROBIOLOGY

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

Preamble:
This course has been designed to introduce field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and microbial infections.

Course Objectives:
The core objective of the course is to identify major categories of microorganisms and analyze their classification, diversity and ubiquity. It also helps to identify and demonstrate how to control microbial growth.

UNIT-I

Introduction to microbiology - History, evolution and development. Diversity of microorganisms- scope and importance - Characterization and Identification of bacteria based on morphology, physiology, biochemistry, ecology, Numerical taxonomy, chemotaxonomy and molecular systematics. Bergey's manual – classification of bacteria and Archea.

Learning Outcomes:
By the end of the Unit, the student will be able to:
- Learn how to classify the microorganisms based on culture dependent techniques.
- Understand the classification of bacteria and archaea

UNIT-II

The study of microbial structure: Microscopy- principles of light, phase, fluorescent and electron microscopy, confocal microscopy. Preparation and staining of specimens. Fixation, Dyes, simple and differential staining and their specific structures. Isolation of pure cultures- Culture dependent techniques (spread plate, streak plate and pour plate methods) and culture independent technique.

Learning Outcomes:
By the end of the Unit, the student will be able to:
- Learn microscopic techniques to study ultrastructure of microorganisms and their diversity.
- Identify the taxon of bacteria based on various characteristic features.
- Learn how to characterize the bacteria based on culture independent technique.

UNIT-III

Microbial nutrition, nutritional types, requirements, design and types of nutrient media, microbial growth- principles, kinetics and methods. The influence of environmental factors on growth. Microbial control- definition, methods of sterilization, physical methods and chemical methods.

Learning Outcomes:
By the end of the Unit, the student will be able to:
- Learn about the nutrients which enhance the growth of microorganisms
- Understand bacterial doubling time, measurement of growth and growth kinetics.
- Learn different methods of sterilization and their mechanisms.

UNIT-IV

Classification of general features of cyanobacteria and importance of Spirulina, Rickettsia, Chlamydia, Mycoplasma, Archaebacteria. Methanogenic and Halophilic bacteria. General account and economic importance of Algae and Fungi. Clinically important bacteria and protozoans. Distribution of microbes in nature.

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

- Understand the classification of Cyanobacteria and their importance.
- Learn economic importance of Algae and Fungi.
- Acquire knowledge on clinically important microbes.

UNIT-V

Bacterial recombination - Transformation, conjugation and transduction. Mapping of prokaryotic genome. Insertion sequences, transposons and mechanism of transposition, retrotransposons and Plasmids.

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

- Understand the bacterial gene recombination and its genetics
- Learn types of transposons and the mechanism of transposition.
- Learn the effect of physical factors that influence the microbial growth.

RECOMMENDED BOOKS:

1. Microbiology by Tortora, Funk & Case, 11th Edition, Pearson education.
2. Textbook of Microbiology by Ananthanarayan & Paniker's, 10th Edition.
3. Brock Biology of Microorganisms by Michael T Madigan & Kelly S Bender, 14th Edition, Pearson education.
4. Microbiology - Principles and Explorations by JG Black, 10th Edition, John Wiley & Sons.
5. Prescott's Microbiology, 11th Edition, McGraw-Hill Publishers.
6. Textbook of Microbiology and Immunology by Parija, 3rd Edition.
8. Understanding Viruses by Teri Shors, 3rd Edition, Jones and Bartlett Publishers.

SBT 205: ENVIRONMENTAL SCIENCE

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

Preamble:

The dynamic changes in the Environment require a precise understanding to adjust to the changes. This paper provides a base line understanding of Environmental changes problems.

Course Objectives:

The objective of the course is to enable student understand importance of environmental science. The course introduces student to ecosystem and its process, sources and effects of Environmental Pollution. It also sensitize student regarding day to day social & environmental issues.

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 this Unit, the student will be able to:

- Understand importance of Environmental Science & Natural Resources.

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.

Learning Outcomes:

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

- Appreciate ecosystems and its process.

UNIT-III

Environmental Pollution: Causes, effects and control measures of Air, Water, Soil pollution, Thermal pollution and Nuclear hazards and Municipal solid waste management.

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.

Learning Outcomes:

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

- Gain knowledge as sources and effects of Environmental 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 The Biological Diversity Act. Disaster definition, Classification, Disaster Management: Explosion, Earth quake, Hazardous materials spill/release.

Learning Outcomes:

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

- Get exposure towards social problems and gain understand on environmental legislation.

UNIT-V

Human Population and the Environment: Population growth, variation among nations, Population explosion, Family welfare program. 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 this Unit, the student will be able to:

- Explain patterns of population growth and problems associated with it.

RECOMMENDED BOOKS:

1. Text Book of Environmental studies for Undergraduate courses by E Bharucha, 2nd Edition,
2. Orient Black Swan publishers.
3. Environmental Science: A Global Concern by WP Cunningham & BW Saigo, 8th Edition,
4. McGraw-Hill publishers.
5. A text book of Environmental Science by PC Joshi & N Joshi, APH PublishingCorporation.
6. A text book of Environmental Science by Arvind Kumar, APH Publishing Corporation.
7. Environmental science by SC Santra, 5th Reprint, New Central Book Agency.
8. Ecology & Environment by PD Sharma, Rastogi Publications.

SBT 207: C-PROGRAMMING

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

Preamble:

C is one of the most popular languages which contain structured programming concepts that have certain popular pointer providers. The course also helps in developing high quality software like system application software, Operating systems drivers, linkers…etc.

Course Objectives:

The objective of the course is to make the students learn algorithms and flowcharts. To acquaint the students in writing programs in C using controls structures. Student also learns about arrays, structures, pointers and functions in C.

UNIT-I

Introduction : Writing Algorithms – Top Down Design – Some Simple Examples For Writing Algorithms – Flowcharts, Structured Programming – Features Of C – Basic Input/Output – Single Character Input/Output – String Input/Output – General Input/Output – Format Specifies.

Variables and Expressions: Character Set – Identifiers and Keywords – Variables – Constants – Data Types – Data Type Conversions – Operators and Expressions.

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

- Describe the basic concepts of Writing Algorithms, Top down Design, Flowcharts (L2).
- Illustrate the concept of Variables, Constants (L3).
- Choose appropriate data type and operators in programs (L3).
- Develop and run simple C programs (L3).

UNIT-II

Control Structures: Decision Making And Branching - If, If-Else, Nested If, Switch, Go To – Decision Making And Looping – For, While, Do-While.

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

- Describe the Decision Making and Branching (L2).
- Construct programs using IF, Switch statements (L3).
- Illustrate the concept of Decision Making and Looping (L3).
- Construct programs using for, while, do-while loops (L3).

UNIT-III

Arrays and Strings: Accessing Array Elements – Initializing Of Array – Multidimensional Arrays – Strings – Arrays of Strings – String Functions – Storage Classes.
Functions And Recursion: Introduction – User Defined And Library Functions – Function Declaration – Function Definition – Return Values **–** Recursion – Towers Of Hanoi.

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

- Illustrate the concept of Arrays and String (L3).
- Describe the Functions (L2).
- Construct the programs using Recursion and towers of Hanoi (L3).

UNIT-IV

Pointers : Definition And use of Pointers - Address Operator – Pointer Variables – Dereferencing Pointers – Pointers to Pointers – Pointers and Arrays

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Describe the Pointers, pointer Variables (L2).
- Illustrate the Pointers to Pointers and Pointers and Arrays (L3).

UNIT-V

Structures and Unions: Declaring and Using Structures – Structure Initialization – Structure within Structure – Operations on Structures – Differences between Structures and Unions.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Illustrate Structures and Unions (L3).
- Describe the Operations on Structures and Differences between Structures and Unions.

RECOMMENDED BOOKS:

1. Mastering C by KRVenugopal & SRPrasad, Tata McGraw-Hill Publishers, New Delhi.
2. Let us C by Yaswant Kanetkar.
3. Programming Techniques through C by NG Venkatesh Murthy, Pearson Education, New Delhi.
4. Programming With C, Schuam's Outline Series by Byron S Goltfried, Tata McGraw-Hill Publishers, New Delhi.

SPH 205: SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II

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 solution chemistry, phase equilibrium, electrochemistry and Functional group chemistry forms the foundation for training a undergraduate students as analytical and synthetic chemist.

Course Objectives:

To introduce the concept of solution phase chemistry in physical chemistry and functional group chemistry in organic chemistry to the undergraduate students. The students will learn the essential functional groups in organic chemistry, their reactions, and properties.

Section A: Physical Chemistry-2

UNIT-I

Solutions
Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions.Lever rule.Azeotropes.

Phase Equilibrium
Phases, components and degrees of freedom of a system, criteria of phase equilibrium.Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver only).

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Learn about the essential concepts impotent principle and terms of phase rule.
- Apply phase rule to one component and two component systems.

UNIT-II

Conductance
Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.Kohlrausch law of independent migration of ions.

Transference number and its experimental determination using Hittorf and Moving boundary methods.Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Electrochemistry

Reversible and irreversible cells.Concept of EMF of a cell.Measurement of EMF of a cell.Nernst equation and its importance.Types of electrodes.Standard electrode potential.Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: *G*, *H* and *S* from EMF data.

Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Learn the elementary concepts of conductance and electrochemistry.
- Learn the applications of Kolhlrausch law. They will be able to calculate thermodynamic properties: G, H and S from EMF data.

Section B: Organic Chemistry-3

UNIT-III

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

Carboxylic acids and their derivatives
Carboxylic acids (aliphatic and aromatic)
Preparation: Acidic and Alkaline hydrolysis of esters.
Reactions: Hell – Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Upto 5 carbons)

Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and theirinterconversion.

Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction,Perkin condensation.

Amines and Diazonium Salts
Amines (Aliphatic and Aromatic): (Upto 5 carbons)
Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamidereaction.
Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: *Preparation:* from aromatic amines
Reactions: conversion to benzene, phenol, dyes.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Learn the concept of synthesis nd reactions carboxyl Functional group and derivatives.

UNIT-IV

Amino Acids, Peptides and Proteins:
Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis.Zwitterion, Isoelectric point and Electrophoresis.
Reactions of Amino acids: ester of –COOH group, acetylation of –NH2group, complexationwith Cu^{2+} ions, ninhydrin test.
Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.
Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal)

and C–terminal (thiohydantoin and with carboxypeptidase enzyme).Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

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

- Learn the elementary reactions and properties, mechanism of amines and diazonium salts.
- Learn the concept of applications of diazonium salts in synthetic organic chemistry.
- Disseminate with synthetic approaches to simple amino acids and concept of proteins.

UNIT-V

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chainand cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

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

- Learn about the classification of carbohydrates.
- Disseminate the reactions and properties of mono, di and polysaccharides.

RECOMMENDED BOOKS:

1. Barrow G.M *Physical Chemistry* Tata Mc. Graw-Hill (2007).
2. Morrison R.T & Boyd R.N *Organic Chemistry,* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar I.L *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar I.L *Organic Chemistry* (*Volume 2),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Nelson D.L & Cox M.M *Lehninger's Principles of Bioch*emistry *7th Ed.*, W.H Freeman.
6. Berg J.M, Tymoczko J.L & Stryer L. *Biochemistry*, W.H Freeman, 2002.

SBT 221: MICROBIOLOGY LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:
This course has been designed to train students with basic techniques of microbiology and the role of microbes in the daily life as well as in the various fields of science. This imparts advanced training in Microbiology for the students and also how the microbes can be controlled is also dealt with.

Course Objectives:

The core objective of the lab is to provide practical skills on basic microbiological techniques and to isolate, characterize and identify common bacterial organisms. It also makes the students to learn how to preserve bacterial cultures and determine their sensitivity.

1. Isolation methods- Pour plate, streak plate and dilution methods.
2. Staining methods: - Simple, Gram, spore, capsule, acid fast and negative staining.
3. Biochemical characterization of selected bacteria.
4. Enumeration of bacterial growth curve.
5. Detection of motility by hanging drop method.
6. Determination of potability of water by MPN test.
7. Microbiological examination of milk by resazurin test.
8. Antibiotic sensitivity test by disc and well diffusion methods.
9. Oligodynamic action of copper on bacteria.
10. Observation of permanent slides of protozoa, fungi and algae.
11. Isolation of bacteriophages from sewage and soil.

Learning outcomes:
By the end of this Course, the student will be able to:
1. Learn all aspects of microbiology as it is required for Biotechnology course.
2. Isolate and characterize the microorganisms based on morphology, biochemical characteristics, distribution and reproduction.
3. Enumerate the microbes from various samples and to understand the role of microorganisms in environment by their biochemical activities.

RECOMMEDED BOOKS:

1. Handbook of Microbiological Media by RL Atlas, 4th Edition.
2. Manual of Clinical Microbiology by EH Lennettee, 2nd Edition.
3. Manual of Clinical Microbiology by PR Murray, 10th Edition.
4. Microbes in action: A Laboratory manual of Microbiology by Seeley *et al.,* 4th Edition.
5. Molecular Biology of the Cell by B Alberts *et al.*, 4th Edition.
6. Laboratory Manual in Microbiology by P Gunasekaran, New Age International.

SBT 223: C-PROGRAMMING LAB

Hours per week : 06		**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

C is one of the most popular languages that contain structured programming concepts which have certain popular pointer providers. The practical course helps in enabling the student to write programs using various functions in C.

Course Objectives:

The objective of the course is to make the student to write programs using operators, control structures in C. It also trains the students in writing programs using arrays, structures and pointers in C.

1. Program using arithmetic operators, logical operators and relational operators.
2. Program using if , if-else , switch control statements
3. Program Using For , While, Do-While control statements
4. Program on searching one dimensional array
5. Program on sorting one dimensional array
6. Program on finding transpose, sum of matrix elements
7. Program on finding product of two matrices and print the result in matrix form
8. Program to implement string library functions
9. Program to find factorial of a number using recursion
10. Program to swap the two given strings using pointers
11. Program to declare, initialize structure and perform operation on structure
12. Program to implement structure with in a structure.

Learning outcomes:

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

- Differentiate and write arithmetic operators, logical and relational operators in C language (L4).
- Examine the working of Control structures in C programs (L4).
- Develop and implement if-else, switch, for, while, do-while programs in C (L3).
- Develop applications with array programs in C (L3).
- List the concepts of string library functions programs in C (L4).
- Understand various recursion, pointers, structure and unions programs in C.

RECOMMEDED BOOKS:

1. Programming in C by E Balaguruswamy, TATA McGraw-Hill.

2. Let us C by Y Kanetkar, BPB Publications.

SPH 225: SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL ORGANIC CHEMISTRY-II LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**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 Objectives:

To make student learn the practical application of solution, phase and electrochemistry for quantitative analysis. The students also learn to differentiate between reducing and non-reducing sugars by qualitative analysis.

Section A: Physical Chemistry

Distribution
Study of the equilibrium of one of the following reactions by the distribution method:

$I_2(aq) + I^-(aq) \quad I_3^-(aq)$
$Cu^{2+}(aq) + x\text{NH2}(aq) \quad [Cu(NH3)x]^{2+}$

Phase equilibria
a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Conductance
1. Determination of cell constant
2. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
3. Perform the following conductometric titrations:
   i. Strong acid vs. strong base ii. Weak acid vs. strong base

Potentiometry
Perform the following potentiometric titrations:
i. Strong acid vs. strong base
ii. Weak acid vs. strong base
iii. Potassium dichromate vs. Mohr's salt

Section B: Organic Chemistry

I Systematic Qualitative Organic Analysis of Organic Compounds possessingmonofunctional groups(-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

II

1. Separation of amino acids by paper chromatography
2. Determination of the concentration of glycine solution by formylation method.
3. Titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. Differentiation between a reducing and a nonreducing sugar.

Learning outcomes:

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

- Learn determination of conductance, cell constant.
- Learn to apply the concepts of electrochemistry for redox titrations by instrumental methods of analysis.

RECOMMENDED BOOKS:

- 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.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.

Note: Out of the above listed experiments eight experiments will be conducted.

IV SEMESTER

SBT 202: BIOCHEMICAL TECHNIQUES

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

Preamble:

The biochemical techniques predominately embrace a broad cross-section of modern analytical techniques and latest sophisticated 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 and also the use of radio tracer techniques in biology.

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:

- By the end 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:

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

- Understand separation of proteins based on mass and charge.
- Distinguish the process of identifying the sub-units in a protein.

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:

By the end 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:
By the end 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.

Learning Outcomes:
By the end 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.

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 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.

SBT 204: BIOPHYSICS

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

Preamble:

To know the influence of biological activity of cells/tissues exposed to radiation.

Course Objectives:
The objective of the course is to understand radiation, its hazards and interaction of radiation for biological processes.

UNIT-I
Radiation physics
Atomic structure, Electromagnetic radiation, Radiation, Radiation interaction with tissue, particle interactions. Interaction of radiation with cell-Sequence of radiation events, Direct and indirect action, radiolysis of water, Characteristics of Actions of radiation, Irradiation of macromolecules, Effects of radiation on cell division and growth.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Outline radiation from electromagnetic spectrum and its interaction with cells/tissues (L2). Examine the action of radiation on cells L5).

UNIT-II
Radiation and Radiation hazards
Cosmic radiation, Radiation from terrestrial sources, radioactivity in body, doses due to natural radiation-man made and current sources.
Radiation hazard-Sources of hazard-time distance, shielding, Neutron sources, dose control and radiation monitoring

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Learn the sources of radiation and hazards of exposure to radiation (L2).
- Interpret the dosage of radiation (L5).

UNIT-III
Optics of tissues
Refelction and refraction, absorption and scattering of laser. Turbid media, photon transport theory and Measurement of optical tissue properties. Introduction to laser-theory and mechanism.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Classify the mechanism of light through different media (L2).
- Determine change in tissue properties due to laser light (L5).

UNIT-IV
Interactions mechanisms
Photochemical interactions,-photodynamic therapy, Thermal interaction-Heat generation, heat transport and heat effects, Laser induced interstitial thermotherapy.
Photoablation-Model of photo ablation, cytotoxicity of UV radiation, Plasma Induced Ablation – Model and analysis of plasma parameters

Learning Outcomes:

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

- Explain the interaction of light with plasma and know its effects (L2).
- Relate various models to estimate plasma parameters (L5).

UNIT-V

Application of lasers

Medical applications -Lasers in opthamology, Dentistry, Gyneacology and Neurosurgery.

Laser Safety-Laser hazards,Eye hazards,skin hazards,Associated hazards from high power lasers,Laser safety standards and hazard Classification ,viewing laser radiation

Biophotonics

Essential basics of phtononics,Light matter interaction,Optical coherence tom ography,optical scanning holography multi photon microscopy and fluorescence nanoscopy

Learning Outcomes:

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

- Understand various applications of lasers and its hazards (L2).

RECOMMENDED BOOKS:

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

SBT 206: OBJECT ORIENTED PROGRAMMING IN C++

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

Preamble:
Object-oriented programming (OOP) is a programming paradigm based on the concept of "objects", which can contain data, in the form of fields and code, in the form of procedures. In OOP, computer programs are designed by making them out of objects that interact with one another. Many of the most widely used programming languages (such as C++, Java, Python, etc.) are multi-paradigm and they support object-oriented programming to a greater or lesser degree.

Course Objectives:
The objective of the course is to understand the difference between procedures in oriented programming and object oriented programming. To learn the basic concept, applications of OOPS and practice of object oriented analysis and design in the construction of robust, maintainable programs which satisfy their requirements. The course generates the ability to implement features of object oriented programming to solve real world problems using Inheritance, data abstraction, encapsulation and Polymorphism.

UNIT-I

Principles of Object Oriented Programming: Software Evolution, Procedure oriented Vs Object Oriented Programming Paradigm, Basic Concepts of OOPs, Benefits of OOP, Features and Applications of OOP, Structure of C++ program. Tokens, Expressions and control structures: Introduction, Tokens, Keywords, Identifiers and Constants, Basic Data types, User-Defined Data types, Derived Data Types and Sizes, Dynamic Initialization of variables, Reference Variables, Scope Resolution Operator, TypeCast Operator, Expressions and their types.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- List the difference between procedures and object oriented programming, applications of OOP (L1).
- Describe the basic concepts of object oriented programming (L2).
- Develop and run simple C++ programs (L3).
- Choose appropriate data type and operators in programs (L3).
- Extend the concepts of C++ in developing efficient programs (L3).

UNIT-II

Functions in C++: Function Prototype, call by reference, Inline functions, Default Arguments, Const arguments Function Overloading, Library Functions. Classes and Objects: Introduction, Specifying a class, making an outside function inline, Arrays within a class, Defining Member functions, Memory Allocation for Objects, array of Objects, Static Data Members, Static Member Functions, Friendly Functions.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Compare and contrast parameter passing techniques of C and C++ (L2).
- Illustrate the concept of classes and objects (L3).
- Develop real world applications by using appropriate concepts (L3).
- Use static members in programming (L3).
- Compare and contrast inline functions with macros (L2).

UNIT-III

Constructor Parameterized Constructor, Multiple Constructors in a Class, Copy Constructor, Dynamic Constructors, Destructors. Operator Overloading: Definition, Overloading Unary, Binary operators, Overloading Binary Operators using Friends, Manipulation of Strings using operators.

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

- Apply Operator overloading concept whenever required (L3).
- Explain the need of Unary and Binary operators (L2).
- Extend the concept of parameter passing techniques with objects (L2).
- Outline the different types of Constructors (L2).

UNIT-IV

Inheritance: Introduction, Defining Derived Classes, Single Inheritance, Multiple Inheritance, Multi Level Inheritance, Hierarchical Inheritance, Hybrid Inheritance, Virtual Base Classes. Constructors in Derived Classes.

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

- Explain the need of reusability concept with inheritance (L2).
- Summarize different types of inheritance (L2).
- Extend the Virtual Base Classes (L3).
- Identify the need of Constructors in Derived Classes (L1).

UNIT-V

Exception Handling: Introduction, Basics of Exception Handling, Exception Handling Mechanism, Throwing Mechanism, Catching Mechanism, Rethrowing an exception, Specifying Exceptions.

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

- Construct programs using Exception handling (L3).
- Classify various Exception Handling processes (L3).
- Apply the concept of Throwing, Catching, Rethrowing an exception (L3).
- Demonstrate handling of run time errors (L2).

RECOMMEDED BOOKS:

1. Object Oriented Programming in C++ by E Balagurusamy, 4th Edition, Tata McGraw-Hill Publication.
2. Mastering C++ by KR Venu Gopal, Tata McGraw-Hill Publication.

SPH 206: COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS

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 coordination chemistry, chemical kinetics and states of matter for training an undergraduate student as synthetic chemist.

Course objectives:
The course objective is to introduce the concept of coordination chemistry and the essentials of inorganic chemistry. It also enables the students to learn reactions kinetics and chemical concepts of states of matter.

UNIT-I

Transition Elements (3d series)
General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Learn the properties of transition elements, Lanthanides and Actinides.

UNIT-II

Coordination Chemistry
Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6.

Drawbacks of VBT. IUPAC system of nomenclature.

Crystal Field Theory
Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Know about Inner and outer orbital complexes
- Comprehend structural and stereoisomerism in complexes and Crystal Field Theory.

UNIT-III

Section B: Physical Chemistry-3 **(30 Lectures)**

Kinetic Theory of Gases
Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.

Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from Vander Waals equation.
Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.

Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

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

- Learn about ideal gases, deviation from ideal behavior. Van der Waals equation of state for real gases.
- Learn to calculate critical constants from Vander Waals equation.

UNIT-IV

Liquids
Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Solids
Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types .Miller indices.X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only).Defects in crystals.

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

- Learn about Surface tension & viscosity and their determination.
- Learn the essentials of solid-state chemistry like symmetry elements, unit cells, crystal systems, and Bragg's equation.
- Learn to determine Miller indices and be familiar with crystal defects.

UNIT-V

Chemical Kinetics
The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants).Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

Learning Outcomes:

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

- Learn concept of reaction rates, factors affecting reaction rates, order and molecularity of a reaction.
- Learn derivation of integrated rate equations for zero, first and second order reactions and theories of reaction rates.

RECOMMENDED BOOKS:

1. Physical Chemistry by Barrow GM, Tata McGraw-Hill (2007).
2. Physical Chemistry by Castellan GW, 4th Editon, Narosa (2004).
3. General Chemistry by Kotz JC, Treichel PM & Townsend JR, Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. University Chemistry by Mahan BH, 3rd Edtion, Narosa (1998).
5. General Chemistry by Petrucci RH, 5th Edition, Macmillan Publishing Co., New York (1985).
6. Basic Inorganic Chemistry by Cotton FA & Wilkinson G, Wiley.
7. Inorganic Chemistry by Shriver DF & Atkins PW, Oxford University Press.
8. Inorganic Chemistry by Wulfsberg G, Viva Books Pvt. Ltd.
9. Inorganic & Solid State Chemistry by Rodgers GE, Cengage Learning India Ltd., 2008.

SFC 104: FUNCTIONAL ENGLISH

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

Preamble:

Functional English aims at enhancing formal writing skills and professional speaking skills. It creates an opportunity for the students to experiment with different formats and methods in writing and speaking. The course makes them to become a confident and competent communicator in written and spoken English.

Course Objectives:

The objective of the course is to enable the students to draft the notices, circulars and minutes of the meeting effectively. The course will help the student to prepare the reports for various events and programs. It also enables them to prepare resume and covering letter confidently and present their ideas on different platforms. The main objective of the course is to give confidence to students in facing the interviews and viva voce sessions.

UNIT-I

Textual Lessons – 7 & 8
Notices and Circulars, Minutes of the Meeting

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Understand the contextual use of the language after reading the text and practice the exercises.
- Know the importance of notices and circulars and draft them.
- Differentiates Minutes from the Agenda and prepare them appropriately.

UNIT-II

Textual Lesson – 9 &10
Memos –formats, Report Writing

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Understand the contextual use of the language after reading the text and practice the exercises.
- Know the purpose of the Memo and draft them
- Find out various formats of the Reports and use the appropriate one as per the need.

UNIT-III

Textual Lesson – 11
Email Writing, Cover Letter and Curriculum Vitae

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Understand the contextual use of the language after reading the text and practice the exercises.
- Know the email etiquette and draft the impressive email.
- Find out the strengths in one self and present them in resume.
- Design the impressive curriculum vitae career enhancement.

UNIT-IV

Textual Lesson – 12
Public speaking- Effective speaking

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

- Understand the contextual use of the language after reading the text and practice the exercises.
- Know the process and procedure of the public speaking.
- Use the learnt skills in their presentations.
- Deliver the effective presentation in front of their classmates.

UNIT-V

Textual Lesson – 13
Interviews –Personal grooming, How to prepare for an Interview, Interview process.

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

- Understand the contextual use of the language after reading the text and practice the exercises.
- Find out the ways to practice Mock interviews.
- Develop the confidence to meet the interviews.
- Focus on required skills to face the interviews confidently.

RECOMMENDED BOOKS:

Part – II (Communicate Units 7 to 13 only) of

Creative English for Communication by N Krishna Swamy & T Sriraman. McMillan India Ltd. (2005 version).

SUPPLEMENTARY READING:

1. Communicative skills for Technical Students by M Faratullah, Orient Longman.
2. Effective Technical Communication by Rizvi & MAshraf, McGraw-Hill.
3. Essentials of Business Communication by Rajendra Pal & J S KorlahaHi, Sultan Chand & Sons, New Delhi. ISBN: 8180547299, Year of Publication: 2012, Price: Rs.375/-.

SBT 222: BIOCHEMICAL TECHNIQUES LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

The biochemical techniques predominately embrace a broad cross-section of modern analytical techniques and latest sophisticated instruments like HPLC, GC etc. The course will help to build the knowledge about the handling of various instruments, where the biomolecules to be studied are subjected to various principles for its separation or purification.

Course Objectives:

The objective of the course is to make the students aware of the principle, operation and applications of various techniques used to analyze biomolecules. To understand the separation of biomolecules by means of various chromatographic methods.

1.Separation of biomolecules by paper chromatography

2.Separation of biomolecules by thin layer chromatography

3.Separation of amino acids/proteins by ion exchange chromatography

4.Separation of proteins by gel filtration and determination of molecular weight of a protein.

5.Separation of proteins by SDS PAGE and determination of molecular weight.

6.Purification of enzyme by affinity chromatography

7.Determination of molar extinction coefficient of tryptophan / tyrosine

8.Ultra violet absorption spectra of protein and nucleic acids

9.Separation of biomolecules by HPLC

10. Separation of lipids by GC.

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

- Separate, identify and quantify the biomolecules.
- Understand the principle, procedure and application of various biochemical separation techniques.
- Gain hands-on experience to handle and operate various chromatographs

RECOMMENDED BOOKS:

1. Modern experimental Biochemistry by Rodney Boyer, 3rd Edition, Benjamin-Cummings Pub. Co.
2. Biochemical methods By Sadasivam & Manikam, 3nd Edition, New Age International Pvt. Ltd. Publishers.
3. An introduction to practical biochemistry by DT Plummer, 2nd Edition, McGraw 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 Publishing House Ltd.

SBT 224: OBJECT ORIENTED PROGRAMMING LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

Object-oriented programming (OOP) is a programming paradigm based on the concept of "objects", which can contain data, in the form of fields and code, in the form of procedures. In OOP, computer programs are designed by making them out of objects that interact with one another. Many of the most widely used programming languages (such as C++, Java, Python, etc.) are multi-paradigm and they support object-oriented programming to a greater or lesser degree.

Course Objectives:

The objective of the course is to make the student differentiate between procedure-oriented programming and object-oriented programming with emphasis on special features of C++ language. It helps in understanding various inheritance mechanisms, operator overloading, polymorphism and their applications.

1. Write a program that contains a function to exchange (swap) values of two arguments by using pointers and References parameters.
2. Write a program to check the given string is palindrome or not using a private member function.
3. Write a program to Demonstrate Inline Function.
4. Write a program to add corresponding elements of two 2-D matrices using friend function. Create two classes each capable of storing one 2-D matrix. Declare the matrices under private access specifier and access them outside the class.
5. Write a program for finding area of different geometric shapes (Circle, Rectangle and Cube) using function overloading.
6. Write a Program to generate Fibonacci Series by using Constructor to initialize the Data Members.
7. Write a program to demonstrate a copy constructor.
8. Write a Program to demonstrate Constructors in derived class using friend function.
9. Write a program to demonstrate single inheritance distinguishing public and private derivation.
10. Write a program to illustrate the implementation of both Multilevel and Multiple (Hybrid) inheritance.
11. Write a program to reverse of a string using operators.
12. Write a program to find transpose of a given matrix of (m * n) size using unary operator overloading.
13. Write a program to add two matrices of (m * n) size using binary operator overloading.
14. Write a program to demonstrate the usage of virtual functions.
15. Write a program to find average marks of the subjects of a student. Throw multiple exceptions and define multiple catch statements to handle division by zero as well as array index out of bounds exceptions.

Learning Outcomes:

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

- Differentiate the fundamental concepts of C and C++ (L4).
- Identify the differences in C and C++ operators and their usage in C++ applications (L4).
- Examine the working of Control structures in C++ programs (L4).
- Develop and implement classes and objects (L3).
- Develop applications with the help of functions, constructors and destructors (L3).
- List the concepts of Polymorphism, Virtual functions and Exception handling and be able to develop applications with them (L4).

RECOMMENDED BOOKS:

1. Object Oriented Programming in C++ by E Balaguruswamy, 4th Edition, Tata McGraw-Hill Publication.

SPH 224: COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**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 Objectives:

To make student learn the practical application of Coordination Chemistry, States of Matter & Chemical Kinetics for quantitative analysis

Section A: Inorganic Chemistry

Semi-micro qualitative analysis using H2S of mixtures - not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : $NH4^{+}$, Pb^{2+}, Ag^{+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^{+}

Anions : $CO3^{2-}$, S^{2-}, SO^{2-}, $S2O3^{2-}$, $NO3^{-}$, $CH3COO^{-}$, Cl^{-}, Br^{-}, I^{-}, $NO3^{-}$,$SO4^{2-}$, $PO4^{3-}$, $BO3^{3-}$, $C2O4^{2-}$, F^{-}

(Spot tests should be carried out wherever feasible)

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of given coloured compound (KMnO4/ CuSO4) and estimate the concentration of the same in a given solution.
3. Determine the composition of the Fe^{3+}-salicylic acid complex solution by Job's method.
4. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
5. Estimation of total hardness of a given sample of water by complexometric titration.

Learning Outcomes:

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

- Learn semi-micro analysis.
- Learn to apply the concepts of coordination chemistry Job's method by instrumental methods of analysis
- Learn the concept of complexometric titration

Section B: Physical Chemistry

(I) Surface tension measurement (use of organic solvents excluded).
Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

(II) Viscosity measurement (use of organic solvents excluded).
Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

(III) Chemical Kinetics

Study the kinetics of the following reactions.

Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate

Learning Outcomes:

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

- Learn to apply the principles of chemical kinetics for ester hydrolysis.

RECOMMENDED BOOKS:

1. *Vogel's Qualitative Inorganic Analysis* by Svehla G, Pearson Education, 2012.
2. *Vogel's Quantitative Chemical Analysis* by Mendham J, Pearson, 2009.
3. 3. *Senior Practical Physical Chemistry* by Khosla BD, Garg VC & Gulati A, R Chand & Co., New Delhi (2011).

Note: Out of the above listed experiments eight experiments will be conducted.

V SEMESTER

SBT 301: METABOLISM-I

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 bioenergetics of living organisms.

Course Objectives:

The objectives of this course are to build the knowledge of undergraduate students about the metabolic significance of various catabolic and anabolic pathways and their integration. The course shall make the students aware of significance of metabolism and its regulation and disorders of 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 and photo phosphorylation.

Learning Outcomes:
By the end of this Unit, students will be able to:
- Understand the Principles of Bioenergetics.
- Understand the role of high energy compounds in biological systems.
- Understand the different mechanisms of phosphorylation reactions.

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 Glyoxylate cycle. Glycogen metabolism- Glycogenesis, Glycogenolysis and regulation.Glycogen storage diseases.

Learning Outcomes:
By the end of this Unit, students will be able to:
- Understand the anaerobic and aerobic energy yielding pathways
- Understand the significance of gluconeogenesis, HMP shunt and Glyoxylate cycle
- Understand the importance of Glycogen metabolism

UNIT-III
Saturated and Unsaturated Fatty acids - synthesis, β-oxidation and regulation.Ketonebodies.Synthesis of Triacyl glycerides, Phospholipids, Cholesterol and Lipo proteins.

Learning Outcomes:
By the end of this Unit, students will be able to:
- Understand the β-oxidation of fatty acids.
- Understand the significance of ketone bodies.

- Understand the Synthesis of Triacyl glycerides, Phospholipids, Cholesterol and Lipo proteins.

UNIT-IV

Synthesis of Eicosanoids - Prostaglandins, Leukotrienes and Thromboxanes.Synthesis of Sphingolipids and storage disorders.

Learning Outcomes:

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

- Understand the Synthesis of Eicosanoids.
- Understand the Synthesis of Sphingolipids.
- Understand the causes of lipid storage disorders.

UNIT-V

Source, requirement, function and deficiency disorders of macro elements (Calcium, Phosphorous, Magnesium, Sodium, Potassium, Chloride and Sulphur) and Micro elements (Iron, Copper, Iodine, Zinc, Cobalt and Fluorine)

Learning Outcomes:

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

- Understand the source, requirement, function and deficiency disorders of macro elements.
- Understand the source, requirement, function and deficiency disorders of Micro elements.

RECOMMENDED BOOKS:

1. Lehninger Principles of Biochemistry by Nelson D & Cox D, 7th Edition, McMillan Pub.
2. Biochemistry by L Stryer, 8th Edition (Freeman-Tappan).
3. Biochemistry by D Voet & JG Voet, 4th Edition (John weily).
4. Biochemistry by Garrett & 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.,* 30th Edition (Langeman).
9. Biochemistry by U Satyanarayana, 4thEdition.

SBT 303: METABOLISM-II

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 bioenergetics of living organisms

Course Objectives:

The objectives of this course are to build the knowledge of undergraduate students about the metabolic significance of various catabolic and anabolic pathways and their integration. The course shall make the students aware of metabolism and its regulation, disordersand integration.

UNIT-I

Protein turnover, Transamination and oxidative deamination, Urea cycle. Biosynthesis and degradation of aromatic and branched chain amino acids. Inborn errors of amino acid metabolism.

Learning Outcomes:
By the end of this Unit, students will be able to:
- Understand the protein turnover and formation of urea and degradation of amino acids.
- Understand the causes of inborn errors of amino acid metabolism.

UNIT-II
Synthesis of Heme, chlorophyll-a, Porphyrias. Degradation of Heme: formation of bilirubin and jaundice.

Learning Outcomes:
By the end of this Unit, students will be able to:
- Understand the synthesis of chlorophyll-a.
- Understand the degradation of heme and formation of bilirubin.
- Understand the causes of jaundice.

UNIT-III
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:
By the end of this Unit, students will be able to:
- Understand the synthesis and degradation of purines and pyrimidine nucleotides.
- Understand the causes of nucleotide metabolism disorders.

UNIT-IV
Metabolism of xenobiotics: PhaseI and Phase –II conjugation. Detoxification of Polycyclic aromatic hydrocarbons (PAHs), Aspirin and Alcohol. Role of cytochrome P450 in detoxification.

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

- Understand the metabolism of xenobiotics.
- Understand the role of cytochrome P450 in detoxification xenobiotics.

UNIT-V

Integration of metabolism, Coordination and control. Role of Liver, Adipose tissue, muscle and brain in metabolic coordination.

Learning Outcomes:

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

- Understand the Integration of metabolism.
- Understand the metabolic coordination different organs.

RECOMMENDED BOOKS:

1. Lehninger Principles of Biochemistry by Nelson D & Cox D, 7th Edition, Mcmillan Pub.
2. Biochemistry by L Stryer, 8th Edition (Freeman-Tappan).
3. Biochemistry by D Voet & JG Voet, 4th Edition (John weily).
4. Biochemistry by Garrett & 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.*, 30th Edition (Langeman).
9. Biochemistry by U Satyanarayana, 4th Edition.

SBT 305: ENZYMOLOGY AND ENZYME TECHNOLOGY

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

Credits : 04 **Sessional : 40 Marks**

Preamble:

This course enables a learner to makes an insight into the enzymes, known as macromolecular biological catalysts that enhances the basic biochemical reactions and fine-tunes the metabolism with high accuracy. Understanding the basic process of biochemistry and are very much crucial for many applications of biological research with specific emphasis on enzyme kinetics, inhibition and regulation. The course shall make the students aware of various functions of enzymes within the context of each topic.

Course Objectives:

To educate students about the fundamental concepts of Enzymology & Enzyme Technology and its related commercial applications, thus preparing them to meet the challenges in medicine and industry. To enhance the basic knowledge and to bring awareness on enzyme inhibition and regulatory processes. To improve the knowledge about the enzyme immobilization

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

- Gain fundamental knowledge on basic concepts of enzymes
- Give account on various factors which influence enzyme activity

UNIT-II

Enzyme Kinetics: Determination of initial velocity, 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:
By the end of this Unit, the student will be able to:

- Understand the molecular basis of enzyme kinetics and various types of inhibitions from the perspective of biochemical pathways occur in biological cellular environments, which are very important in the understanding the life processes.

UNIT-III

Active site determination / investigation: Mechanism of enzyme action of Carboxypeptidase-A and Ribonuclease-A. Multienzyme systems (PDH complex & Fatty acid synthase complex). Isolation and purification of enzymes. Enzyme regulation: Allosteric enzymes, zymogen activation, covalent modification and isoenzymes.

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

- Understand the active site investigation to decipher the key active site residues.
- Gain knowledge about the fine-tuning of metabolism by means of enzyme regulation.
- Purify the enzymes under controlled conditions.

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

- Be familiar with various types of enzyme immobilization.
- Apply the knowledge of enzyme immobilization technology in medicine and industry.

UNIT-V

Abzymes – Types and strategies for designing abzymes. Ribozymes – Types and mechanism of action. Synzymes, Enzyme engineering by site-directed-mutagenesis. Production of extracellular microbial enzymes: protease and amylase.

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

- Gain knowledge about design strategies for making abzymes.
- Understand the synzymes and ribozymes with respect to their mechanism and functions.
- Produce extracellular microbial enzymes

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 *et.al*., 2nd Edition, Pearson Publishers.
8. Biochemical engineering fundamentals by Bailey & Ollis, 2nd Edition, McGraw-Hill Lange Publishers.

SPH 383: GREEN 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 green techniques in synthetic and analytical chemistry. This course will lay the foundation for the student to be able to appreciate eco-friendly methods in chemistry and develop as a responsible chemist forth benefit of the society and environment.

Course Objectives:
The concept of green chemistry encompassing green chemistry strategies, concepts and practices will be introduced to the undergraduate students. Students will also learn the fundamental concepts of various green synthetic methods and techniques for quantitative analysis. The student will also Green separation and extraction for sample preparation

UNIT-I

Introduction to Green Chemistry
Green chemistry - Introduction - need for green chemistry - goals of green chemistry - Anastas' twelve principles of green chemistry - Designing a green synthesis (tools) - choice of starting materials, solvents, catalysts, reagents, processes with suitable examples.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Learn the goals and principles of green chemistry.

UNIT-II

Ionic liquids - synthesis, physical properties of ionic liquids - applications in alkylation, epoxidation, Friedal-Crafts reaction - Diels-Alder reactions – Knoevengal condensations and Wittig reactions.
Phase Transfer Catalyst (PTC) - Definition - advantages, types of PTC reactions - synthesis of PTC, applications of PTC in organic synthesis - Michael reaction - alkylation of aldehydes and ketones. Wittig, generation of dihalocarbene, elimination reaction

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Learn the properties of ionic liquids and synthesis of molecules using the green solvents-ionic liquids.

UNIT-III

Supercritical CO_2- phase diagram - uses in extracting natural products, dry cleaning, bromination, Kolbe-Schmidt synthesis - Friedel-crafts reaction. Dimethyl carbonate as a methylating agent in green synthesis

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Learn the concept of atomic spectrometry for quantitative analysis.

UNIT-IV

Microwave and Ultrasound Assisted Reactions
Microwave activation - advantages of microwave exposure - Microwave assisted reactions, condensation reactions - oxidation, reduction reactions, multicomponent reactions.
Sonochemistry - use of ultrasound in organic synthesis (alternate source of energy) - saponification - substitution, addition, oxidation reactions, reductions.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Disseminate the basic thermo and electro-analytical methods for chemical analysis.

UNIT-V

Green Analytical Techniques
Micelle mediated extraction- Cloud point extraction and adsorptive miceller flocculation methods. Solid Phase Micro Extraction (SPME)

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Learn concept of separation methods in chemical analysis.

RECOMMENDED BOOKS:

1. Green Chemistry by Paul T Anastas & John C Warner, Oxford University Press, Indian Edition, 2008.
2. New Trends in Chemistry by VK Ahluwalia & M Kidwai, Anamaya Publishers, 2nd Edition, 2007.
3. An Introduction to Green Chemistry by V Kumar, Vishal Publishers, 1st Edition, 2007.
4. Green Solvents by VK Ahluwalia & RS Varma, Narosa Publishing, 1st Edition, 2009.
5. Organic Synthetic Special Techniques by VK Ahluwalia & Renu Aggarwal, Narosa, 2nd Edition, 2009.
6. Green Chemistry - Environmentally Benign Reactions by VK Ahluwalia, Ane books, India, 2006.
7. Introduction to Green Chemistry by Matlack AS, Marcel Dekker (2001).

SBT 321: ENZYMOLOGY LAB

Hours per week : 06 **End examination: 40 Marks**

Credits : 03 **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. They are 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 to understand the kinetics aspects of enzymes.

Course Objectives:

The main objective of the course is 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 behaviour at various temperatures, pH etc. with respect to the kinetic parameters such as Km and Vmax. To make students gain expertise in purifying the enzymes using various chromatographic approaches.

1. Assay of Salivary amylase
2. Assay of bovine pancreatic trypsin
3. Assay of potato acid-phosphatase
4. Assay of bovine pancreatic RNase
5. Assay of bovine pancreatic DNase
6. Effect of pH on enzyme activity and determination of optimum pH
7. Effect of temperature on enzyme activity and calculation of activation energy
8. Effect of substrate concentration on enzyme activity and determination of Km
9. Effect of metal ions on enzyme activity
10. Partial purification of enzymes – Salt precipitation
11. Partial purification of enzymes Gel filtration
12. Purification of enzymes Ion-exchange chromatography

Learning Outcomes:

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

- Gain hands-on experience in conducting various enzyme assays and analysis
- Perform enzyme kinetics related experiments.
- Conduct partial purification of enzymes using different chromatographic methods

RECOMMENDED BOOKS:

1. Enzyme assay: A Practical Approach by R Eisenthal & MJ Danson, 1992 Edition, IRL Press.
2. Biochemical methods by Sadasivam & Manickam, Wiley Eastern limited.
3. An introduction to practical Biochemistry by DT Plummer, 3rd Edition, McGraw-Hill.
4. Biochemistry - A laboratory courses by JM Beckar, 2nd Edition, Academic Press.
5. Introductory practical Biochemistry by SK Sawhney & Randhir Singh (Eds), Narosa Publishing House.

SPH 341: GREEN CHEMISTRY LAB

Hours per week : 06 **End examination: 40 Marks**

Credits : 03 **Sessional : 60 Marks**

Preamble:

The students of undergraduate program in science in Chemistry need to be conversant with the various basic methodologies of green chemistry. Therefore, green chemistry is introduced which helps the student familiarize with the techniques essential for green chemistry.

Course Objectives:
To make student to learn the practical application of green analytical and synthetic techniques for waste utilization.

1. **Safer starting materials**
   Preparation and characterization of nanoparticles of gold using tea leaves.

2. **Using renewable resources**
   Preparation of biodiesel from vegetable waste cooking oil.

3. **Avoiding waste**
   Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied
(I) Triethylamine ion + OH^- → propene + trimethylpropene + water
H_2SO_4/□
(II) 1-propanol ⟶ propene + water

Other types of reactions, like addition, elimination, substitution and rearrangement should also bestudied for the calculation of atom economy.

4. Use of enzymes as catalysts
Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

5. Alternative Green solvents
Extraction of D-limonene from orange peel using liquid CO2 prepared form dry ice.
Mechanochemical solvent free synthesis of azomethines

6. Alternative sources of energy
1. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
2. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Learning Outcomes:
By the end of this Course, students will be able to:
- Learn synthesis of nanomaterial, biodiesel and simple organic molecules.

RECOMMENDED BOOKS:

1. Green Chemistry: Theory and Practice by Anastas PT & Warner JC, Oxford University Press (1998).
2. Greener approaches to undergraduate chemistry experiment by Kirchoff M & Ryan MA, American Chemical Society, Washington DC (2002).
3. Introduction to Green Chemistry by Ryan MA *et.al*, American Chemical Society, Washington DC (2002).
4. Green Chemistry Experiment: A monograph by Sharma RK, Sidhwani IT & Chaudhari MK, IK International Publishing House Pvt. Ltd., New Delhi, Bangalore, 2013.
5. Real world cases in Green Chemistry by Cann MC & Connelly ME, American Chemical Society, 2008.

Note: Out of the above listed experiments ten experiments will be conducted.

VI SEMESTER

SBT 302: MOLECULAR BIOLOGY

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

Credits : 04 **Sessional : 40 Marks**

Preamble:

Molecular biology is a branch of biology that concerns the molecular basis of biological activity. It is the study of the structure, function, processing, regulation, interaction and evolution of biomolecules in the various systems of a cell, including molecular genetics.

Course Objectives:

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

Nature of genetic material, organization of genetic material in prokaryotes and eukaryotes. Structure of chromatin, Fine structure of the gene. Different kinds of genes - split genes, overlapping, assembled, polyprotein and nested genes. Gene amplification and polytene chromosome. C - Value paradox, Mitochondrial and plastid genomes.

Learning Outcomes:

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

- Acquire basic knowledge on molecular architecture of prokaryotic and eukaryotic genomes.

UNIT-II

DNA replication - Types of DNA polymerases. Mechanism of DNA replication. Enzymes and accessory proteins involved in DNA replication. Replication of telomeres and its significance. Differences in prokaryotic and eukaryotic DNA replication and regulation. DNA damage and repair.

Learning Outcomes:

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

- Learn various molecular events that lead to duplication of DNA.
- Understand the mechanisms by which DNA could be damaged and repairs itself will be also studied.

UNIT-III

Transcription in prokaryotes and eukaryotes. Mechanism of transcription, types of RNA Polymerases and Promoter-Polymerase interactions. Transcriptional factors. Processing of mRNA, tRNA and rRNA. RNA editing and transport. Molecular Tools - Run-Off Transcription and G-Less Cassette Transcription. Nuclear Run-On Transcription, Reporter Gene Transcription,

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

- Learn the basic mechanism and methods to measure rate of gene expression.

UNIT-IV

Translation in prokaryotes and eukaryotes: Genetic code, translational machinery, mechanism of initiation, elongation and termination. Regulation of translation, Co- and Post- translational modifications. Leader sequences and protein targeting. Measuring Protein Accumulation *in vivo*. Methods for studying DNA-protein interactions: EMSA, DNase I footprinting, methylation interference assay and CHIP. Methods for studying protein-protein interactions: Co-immunoprecipitation, Pull-down assay, Cross-linking protein interaction analysis, Label transfer protein interaction analysis, Far–western blot analysis**.**

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

- Learn how expressed genes can be translated into proteins following a central dogma.
- Learn the methods to study DNA and protein interactions.

UNIT-V

Regulation of gene expression in prokaryotes and eukaryotes - the operon concept, Negative and Positive control and Attenuation. Role of Enhancers, Cis-trans elements, DNA methylation and Chromatin remodeling in gene expression. Environmental regulation of gene expression. RNAi and gene silencing, Genome editing mechanisms - ZFNs, TALENS, CRISPR-Cas9.

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

- Understand 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. Cell and Molecular Biology by DeRoberties & DeRoberties, 8th Edition, S Chand & Co.
4. Freifelder's Essentials of Molecular Biology by GM Malacinski, 4th Edition, Jones & Bartlett.
5. DNA Science: A First Course by DA Micklos *et.al.*, 2nd Edition, Carolina Publishing Company.
6. Molecular Biology of the Gene by JD Watson *et.al.*, 7th Edition, Benjamin-Cummings Pub. Co.
7. Molecular Biology by Robert F Weaver, 5th Edition, McGraw-Hill.

SBT 304: IMMUNOLOGY-I

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

Preamble:

This course deals about the structure and organization and biological functions 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 concept of tolerance and the factors contributing to tolerance. The course explains how the immune system responds in autoimmunity.

Course Objectives:

The main objective of the course is to make student learn about different cells, organs and other components of the immune system. They will learn about the development and activation of B cells and T cells and the processing and presentation of antigens. Course helps to gain awareness on different kinds of immune responses, humoral, cell mediated, complement and inflammatory pathways. This course aims to get knowledge on tolerance and autoimmunity

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 antigenecity. Superantigens. B and T cell epitopes.

Learning Outcomes:
By the end of this Unit, students will be able to:
- Learn different cells and various lymphoid organs of the immune system.
- Comprehend 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.
- Learn the functions of different classes of antibodies and antibody diversity.
- Gain knowledge on 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 disequilbrium. 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.
- Know the significance of MHC in antigen processing and presentation.
- Gain knowledge on biological functions of cytokines.

UNIT-IV

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

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

- Gain knowledge about complement system.
- Understand the functions of Cytokines.
- Have complete idea on the mechanism of inflammation.

UNIT-V

Immunological tolerance - Factors involved in maintaining tolerance. Autoimmune diseases-Organ specific and Systemic. Hypersensitivity - Mechanism and pathophysiology of different types of hypersensitivity.

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

- Understand about tolerance.
- Get complete understanding on the incidences of Autoimmunity.
- Understand about Hypersensitivity.

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.
8. The Immune System by Charles Janeway *et.al.,* Garland Publishing.

SBT 306: PHYSIOLOGY

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

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 animals (Circulatory, respiratory and excretory system).

UNIT-I

Water relations: Cell water potential, soil plant atmosphere continuum. Photosynthesis: Light absorption, emission, energy transfer, Z-scheme of photosynthesis, electron transfer, photophosphorylation, CO_2 fixation in C3, C4, CAM plants, environment and its impact on photosynthesis.

Learning Outcomes:
By the end of this Unit, students will be able to:
- Explain the inextricable link between energy gain and water loss in land plants.

UNIT-II

Photorespiration: Respiration complexes, structure, function and regulation; cyanide resistant respiration. Plant hormones: Biosynthesis, transport, regulation and applications.

Learning Outcomes:
By the end of this Unit, students will be able to:
- Explain plant responses to environmental stimuli.
- Define hormone and explain its general role as a signal transducer.

UNIT-III

Composition of blood, coagulation of blood and fibrinolysis. Circulatory systems: general plan, electrical and mechanical properties of myogenic and neurogenic hearts. Heart - cycle including electrocardiogram, Hemodynamics. Cardiovascular response to extreme conditions like exercise, diving and hemorrhage. Neural control of cardiovascular system. Respiratory system: respiratory pigments, transport of gases in blood, regulation of body pH, respiratory response to extreme conditions like hypoxia, diving and exercise. Physiology of respiration and neural control of breathing.

Learning Outcomes:
By the end of this Unit, students will be able to:
- Understand the interrelationship between structure and function of each of the cardiovascular and respiratory systems and how these two systems contribute to homeostasis.

UNIT-IV

Structure of nerve cell, Origin of membrane potential, Mechanism of propagation of nerve impulse in unmyelinated and myelinated nerve fibres. Neuro transmitters. Structure and organization of muscle cells. Biochemical changes associated with muscle contraction and relaxation.

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

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

UNIT-V

Gastrointestinal system: Functional structure of digestive glands - salivary glands, pancreas, liver, gastric and intestinal wall glands- neural and hormonal regulation of secretion of digestive juices. Digestion of food nutrients in different parts of the alimentary canal in animals. Absorption of food- the molecular structure of the absorptive surface. Assimilation of food, egestion. The peristaltic movements, their regulation and significance.

Excretory system: Functional anatomy of kidney - the nephron and its functions, the mechanism of urine formation and its concentration - the countercurrent theory, electrolyte balance, acid-base balance. The feedback and hormonal control of renal functions. Micturition

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

- Recognize and describe the main components of the digestive and renal systems and demonstrate knowledge of how they contribute to the maintenance of homeostasis.
- Recognize 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. Text book of Medical Physiology by AG Guyton & JE Hall, 11th Edition, Harcourt, Asia.
3. Medical Physiology by Sembulingam.
4. Human Physiology by Ross & Wilson.
5. Text book of Medical Biochemistry by Chaterjee, Jaypee.
6. Harper's Biochemistry by RK Murray *et.al.,* 30th Edition, McGraw-Hill Lange Publishers.

SPH 382: INDUSTRIAL CHEMICALS AND ENVIRONMENT

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

Preamble:

With industrial development in gigantic proportions, the onus of safeguarding the environment from the hazard of the chemicals synthesis, usage and disposal lies a great deal on every individual. It becomes imperative to inculcate the education related to safe use of handling of chemicals. An understanding of the potential hazards and precautions required in handling of chemicals is of utmost importance in preventing exposure to chemicals and mishaps.

Course Objectives:

Individual and material safety is of utmost importance in any organization. Many times accidents take place due to unsafe working in environment. Wide ranges of chemicals are used in universities, national laboratories and industries, each with its own inherent hazards. The course is designed to impart basic knowledge of production, uses, storage and hazards in handling industrial gases and chemicals. Essential knowledge of the components of the environment, sources of pollution and pollutants shall be imparted to the students

UNIT-I

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of thefollowing gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling thefollowing chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Learning Outcomes:

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

- Learn about the production, uses, storage and hazards in handling industrial gases and chemicals.

UNIT-II

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere.Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by SO_2 , CO_2, CO, NOx, H_2S. Methods of estimation of CO, NOx, SOx and control procedures.

Learning Outcomes:

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

- Learn about the biogeochemical cycles in environment and air pollution: sources and pollutants.

UNIT-III

Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal.Control of particulates.

Water Pollution : Hydrological cycle, water resources, aquatic ecosystems, Sources andnature of

water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Learn the concept of global warming.
- Learn about water pollution.

UNIT-IV

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: textile, tannery, dairy, petroleum and petrochemicals.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Disseminate with water quality parameters, water and wastewater treatment and industrial waste treatment.

UNIT-V

Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Learning Outcomes:
By the end of this Unit, the student will be able to:
- Learn about sources of energy.
- Learn about nuclear pollution and waste management.

RECOMMENDED BOOKS:

1. Industrial Chemistry by E Stocchi, Volume-I, Ellis Horwood Ltd. UK.
2. Elementary Principles of Chemical Processes by RM Felder & RW Rousseau, Wiley
3. Publishers, New Delhi.
4. Riegel's Handbook of Industrial Chemistry, by JA Kent, CBS Publishers, New Delhi.
5. A Textbook of Engineering Chemistry by SS Dara, S Chand & Company Ltd., New Delhi.
6. Environmental Chemistry by K De, New Age International Pvt. Ltd, New Delhi.
7. Environmental Pollution Analysis by SM Khopkar, Wiley Eastern Ltd., New Delhi.
8. Environmental Chemistry by SE Manahan, CRC Press, 2005.
9. Environmental Science by GT Miller, 11th Edition, Brooks/Cole, 2006.
10. Environmental Studies by A Mishra, Selective and Scientific Books, New Delhi, 2005.

SBT 322: MOLECULAR BIOLOGY LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

This course would familiarize students with facile molecular techniques involved in isolation and manipulation of genetic material. Training in various molecular techniques for gene manipulation help students in basic and applied research.

Course Objectives:

The experiments are designed to make students gain hands on experience to isolate DNA and RNA from prokaryote and eukaryotes; to know the extraordinary power of restriction and other enzymes in molecular cloning and genetic manipulations.

1. Isolation of Prokaryotic genomic DNA from bacteria.
2. Isolation of plasmid DNA.
3. Isolation of Eukaryotic genomic DNA (Plant / animal).
4. Southern blotting technique.
5. Estimation of DNA using Diphenylamine reagent by spectrophotometry.
6. DNA Denaturation and Hyperchromic effect.
7. Isolation of RNA from yeast.
8. Estimation of RNA using Orcinol reagent by spectrophotometry.
9. Demonstration of cDNA synthesis from RNA.
10. Northern Blotting technique.

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

- Apply landmark discoveries in developing a number of facile molecular techniques used in rDNA technology.
- Isolate DNA and RNA from prokaryote and eukaryotes.
- Gain hands-on training in various molecular techniques for gene manipulation.

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.

SPH 340: INDUSTRIAL CHEMICALS & ENVIRONMENT LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

Application of basic chemistry and chemical calculations to measure chemical, parameters of water and waste water. Laboratory methods and interpretation of results with regard to environmental analysis are important for studying the pollution trend.

Course Objectives:

To introduce students to how the common environmental experiments relating to water and wastewater quality are performed. This course will help students know which tests are appropriate for given environmental problems and apply the laboratorial results to problem identification, quantification and basic solutions.

1. Determination of dissolved oxygen (DO) in water.
2. Determination of Chemical Oxygen Demand (COD).
3. Determination of Biological Oxygen Demand (BOD).
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO^{3-}) using double titrationmethod.
7. Measurement of dissolved CO_2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Learning Outcomes:

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

- Perform environmental experiments relating to water and wastewater quality, and know which tests are appropriate for given environmental problems.

RECOMMENDED BOOKS:

1. Industrial Chemistry by E Stocchi, Volume-I, Ellis Horwood Ltd., UK.
2. Elementary Principles of Chemical Processes by RM Felder & RW Rousseau, Wiley Publishers, New Delhi.
3. Riegel's Handbook of Industrial Chemistry, by JA Kent, CBS Publishers, New Delhi.
4. A Textbook of Engineering Chemistry by SS Dara, S Chand & Company Ltd., New Delhi.
5. Environmental Chemistry by K De, New Age International Pvt., Ltd., New Delhi.
6. Environmental Pollution Analysis by SM Khopkar, Wiley Eastern Ltd., New Delhi.

VII SEMESTER

SBT 401: GENETIC ENGINEERING

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

Preamble:

This course has been designed to enrich students' understanding about isolation of DNA, chemical synthesis of DNA and techniques of gene transfer, gene cloning and various hybridization techniques. The course also helps to understand about construction of genomic libraries and different variants of PCR.

Course Objectives:

To enlighten the students about rDNA technology. To teach students about various approaches in conducting genetic engineering and their application in biotechnology industry

UNIT-I

Isolation of DNA, cDNA synthesis, chemical synthesis of DNA by Phosphoramidite method. Enzymes used in genetic engineering. Restriction endonucleases and Restriction mapping, DNA Ligase, DNA polymerase I, Taq polymerase, Reverse transcriptase, Sl nuclease, Terminal nucleotide transferase, Alkaline phosphatase, Polynucleotide Kinase, Polynucleotide phosphorylase.

Learning outcome:

On completion of this practical course, the student will be able to

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

UNIT-II

Cloning vectors - Salient features, plasmid vectors, phage vectors, cosmids, phagemids (Lambda and M13 phages), viral vectors (SV40, Baculo virus and CMV), Artificial chromosomes - BAC, YAC and MAC. Ligation of DNA to vectors - cohesive end, blunt end, homopolymer tailing, linkers and adaptors.

Learning outcome:

On completion of this practical course, the student will be able to

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

UNIT-III

Gene transfer Techniques - Transformation, Transfection, Microinjection, Electroporation, Lipofection and Biolistics. Reporter gene assay, selection and expression of rDNA clones, purification of recombinant proteins by affinity tags. Polymerase Chain Reaction, Variants of PCR (Nested PCR, Inverse PCR, RT-PCR, MT-PCR and Real-time PCR) and their applications.

Learning outcome:

On completion of this practical course, the student will be able to

- Understand various gene transfer techniques
- Perceive the concept of recombinant protein production
- Have clarity on PCR and its variants

UNIT-IV

Construction of genomic libraries and cDNA libraries. Colony and Fluorescent *in situ* hybridization, Southern, Northern and Dot blotting techniques. Nucleic acid probes and probe construction. DNA microarray technology.

Learning outcome:

On completion of this practical course, the student will be able to

- Be able to distinguish genomic and cDNA library construction
- Visualize the concept of in situ hybridization
- Understand the principle of molecular probes

UNIT-V

DNA sequencing by Chemical, Enzymatic, Automated and NGS methods. Salient features of human genome project. Applications of genetic engineering in Agriculture, Animal husbandry, Medicine and Industry.

Learning outcome:

On completion of this practical course, the student will be able to

- Understand the concept of DNA sequencing
- Appreciate the salient features of human genome project
- Analyse the application of genetic engineering in different areas

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 analysis an introduction by TA Brown, 5th Edition, Blackwell Pub.
4. Genomes by TA Brown, 3rd Edition, Garland Science publishers.
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 Learning Publishers.

SBT 403:PLANT BIOTECHNOLOGY

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

Credits : 04 **Sessional : 40 Marks**

Preamble:

This course has been designed to enrich students to understand basic principles and impart theoretical knowledge on various techniques of plant tissue culture and plant genetic transformation and their application in crop improvement. This course introduces students to key principles of marker assisted selection and applications of DNA markers for crop improvement.

Course Objectives:

To impart theoretical knowledge on various techniques of plant biotechnology like tissue culture, plant genetic transformation, molecular markers, marker assisted selection, biofertilizers and their application in Agri -biotech industries**.**

UNIT-I

Plant tissue culture: Historical perspective, Sterilization techniques, media preparation - nutrients and plant hormones. Establishment of *in vitro* cultures- callus culture, cell suspension culture, organogenesis, somatic embryogenesis and cyto differentiation. Mode of action and significance of Phytohormones.

Learning outcomes:

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

- Gain fundamental knowledge in media preparation and the role of nutrients in plant growth and development.
- Develop and understand the establishment of *in vitro* cultures
- Understand the action and significance of Phytohormones in Plant tissue culture

UNIT-II

Micropropagation - Stages and applications. Methods to detect pathogens in propagation sources, procedures to eliminate pathogens from plant parts. Production of haploids - Anther, Pollen, Embryo and Ovule culture and their applications. Protoplast isolation, culture and usage. Somatic hybridization - methods and applications, cybrids, somaclonal variations, artificial seeds and germplasm conservation.

Learning outcomes:

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

- Gain knowledge in various techniques of Plant tissue culture and their applications and in situ and ex situ conservation methods.
- Understand the methods to detect and eliminate pathogenes during *in vitro* propagation.
- Identify the advantages and limitations of haploid cultures and the process of somatic hybridization.

UNIT-III

Methods of gene transfer in plants- *Agrobacterium* mediated (Ti and Ri plasmids, T-DNA transfer), PEG - mediated, Particle bombardment gene gun transformation. Advanced methodologies - cisgenesis, intragenesis and genome editing.Identification of transgenic plants.

Molecular markers (RFLP, RAPD, AFLP and SSR) - Principle and their applications in crop improvement. Marker assisted selection (MAS) - strategies for introducing genes of agronomic importance.

Learning outcomes:

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

- Understand various methods of gene transfer in plants and their advantages and limitations.
- Learn key principles of molecular markers and strategies used in introducing genes for crop improvement.

UNIT-IV

Transgenic crop technology: Development of herbicide resistant transgenic crops; insect resistance - Bt toxin, Protease inhibitor and other plant derived insecticidal genes; crop engineering for disease resistance (bacterial, fungal and viral) and genetic improvement of abiotic stress tolerance. Molecular Pharming: Production and applications of edible vaccines and plantibodies in plants.

Learning outcomes:

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

- Gain knowledge in transgenic technology and their applications to overcome biotic and abiotic stress
- Learn the techniques involved in molecular pharming and their applications.

UNIT-V

Engineering for nutritional quality - Improved seed storage proteins, improving and altering the composition of starch and plant oils. Enhancement of micro-nutrients - beta carotene and iron. Introduction, types and industrial improtance of Plant Secondary metabolites.Types of nitrogen fixing microorganism - Rhizobium, Azotobacter, Azolla, Cyanobacteria and Fungal biofertilizers, *nif* gene.Mode of action of Biofungicides (*Trichoderma*, *Pseudomonas fluorescens*) and Bioinsecticides (*Bacillus thuringiensis*, Baculoviruses).

Learning outcomes:

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

- Learn the applications of genetic engineering and gene transfer technique in improvement of nutritional quality in various crops.
- Develop and understand the types and importance of Plant secondary metabolites.
- Understand the mode of action of various biofertilizers and enhancement of crop yield by its application.

RECOMMENDED BOOKS:

1. Plant Biotechnology: The genetic manipulation of plants by A Slater, NWScott & MR Fowler, 2nd Edition, Oxford University press.
2. Biotechnologies of Crop Improvement, Volume I: Cellular Approaches by SS Gosal & SH Wani, Reprint 2018, Springer.
3. Plant Breeding principles & Methods by BD Singh, Reprint 2015,Kalyani Publishers.
4. Plant Cell and Tissue Culture by JW Pollard& JM Walker, Springer Publishers.
5. Agricultural biotechnology by SS Purohit, 3rd Edition, Agrobios Publications.
6. An Introduction to Plant Tissue Culture by MK Razdan, 3rd Edition, Oxford and IBH Publishing.
7. Introduction to Plant Biotechnology by HS Chawla, 3rd Edition, Oxford and IBH Publishing.

SBT 405: ANIMAL BIOTECHNOLOGY

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

Credits : 04 **Sessional : 40 Marks**

Preamble:

This course deals with basic methodology associated with cell, tissue and organ culture and importance of media and kinetics of cell growth. This paper explains the properties of stem cells and induced pluripotency. This course reviews various aqua culture practices. This course gives a detailed view on Tissue engineering and transgenic techniques.

Course objectives: The objectives of this course are to introduce the techniques of cell, tissue and organ culture, stem cells and induced pluripotency. Student will learn about basics and advanced developments in tissue engineering. This course also helps to make students aware of different practices employed for culturing fish, prawn and pearls and different methods used in the production of transgenic plants/animals.

UNIT-I

Basic techniques of cell, tissue and organ culture. Kinetics of cell growth. Properties of transformed cells. Role of carbon dioxide, serum and other supplements in cell culture. Different types of culture media - natural media, BSS, MEM and serum free media. Different methods for the estimation of cell viability and cytotoxicity. Applications of cell culture. Sources of cell culture contamination and eradication. Bioethics and Biosafety.

Learning outcomes:

By the end of this unit, the student should be able to understand

- Basic requirements for cell, organ and tissue culture and culture kinetics
- Management of culture contamination
- Bioethics and biosafety

UNIT-II

Stem cells - embryonic and adult stem cells. Isolation and culture of stem cells. Cancer stem cells. Induced pluripotency. Stem cell markers. Stem cell plasticity and differentiation. Application of stem cells in medicine. Apoptosis - mechanism and significance with reference to neuro degenerative diseases - Parkinson's disease and stroke.

Learning outcomes:

By the end of this unit, the student should be able to understand

- Properties and types of stem cells and cancer stem cells
- Induced pluripotency
- Mechanism of Apoptosis and Apoptosis in neurodegenerative disorders

UNIT-III

Tissue engineering: General process of bioengineering artificial tissue, Design principles, 2D Vs 3D Culture. Cell Sourcing, Biomaterials - Classification, Tensile properties, Biocompatibility, Biomimetic. Tissue Fabrication Technology - Scaffold free, scaffold based, cell patterning techniques. Rapid prototyping technology, printing and organ on achip model. Vascularization of Artificial tissue, Bioreactors - Classification and design considerations, Tissue engineering: Bio-artificial skin, liver and pancreas.

Learning outcomes:

By the end of this unit, the student should be able to understand

- Process and basic principles of tissue engineering
- Tissue fabrication technology
- Tissue engineering methods in the production of Skin, liver and pancreas

UNIT-IV

Aquaculture. Freshwater fish culture and prawn culture practices. Brackish water fish, shrimp and crab culture practices. Pearl culture. Fish byproducts. Induced breeding techniques. Hypophysation and Eyestalk oblation. Economically important aquatic resources.

Learning outcomes:

By the end of this unit, the student should be able to understand

- Culture practices of fish, prawn and shrimp
- Pearl culture technology
- Artificial breeding techniques

UNIT-V

Production of transgenic animals - mouse, sheep, cattle and fish by microinjection, retroviral vector method and embryonic stem cell method. Animal cloning - somatic cell nuclear transfer and embryonic stem cell nuclear transfer methods. Biopharming and gene knockout.

Learning outcomes:

By the end of this unit, the student should be able to understand

- The process of production of transgenic animals
- The mechanism of animal cloning
- Biopharming and gene knockout

RECOMMENDED BOOKS:

1. Culture of Animal cells: A manual of Basic techniques by R Ian Freshney, 6th Edition, Wiley-Blackwell publishers.
2. Molecular Biotechnology: Principles and applications of recombinant DNA technology by BR Glick, JJ Pasternak & CL Patten, 4th Edition, ASM Press.
3. Elements of Biotechnology by PK Gupta, Rastogi Publications.
4. Biotechnology by U Satyanarayana, 3rd Edition, Books and Allied Sciences Publishers
5. Concepts of Biotechnology by Balasubrahmanian*et al.,* Revised Edition, University press.
6. Aquaculture: Principles and practices by TVR Pillay, Reprint 1993, Wiley publishers.
7. Coastal aquaculture in India by Santhanam, CBS Publishers.
8. A Textbook of Fisheries Science and Indian Fisheries by CBL Srivatsava, Kitab Mahal publishers.

SBT 407: IMMUNOLOGY-II

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

Preamble:

This course deals with the advanced concepts in Immunology. This course gives a comprehensive view on different immunological techniques based on antigen and antibody reactions. This course also helps in analyzing the immune responses in transplantations and in various infections. This course also helps the student get a view on immunodeficiencies and cancer biology and a detailed understanding on the role of immune system in cancer resistance.

Course objectives:

Student will learn about different techniques based on antigen and antibody interactions. Student learns about the response of immune system inorgan and cellular transplantations. Student can get a detailed view on cancer biology and immune response in cancer resistance. Students will learn about the functioning of immune system in immune deficiencies.

UNIT-I

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, the student should be able to understand

- Understand about antigen and antibody interactions
- Learns different immunological techniques

UNIT-II

Transplantation immunology. Immunological response in transplantation and graft rejection, Clinical manifestations of graft rejection, Tissue typing. GVHD. General and Specific immunosuppressive therapies. Immune tolerance to allografts. Applications of organ and cellular transplantation.

Learning outcomes:

By the end of this unit, the student should be able to understand

- Understand immune response in transplantation
- Learns about Immunosuppressive therapies
- Analyze the process of organ transplantation

UNIT-III

Nature of immune responses in different types of infections.Viral Infections - nature of immune response in influenza and H5N1 infection. Bacterial infections - Nature immune response to extra cellular and intracellular bacteria. Immune responses in Diphtheria and Tuberculosis infections. Parasitic infections-Malaria, African sleeping sickness, Leishmaniasis and infections caused by

parasitic worms like helminths.

Learning outcomes:

By the end of this unit, the student should be able to understand

- Understand immune response in transplantation
- Learns about Immunosuppressive therapies
- Analyze the process of organ transplantation

UNIT-IV

Immune responses in Immunodeficiency diseases: Congenital immunodeficiencies - Role of T cells and B cells, Severe combined immunodeficiency (SCID), Wiskott-Aldrich Syndrome (WAS), X-linked agammaglobulinemia, common variable immunodeficiency (CVI) Acquired Immunodeficiencies- immunobiology of HIV infection and AIDS. Therapeutic options and challenges in the treatment of HIV infection.

Learning outcomes:

By the end of this unit, the student should be able to understand

- Gain knowledge in immune responses in different immunodeficient conditions
- identify therapeutic options and challenges posed by HIV

UNIT-V

Immunobiology of cancer: Malignant transformation of cells, Oncogenes and cancer induction, Tumor antigens, Immune Response against Tumors, Tumor editing, Tumor Evasion of the Immune System, Cancer Immunotherapy.

Learning outcomes:

By the end of this unit, the student should be able to understand

- Gain knowledge about immunobiology of cancer
- identify the factors that cause cancer and understand relation between caner and immune system.
- Understand about cancer immunotherapy

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.,* 8th 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 KD Elgret, Wiley-Liss Publishers, NY.
7. Cellular and Molecular Immunology by AK Abbas & AH Lichtman, 9th Edition, Elsevier.
8. The Immune System by Charles Janeway *et al.,* Garland Publishing.

SBT 421: GENETIC ENGINEERING AND IMMUNOLOGY LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

The course offers an excellent opportunity for students to gain practical experience In genetic engineering and immunology lab techniques.

Course objectives:

To train students in the practical aspects of genetic engineering so that they can perform gene cloning, amplify DNA and use these techniques in forensic sciences. To make students gain expertise in immunological techniques and agglutination, precipitation assays.

1. Amplification of DNA by PCR.
2. DNA restriction digestion and separation of DNA fragments by Agarose gel electrophoresis.
3. Elution of DNA from agarose gels.
4. Ligation of DNA fragments.
5. Bacterial transformation and identification of transformants by blue white colony / GFP.
6. RAPD and RFLP analysis.
7. Ouchterlony double immunodiffusion method
8. Radial Immunodiffusion method
9. Quantitative precipitin assay
10. Latex agglutination test
11. Western blotting
12. Enzyme-linked Immunosorbent Assay (ELISA)
13. Immunodiagnostics : Pregnancy test, VDRL test, Widal test and Blood grouping
14. Blood smear identification of leucocytes by Giemsa stain

Learning outcomes:

1. Students would gain hands on expertise in genetic engineering techniques and experiments
2. Students will be able to understand the importance of PCR, and its application in forensic medicine by RAPD method.
3. Students would be able to successfully transfer and detect nucleic acids (DNA and RNA)

RECOMMENDED BOOKS:

1. Biotechnology: A laboratory course by JM Becker, 2nd Edition, Wiley publishers.
2. Molecular Cloning: A laboratory manual by Gren & Sambrook, 4thEdition, CSHL Press
3. Laboratory manual in Biochemistry by JJayaraman, 2ndEdition, Wiley Eastern limited.
4. Biochemistry - a laboratory courses by JMBeckar, 2nd Edition, Academic Press.
5. Immunology methods manual - The comprehensive source book by I Lefkovits.
6. Manual of clinical laboratory immunology by NR Rose.
7. The experimental foundations of modern immunology by WR Clark.
8. Laboratory Immunology by Bradshaw U.

SBT 423: PLANT AND ANIMAL BIOTECHNOLOGY LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble :

To impart practical skills on basic plant and animal biotechnology techniques like tissue culture, plant genetic transformation, cell viability and their application in biotech industries.

Course Objectives

Learn good laboratory practices and biosafety aspects in Plant and Animal tissue culture laboratories. Acquire skills and hands on experience in basic plant tissue culture using various explants. Perform basic experiments in cell viability and growth. Gain knowledge in preparation of glycerol stocks and preservation of cell lines.

1. Preparation of media for plant tissue culture (MS and Gamborg).
2. Establishment of callus cultures from carrot cambial tissue.
3. Embryo culture of Maize.
4. Organogenesis and regeneration of plants from tomato explants.
5. Anther culture and production of haploids.
6. Isolation of protoplasts and culture.
7. Polyethylene glycol (PEG) mediated fusion of protoplasts.
8. *Agrobacterium*mediated transformation.
9. Preparation of animal cell culture media and membrane filtration.
10. Preparation of single cell suspension from spleen.
11. Cell counting by haemocytometer.
12. Isolation of lymphocytes from blood using ficoll gradient.
13. MTT assay for cell viability and growth.
14. Microtomy and section cutting of tissues.

Learning Outcomes:

On completion of this course, students will be able to perform basic experiments on plant and animal biotechnology and help them to take up plant and animal biological research as well as placement in relevant biotech industry.

RECOMMENDED BOOKS:

1. Plant cell culture: A practical approach by RA Dixion & RA Gonzales, 2nd Edition, IRL press.
2. Plant tissue culture - Theory and practice by SS Bhojwani & MK Razdan, 1st Edition, Elsevier.
3. Biotechnology: A laboratory course by JM Becker, 2ndEdition, Wiley publishers.
4. Animal cell culture - A practical approach byJohn RW Masters, 3rd Edition, IRL Press.
5. Animal cell culture techniques by Martin Clyenes, Springer publishers.
6. Culture of Animal cells; A manual of Basic techniques by R Ian Freshney, 6thEdition, Wiley-Blackwell publishers.

VIII SEMESTER

SBT 402: BIOPROCESS ENGINEERING AND TECHNOLOGY

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

Credits : 04 **Sessional : 40 Marks**

Preamble:

The significance of this course is to provide knowledge with principles relevant to Bioprocess Engineering and Technology. This course helps to understand various principles of fermentation processes and downstream processing At the outset, the learner can understand product development having market viability using microorganisms.

Course Objectives:

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

UNIT-I

Isolation, screening and maintenance of industrially useful microorganisms. Strain improvement by Mutations, Site directed mutagenesis and Genetic recombination. Media for industrial fermentation. Sterilization of air and media. Thermal death kinetics.

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
- Understand the concept of thermal death kinetics to develop sterilization protocols
- 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 bed, photo bioreactors, tower fermenter and 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

Industrial production of Vitamins (Vitamin B_{12} and Riboflavin), Amino acids(lysine and glutamic acid), Organic acids (Citric acid and Acetic acid), Alcoholic beverages (beer and wine), Organic solvents (Ethanol, Acetone and Butanol) and Antibiotics (penicillin and streptomycin).

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-IV

Downstream processing, removal of microbial cells and solid matter, cell disruption, extraction, concentration, purification, drying and crystallization of the products, *In situ* recovery of the products.

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.

UNIT-V

Production of bioinsecticides and bioherbicides. Production of single cell proteins. Intellectual Property Rights (IPR), patent protection for biological inventions.

Learning outcomes:

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

- Be familiar with the production of bioinsecticides and bioherbicides.
- Give account on production of single cell proteins and their significance.
- Be acquainted with intellectual property rights and protection of biological inventions.

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*., 1st Ed., Blackwell Science Ltd.
4. Modern Industrial Microbiology and Biotechnology by Nduka Okafor & BC Okeke, 2nd Edition, CRC Publishers.
5. Industrial Microbiology by LE Casida Jr., 2nd Edition, New Age International Pub.
6. Biochemical engineering fundamentals by Bailey & Ollis, 2nd Edition, Intl. Pub.
7. Molecular Biotechnology: Principles and applications of recombinant DNA technology by BR Glick, JJ Pasternak & CL Patten, 4th Edition, ASM Press.
8. Biotechnology and genomics by PKGupta, Rastogi Publications.
9. Environmental Biotechnology by CF Forster & DAJ Wase, Ellis Horwood Ltd.

SBT 404: 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:

This course helps us to understand about the production and applications of health care products and Hybridomas. Gives a view on the design of vaccines and problems associated with the development of vaccines against some of the diseases. To enlighten the knowledge of the students on different areas of Medical Biotechnology.

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 understand the process of immunization and be able to learn different strategies of vaccine production .
- Be able to enumerate various advantages and disadvantages of edible vaccines and strategies for development of vaccines against HIV and Malaria.

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 about the production and applications of health care products like insulin, growth hormone, factor VIII, tissue plasminogen activator, urokinase etc.
- This course critically examines the design and nanoparticles mediated drug delivery and its applications in nanomedicine.

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-viralvectors, Gene therapy for Cancer, AIDS. Antigene and antisense therapy.

Learning Outcomes: Student will be able to

- understand different methods of gene theraphy.
- Learn various vectors used in gene theraphy

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 basic concepts of male and female reproductive systems
- various methods to enhance fertility of males and females.

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 USatyanarayana, 3rd Edition, Books and Allied Sciences Publishers.
5. Biotechnology and genomics by PKGupta, Rastogi Publications.

SBT 406: BIOINFORMATICS

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

Preamble:

Bioinformatics is an interdisciplinary field that develops methods and software tools for understanding biological data. It is useful for the body of biological studies that use computer programming as part of their methodology, as well as a reference to specific analysis pipelines that are repeatedly used, in the field of omics.

Course Objective:

The objective of this course is to provide theoretical and practical knowledge of the usage of computational tools and databases which enable investigation of molecular biology and evolution-related ideas. Get awareness on various phylogenetic tree construction methods which gives a clear picture on molecular evolution of biological macromolecules.

UNIT-I

Introduction to computers, anatomy of computers and its accessories, types of computers, scope of computers in biological research. Introduction to operating systems – DOS, Windows, UNIX, Linux. Introduction to programming in C, SQL, PERL, HTML.

Learning Outcomes:

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

- Learn about the salient features of computers and internet.
- Acquire basic knowledge about the operating systems and programming languages that are useful in biological research

UNIT-II

Introduction to Bioinformatics, Biological databases – types of databases (Nucleotide sequence databases, Protein sequence databases, Structure databases, viral databases, immunodatabases, genome databases and Gene expression databases). Database searching using BLAST and FASTA.

Learning Outcomes:

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

- Gain knowledge of various biological databases and their uses in research.
- Know about the similarity searching of biomolecules using various *insilico* tools.

UNIT-III

Sequence alignment – pair wise sequence alignment (Dot plot, Dynamic programming), multiple sequence alignment. Genome sequencing and assembly. Genome annotation – identification of genes (promoter, ribosome binding sites, initiation codons, intron - exon boundaries in a gene, splice sites, termination codons) CpG Islands, repetitive elements, DNA barcoding.

Learning Outcomes:

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

- Be acquainted with the genome sequencing, assembly and its annotation using both wet-lab and dry-lab techniques
- Acquire knowledge on different barcoding strategies

UNIT-IV

Introduction to genomics and its applications, functional genomics, comparative genomics and metagenomics. Molecular phylogeny - phylogenetic trees, tree construction methods (Character based and distance based methods) and evaluation.

Learning Outcomes:

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

- Comprehend various fields in genomics and their importance in present day scenario
- Deal with the phylogenetic tree construction methods which gives a clear picture of molecular evolution

UNIT-V

Introduction to proteomics, laboratory techniques in proteomics (protein isolation, purification and characterization). *Insilico*protein sequence analysis – primary, secondary, tertiary (homology modeling). Drug designing and Molecular docking.

Learning Outcomes:

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

- Learn about the isolation, purification and characterization of protein using both wet-lab and dry-lab techniques.
- Distinguish between a drug and lead molecule

RECOMMENDED BOOKS:

1. Essential Bioinformatics by JinXiong, Reprint 2011, Cambridge University Press.
2. Biological Sequence Analysis by R Durbin *et al*., Indian Reprint, Cambridge University Press.
3. Bioinformatics and Functional Genomics by J Pevsner, 3rd Edition, Wiley-Blackwell publishers.
4. An Introduction to Bioinformatics by TK Attwood & DJ Parry-Smith, Reprint 2011, Addison Wesley Longman Limited.
5. Introduction to Bioinformatics by AM Lesk, 3rd Edition, Oxford University Press.
6. Bioinformatics: Sequence and Genome Analysis by DW Mount, 2nd Edition, CSHL Press.

PROGRAM ELECTIVE I

SBT 441: CANCER BIOLOGY

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

Preamble:

The course is designed to give a detailed understanding of the field of cancer biology to students. Established concepts and emerging techniques are assembled together in this course. An universal perspective of cancer-causing agents, biological process involved in tumor formation, diagnosis and treatment options available are discussed in detail to give students a focus on cancer biology.

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-tumour, neoplasia, benign and metastatic tumour, oncogenes, tumour suppressor genes; General features 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 outcome:

By the end of the unit, student would be able to
- distinguish different tumors
- describe the general features of cancer
- explain the different types of carcinogens

UNIT-II

Cell cycle alterations in cancer. Genetic Variations in Cancer. Mechanisms of genetic instability and chromosome aneuploidy in cancer. Defects in DNA repair mechanisms. Telomeres and telomerase dynamics in cancer. Epigenetic elements and processes in cancer. e

Learning outcome:

By the end of the unit, student would be able to
- explain the genetic variations in cancer
- appreciate the role of DNA repair mechanisms
- learn the role of epigenetic elements in cancer

UNIT-III

Role of growth factors, receptors, secondary messengers in signaling pathways of cancer induction and progression. Angiogenesis-Mechanism, molecular mediators endogenous inhibitors of angiogenesis. Metastasis-initiation and Progress. Apoptosis-changes in apoptosis leading to cancer. Mechanisms of Immune response and surveillance in tumor formation.

Learning outcome:

By the end of the unit, student would be able to
- delineate the signaling pathways in cancer progression
- decipher the process of angiogenesis and metastasis
- describe cell death and immune response

UNIT-IV

Cancer diagnostics and therapeutics; Recent advances in new diagnostic tests. Tumor imaging, Detection of metastasis. Immunohistochemical diagnosis. Treatment of cancers in different organs of the body-Chemotherapy, Surgery, Radiation Therapy, endocrine therapy and Immunotherapy.

Learning outcome:

By the end of the unit, student would be able to
- appreciate the recent advances in cancer diagnostics
- understand different treatment forms available for cancer
- gain expertise in tumor imaging

UNIT-V

Cancer genome and Proteome analysis. Present status of drug development, clinical trials and treatment. Future scope of research in design and development of new vaccines and other anticancer drugs. Ethical and regulatory issues involved in cancer drug design.

Learning outcome:

By the end of the unit, student would be able to
- discuss the various clinical trials of cancer treatment
- design effective research topics for anti-cancer drugs
- debate on ethical and regulatory issues involved in cancer drug desgin

RECOMMENDED BOOKS:

1. Molecular Biology of Cancer: Mechanisms, Targets and Therapeutics by L Pecorino, Oxford University press.
2. Cancer: Principles and Practice of Oncology by VT DeVita Jr., TS Lawrence & SA Rosenberg, 9th Edition, Lippincott Williams and Wilkins publishers.
3. The Biology of Cancer by RA Weinberg, 2nd Edition, Garland Science.
4. Introduction to Cancer Biology by R Hesketh, Cambridge University Press.
5. Principles of Cancer Biology by LJ Kleinsmith, 1st Edition, Pearson publishers.

SBT 443: 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:

To teach students the importance and availability of stem cells in the body. To make students understand how stem cells function, divide and respond to various factors. To teach students how pluripotent stem cells can be produced in the laboratory and their applications. To teach students the applications of stem cells in transplantation and regenerative medicine. 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

- be able to differentiate the different types of stem cells that exist
- understand differences between adult and embryonic cells
- 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 signaling 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

- develop an understanding on how stem cells can be isolated
- appreciate the different markers that distinguish stem cells
- 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

- appreciate the concept of induced pluripotency
- comprehend the attempts and advancements in production of iPSCs
- analyse the applications of iPSCs

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

- conceptualize tissue engineering and transplantation
- 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

- understand the principle of stem cell cryopreservation and banking
- appreciate the use of stem cells in medicine and research
- debate the ethical and regulatory issues of stem cells

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 Ed., CRC Press.

SBT 445: 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 of proteins 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, etc. Protein engineering with unnatural amino acids and its applications.

Learning outcomes:

- Students will be able to recognize the characteristics of individual amino acids and their effect on the solubility, structure and function of proteins

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; Hydrodynamic properties – viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy – emphasis on parameters that can be measured/obtained from NMR and their interpretation.

Learning outcomes:

- Students will be able to review factors significant for protein folding processes and stability

UNIT-III

Computational approaches**:** Computational approaches to protein engineering: sequence and 3D structure analysis, Data mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles vis-à-vis those from mesophiles; Protein design, Directed evolution for protein engineering and its potential.

Learning outcomes:

- Students will be able tolearn the fundamental concepts in protein structure, biophysics, optimization and informatics that have enabled the breakthroughs in computational structure prediction and design.

UNIT-IV

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; Module shuffling; Guided protein recombination, etc., Optimization and high throughput screening methodologies like Giga Metrix, High throughput microplate screens etc.,

Learning outcomes:

- Students will be able to learn various experimental methods leveraging directed evolution of proteins to improve protein folding.

UNIT-V

Protein engineering Applications for biosensors, vaccine development, engineering proteins for the degradation of recalcitrant compounds, Engineering antibody affinity by yeast surface display; Peptidomimetics and its use in drug discovery.

Learning outcomes:

- Students will be able to 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 RajBhandaray, 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.

SBT 447: DRUG DESIGNING AND DEVELOPMENT

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

Preamble:

Drug design, is 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 Drugs: Drug discovery and Design – A historical outline, Leads and Analogues, Sources of leads and drugs, Methods and Routes of Administration, Classification of drugs.

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

Drug Target Identification: Properties of Drug Targets, Target identification by *Invivo* and *Invitro* Methods – Haploinsufficiency Profiling, Chemogenomics approach, Chemical Proteomics, Signature Tag Mutagenesis, Gene knockout technology, Expression profiling.

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-III

Computational Drug Design: Computational Aspects of Library Design- Introduction, Virtual Screening, Computational filtering, Combinatorial library design, Computer Aided Drug Design – SBDD, LBDD.
Molecular Docking – Docking problem, Docking process, Scoring functions, Validation, Various methods of docking.

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.

UNIT-IV

Rational Drug Designing: Introduction, Target Identification, Lead Identification, Lead Optimization – Structure activity relationships (SAR), QSAR - Parameters, Descriptors, Analysis and Case study, 3D-QSAR, ADMET properties,Experimental design for preclinical and clinical PK/PD/TK studies, Selection of animal model; Regulatory guidelines for preclinical PK/PD/TK studies; Scope of GLP, SOP for conduct of clinical & non clinical testing, control on animal house, report preparation and documentation. FDA registration.

Learning Outcomes:

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

- Optimize the drugs with respect to various parameters
- Gain knowledge in the parameters required to release a drug into the market.

UNIT-V

Drug Development: Introduction, Chemical development, Pharmacological and toxicological testing, Drug metabolism and Pharmacokinetics, Formulation development,Requirements of GMP implementation, Documentation of GMP practices, CoA, Regulatory certification of GMP, Quality control and Quality assurance, concept and philosophy of TQM, ICH and ISO 9000; ICH guidelines for Manufacturing, Understanding Impurity Qualification Data, Stability Studies, Patent protection and Regulation.

Learning Outcomes:

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

- Comprehend strategies required for development of a drug.
- Be familiar with various regulatory guidelines to release a drug.

RECOMMENDED BOOKS:

1. Medicinal Chemistry by Gareth Thomas, John-Wiley Publishers, 2nd Edition.
2. Foye's Principles of Medicinal Chemistry by Lemke & Williams, 7th Edition, Lippincott and Wilkins Publishers.
3. Medicinal Chemistry by Graham L Patrick, 3rd Edition, Oxford Press.
4. Computational Drug Design: A Guide for Computational and Medicinal Chemists by David C Young, Wiley Publishers.

SBT 422: INDUSTRIAL BIOTECHNOLOGY LAB

Hours per week	**: 06**	**End examination**	**:40 Marks**
Credits	**: 03**	**Sessional**	**:60 Marks**

Preamble :

Industrial Biotechnology is an applied area where microorganisms are cultivated in bioreactors to produce enzymes, materials for industry, organic acids, solvents, bioplastics, food, agricultural and pharmaceutical products. Use cheaper raw materials and waste from agriculture and forestry for the manufacture of industrial goods. This course enables the learner to develop laboratory skills towards the isolation and screening of various useful microorganisms and to enhance the fermentation skills to produce various enzymes, alcoholic beverages, amino acids etc. Further, the course provides the insights and tools for the design of biotechnological process for producing various important products of commercial value.

Course Objectives:

To train the students in isolation and screening of useful microorganisms from their native habitats. To make students gain expertise in industrial methods such as batch fermentation, production and estimation of enzymes and alcoholic beverages. To improve the base knowledge and to bring awareness on various industrial processes.

1. Selective isolation of actinomycetes and fungi from soil samples.
2. Microbiological assay of an antibiotic including the construction of standard curve.
3. UV survival curve.
4. Production of protease by shake flask method batch fermentation.
5. Production of amylase by shake flask method batch fermentation.
6. Immobilization of an enzyme by gel entrapment.
7. Immobilization of whole cells for enzyme production by gel entrapment.
8. Production of alcohol by *Saccharomyces cerevisiae* and its estimation.
9. Production of citric acid by *Aspergillus niger*.
10. Production of red wine from grapes.
11. Production of Glutamic acid by *Corynebacterium glutamicum*.

Student Learning Outcomes:

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

- Gain knowledge to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to isolate a potent production strain.
- Be acquainted with immobilization skills to produce enzymes and able to demonstrate the reusability of enzymes under *in vitro* conditions.
- Perform wine production and distillation.

RECOMMENDED BOOKS:

1. A manual of Industrial Microbiology and Biotechnology by AL Demain *et al.*, 3rd Ed, ASM press.
2. Immobilization of enzymes and cells: Methods in Biotechnology volume I by GF Bickerstaff, Springer publishers.
3. Principle of fermentation technology by Stanbury, 2nd Edition, Elsevier.

SBT 424: BIOINFORMATICS LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

Bioinformatics is an interdisciplinary field that develops methods and software tools for understanding biological data. As an interdisciplinary field of science, bioinformatics combines biology, computer science, information engineering, mathematics and statistics to analyze and interpret biological data. This has been used for in silico analyses of biological queries using mathematical and statistical techniques.

Course Objectives:

The objective of this course is to provide practical training in bioinformatics methods including accessing major public sequence databases. It also aims in use of different computational tools in identification of candidate genes, SNPs, ESTs…etc. Analysis of protein and nucleic acid sequences by various software packages.

1. Using NCBI and Uniprot web resources.
2. Introduction and use of various genome databases.
3. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot /TrEMBL, UniProt.,
4. Similarity searches using tools like BLAST and interpretation of results.
5. Similarity searches using tools like Psi-BLAST and interpretation of results
6. Multiple sequence alignment using ClustalW.
7. Construction of phylogenetic tree using UPGMA, NJ, Maximum parsimony and maximum likelihood methods using MEGA software.
8. Use of gene prediction methods (Genscan, Glimmer).
9. Using RNA structure prediction tools.
10. Use of various primer designing and restriction site prediction tools.
11. Use of miRNA prediction, designing and target prediction tools.
12. Use of different protein structure prediction databases (PDB, SCOP, CATH).
13. Homology modelling of proteins.
14. Molecular docking by using Swiss Dock tool.

Student Learning Outcomes:

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

- Describe contents and properties of most important bioinformatics databases;
- Perform text- and sequence-based searches and analyze& discuss results in perspective of biological knowledge;
- Predict secondary and tertiary structures of protein sequences.
- Compute phylogenetic trees using both character-based and distance-based methods.

RECOMMENDED BOOKS:

1. Bioinformatics Practical Manual by M Iftekhar, Create Space Independent Publishing Platform.
2. Bioinformatics: Sequence and Genome Analysis by DW Mount, 2nd Edition, CSHL Press.
3. Introduction to Bioinformatics by AM Lesk, 3rd Edition, Oxford University Press.

IX SEMESTER

SBT 501: FOOD BIOTECHNOLOGY

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

Preamble:

This course has been designed to offer students a good command of basic principles of food science and technology and applying this understanding to growing and dynamic needs of food industries.

Course Objectives:

Demonstrate a level of comprehension of concepts of food science.Critically evaluate and solve issues or problems pertaining to food science.

UNIT-I

Energy: Energy content of foods - physiological fuel value - review. Measurement of energy expenditure: BMR, RMR, thermic effect of feeding and physical activity, methods of measurement. Estimating energy requirements of individuals and groups.

Learning outcomes:

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

- Learn fundamentals of food biotechnology
- Basic knowledge of Measurement of energy expenditure
- Estimating energy requirements

UNIT-II

Microorganisms in foods. Factors affecting the microbial growth. Microbial food borne diseases. Food poisoning, control measures for food poisoning out breaks. Analysis of microorganisms and their products in foods, Fermented foods, role of microbes in fermented foods and genetically modified foods.

Learning outcomes:

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

- Learn Factors affecting the microbial growth and Microorganisms in foods
- Analysis of microorganisms
- Fermented foods and genetically modified foods.

UNIT-III

Food groups, functions of foods. Nutritive value, composition, storage and preservation of cereals, pulses, nuts & oil seeds, milk & milk products, egg, fish, meat, vegetables, fruits, sugars, fats and oils. Food additives: Synthetic & natural colorants, natural & artificial sweeteners, stabilizers and emulsifiers.

Learning outcomes:

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

- Obtain an appreciation for role and importance of nutrition in preserved foods
- Importance of Synthetic & natural food additives
- Role of stabilizers and emulsifiers

UNIT-IV

Applications of enzymes in food industry: Amylases, Proteases, Lipases, Glucose isomerase, lactase, pectinase and renin in food industry. Production of bread, cheese, idly, beverages and appetizers. Food packaging methods and materials.

Learning outcomes:

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

- Co-relate enzymes used in various branches of food and feed industry
- Learn mechanism of action of enzymes used in specific processes

UNIT-V

Functional foods: Advances in Biotechnology for the production of functional foods; 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:

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

- Understand State functions of packaging
- Learn various forms of packaging materials in common use contemporarily
- Understand various food safety parameters

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 Packaging: Principles and practice by GL Robertson, 3rd Edition, Taylor and Francis group.
4. Food Chemistry by Meyer LH, Affiliated East and west Press Ltd., Bombay,1987.
5. FSSAI Training manual.
6. Nutrition Science by B Srilakshmi, 2nd Edition, New Age International Publishers Pvt. Ltd.
7. Food Science by B Srilakshmi, 2nd Edition, New Age International Publishers Pvt. Ltd.
8. Food facts and Principles by N Shakuntala Manay & M Shadakshara Swamy, New Age International Publishers Pvt. Ltd., 1987.
9. Food Microbiology by Frazier, 4th Edition, WC McGraw-Hill Incorporation.

SBT 503: AQUACULTURE AND MARINE BIOTECHNOLOGY

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

Preamble:

This course has been designed for giving students a thorough understanding of basic science behind the aquaculture and salient marine biological processes related to marine ecosystem and microbiology as well as familiarize them with the possible applications leading to fisheries and marine biotechnology.

Course Objectives:

To teach sustainable use of aquatic resources with various approaches in biotechnology. Introduce students to marine environment and its physical features; Introduce students to principal marine fisheries of coastal areas. Educate students on status and trends of major fish resources and their conservation in region.

UNIT-I

Marine biology and ecology: Classification of marine environment, Types of aquatic habitats - coral reefs, coastal sand dunes, mangroves, sea grasses. Habitat preferences, Adaptations in marine organisms and energy transfer. Marine biomass and productivity - primary production, photosynthetic efficiency; secondary production, productivity distribution in ocean environment. Role of microbes in marine food web dynamics and biogeochemical processes. Red tides.

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

- Learn different aquatic and marine habitats
- Familiarize with factors influencing primary and secondary production in relation to food web.
- Understand the role of microbes and elements in biogeochemical

UNIT-II

Culture Practices and breeding: Culture practices– Extensive, semi intensive and intensive. Culture practices with reference to Carps, Trouts, Tilapia, Fin Fish, Whiteleg shrimp and Giant freshwater prawn. Crab Culture.Aqua farms-Design and construction, Induced Breeding techniques-Hypophysation, Eye stalk ablation. Application of synthetic hormones in induced breeding. Cross breeding. Selective breeding. Inbreeding and heterosis

Learning outcomes:

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

- Learn methods of culture practices of fishes, shrimpsand lobsters
- Understand the induced breeding techniques and seed production in aqua farms

UNIT-III

Design and Management of hatchery: Hatchery-Types, design and management. Broodstock management. Induced spawning; Mass production of seeds; feed formulation; Culture of Live food organisms: green algae, diatoms, rotifers, infusoria, tubifex, brine shrimp and earthworms.

Learning outcomes:

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

- Learn methods of hatcheries for fish and shrimp farming
- Learn formulation of fish feed and live food organisms

UNIT-IV

Advanced techniques in aquaculture management: Artificial Hybridization: Heterosis, Control of fish diseases by selection; selective breeding of disease resistant fish; Marine Bioprospecting: Mining untapped potential of living marine resources; Molecular Tools in conservation of Fisheries-Resources: Molecular Markers: development of RAPD, RFLP, AFLP, ESTs, SNPs, Mini-satellites and micro-satellites.

Learning outcomes:

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

- Understand fish diseases and breeding of disease resistant fishes
- Learn applications of molecular tools and molecular markers in conservation of fishes.

UNIT-V

Marine pollution and management: Marine pollution- Causes and Management; Biosensors in pollution detection; BOD, COD; Marine fouling, genetically modified microbes for wastewater treatment; Bioaugmentation Bioremediation, Biodegradation Bioremediation and Phytoremediation in management of Oil pollution & Phytoremediation. Ocean policy and Coastal regulation zone (CRZ)

Learning outcomes:

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

- Understand the interaction between marine microorganisms and the environment
- Learn the importance of Bioaugmentation, Bioremediation and Biodegradation
- Understand environmental pollution management technologies and regulations against growing marine pollution.

RECOMMENDED BOOKS:

1. Marine Ecology by O Kinne, Volumes I, II and III, John Wiley & sons.
2. A text book of Marine biology by NB Nair & DM Thampy, Mcmillan publishers.
3. Plankton and productivity in oceans. Volume I: Phytopankton & Volume II: Zooplankton by Raymont JEG, 2nd Edition, Pergamon publishers.
4. Aquaculture: Principles and practices by TVR Pillay, Reprint 1993, Wiley publishers.
5. Coastal aquaculture in India by Santhanam, CBS Publishers.
6. A Textbook of Fisheries Science and Indian Fisheries by CBL Srivatsava, Kitab Mahalpublishers.
7. Aquaculture: Farming Aquatic Animals and Plants by JS Lucas, 2nd Edition, Wiley-Blackwell.
8. Aquaculture and Fisheries Science: Principles and Practices by Dr.VPAgrawal, S.R. Scientific Publication,2014.
9. Carp and Pond Fish Culture: Including Chinese Herbivorous Species, Pike, Tench, Zander, Wels Catfish, Goldfish, African Catfish and Sterlet by László Horváth, Wiley Blackwell.

10. SBT 505: VIROLOGY

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

Preamble:

This paper is designed to help students to acquire sufficient level of knowledge, skills and aptitude in all aspects of the epidemiology, prevention, diagnosis and management of infections and communicable diseases related to Virology.

Course Objectives:

The objectives of this course is to introduce field of Virology with special emphasis on structure of viruses, interaction of virus and host, pathogenesis of various viral infections, methods to culture viruses, purify and inactivation of viruses, epidemiology and emerging and remerging of viruses and diagnostic methods for their early detection.

UNIT-I

History and development of viruses. Nature, origin and evolution of viruses. Nomenclature, Recent classification (ICTV) structure and characteristics of viruses.

Learning outcomes:

By the end of the course, the student will be able to:
- Acquire knowledge regarding history, origin and evolution of viruses
- Know the structure and classification and characteristics of important viruses

UNIT-II

Isolation, Cultivation and Identification of viruses. Biological and chemical properties of viruses. Animal, plant and bacterial viruses and their interactions with hosts.

Learning outcomes:

By the end of the course, the student will be able to:
- Understand better the process of infection.
- Develop a detailed knowledge of Animal, plant and bacterial viruses and their interactions with hosts.

UNIT-III

Virus replication and genome expression. Process of infection- animal, plant and bacterial cells. Molecular mechanisms of viral pathogenesis with respect to poliovirus, rotavirus, herpes virus.

Learning outcomes:

By the end of the course, the student will be able to:
- Develop a detailed knowledge about viral replication and genome expression
- Understand the molecular mechanisms of viral pathogenesis.
- Acquire a detailed knowledge of process of infection with respect to predominant viral diseases.
- Know the concepts of latency and persistence and immunologic response to viral infection

UNIT-IV

Transmission of viruses (Direct and Indirect) persistence of viruses and their mechanism. Purification and inactivation of viruses - physical and chemical methods. Virus ecology and epidemiology, scope and concepts of epidemiology.

Learning outcomes:

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

- Understand methods of transmission of plant and animal viruses
- Develop knowledge on methods involved in purification and inactivation of viruses
- Learn the epidemiology of viral infections.

UNIT-V

Structure , life cycle and patho physiology of Prions, Human Immuno deficiency Virus (HIV), Hepatitis B Virus (HBV), Human Papilloma Virus (HPV), ZikaVirus. Trends in Viral diseases and diagnosis.

Learning outcomes:

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

- Develop a detailed knowledge on structure and life cycle of HIV and Prions
- Understand the mechanism of leading viral diseases
- Learn the trends in viral diseases and diagnosis

RECOMMEDED BOOKS:

1.Brock Biology of microorganisms by Madigan, Martinko & Parker, 9th Edition.

2. Introduction to microbiology by Ross

3. Introduction to Modern Virology, Basic Microbiology by N Dimmock, A Easton & Keith Leepard, 6th Edition, John Wiley and Sons.

4. Virology: Principles and Applications by John Carter & Venetia A Saunders, John Wiley & sons.

5. General Microbiology volume I and II by Power.

6. Basic Virology by Edward K Wagner, MJ Hewlett, DC Bloom & D Camerini, 3rd Edition, John Wiley and Sons, 2009.

7. Microbiology- Principles and applications by JG Black, John Wiley and sons, New York.

8. Microbiology by G Tortora, BR Funke & CL Case.

9. Principles of Virology by SJ Flint, 3rd Edition, ASM Press.

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PROGRAM ELECTIVEII

SBT 541: PHARMACEUTICAL 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. This course gives a comprehensive view on the design, discovery and metabolism of drugs. This course also deals with the synthesis of nanoparticles using biological systems and significance and applications of nanotechnology.

Course objectives:

This course helps us to understand about the production and applications of health care products and Hybridomas. Gives a view on the design of vaccines and problems associated with the development of vaccines against some of the diseases. This course critically examines the design and metabolism of drugs and the synthesis of nanoparticles and the applications of nanobiotechnology.

UNIT-I

Production of recombinant health care products- insulin, growth hormone, factor VIII, tissue plasminogen activator, urokinase, interferons, lymphokines and Hepatitis-B vaccine. Tissue Engineering: - production of artificial skin, liver and pancreas, advantages and disadvantages of tissue engineering and the ethical issues.

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.
- Be able to enumerate various advantages and disadvantages of tissue engineering and explain about ethical issues.

UNIT-II

Hybridoma technology - production and applications of monoclonal antibodies. Antibody engineering, chimeric antibodies. Vaccines and vaccination technology-strategies for development of vaccines against HIV and malaria. Current development in diagnosis of tuberculosis, malaria and HIV. Disease diagnosis using DNA and enzyme probes. Molecular probes in forensic medicine. Gene therapy.

Learning Outcomes: Student will

- Understand about the production and application of hybridomas
- Can describe about strategies to design various vaccines and explain about the challenges faced in the design of vaccines against malaria and HIV
- Understand about the applications of DNA and enzyme probes and forensic medicine

UNIT-III

Drug discovery & drug delivery: Drug discovery without a lead, lead discovery (random Screening, targeted screening). Lead modifications – identification of active part (Pharmacophore) and functional group modifications. Structural modifications to increase potency. Drug delivery: oral delivery systems, pulmonary delivery systems, transmucosal and transdermal delivery systems. Ligand based targeting approach. Programmable drug delivery systems.

Learning Outcomes:

- Understand about drug discovery and drug delivery various delivery systems
- Able to explain different lead modifications

UNIT-IV

Drug metabolism: Analytical methods in drug metabolism(isolation, separation, identification, quantification). Oxidative, reductive, hydrolytic and conjugative metabolism of drugs. Pharmacogenetics: genetic polymorphism in drug metabolism. Genetic polymorphism in drug transport and drug targets.

Learning Outcomes:

- Understand about drug metabolism
- Be able to explain pharmacogenetics and genetic polymorphism

UNIT-V

Nanobiotechnology: synthesis of nanostructures using sol-gel process and biological production using fungi and bacteria, yeast and actinomycetes. Introduction to nanocarriers. Interaction of nanocarriers with blood stream. Cellular targeting of nanocarriers. Drug delivery and toxicity of nanocarriers.

Learning Outcomes:

- Be able to explain the synthesis of nanoparticles by different methods
- Understand about nanocarriers and their toxicity

RECOMMENDED BOOKS:

1. Gene cloning and DNA analysis an introduction by TA Brown, 5th Edition, Blackwell publishers.
2. Fundamentals of Ecology by EP Odum& GW Barrett, 5th Edition, McGraw-Hill publishers.
3. Biotechnology by U Satyanarayana, 3rd Edition, Books and Allied Sciences Publishers.
4. Biotechnology and genomics by PK Gupta, Rastogi Publications.
5. Pharmaceutical biotechnology, concepts and applications by G Walsh, John Wiley publications.
6. Drug metabolism in drug design and development by D Zhang *et al.*, Wiley publications.
7. The organic chemistry of drug design and drug action by RB Silverman & MW Holladay, 3rd Edition, Academic press.

SBT 543: NANOBIOTECHNOLOGY

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

Credits : 04 **Sessional : 40 Marks**

Preamble:

The course aims at providing a general and broad introduction to multi-disciplinary field of nanotechnology. It will familiarize students with the combination of the top-down approach of microelectronics and micromechanics with the bottomup approach of chemistry/biochemistry; a development that is creating new and exciting cross-disciplinary research fields and technologies. The course will also give an insight into complete systems where nanotechnology can be used to improve our everyday life.

Course Objectives:

- Students should be able to learn basic science behind the properties of materials at nanometre scale.
- Understand advanced experimental and computational techniques for studying nanomaterials.
- Applications of nanaomaterials in allied fields of medicine.

UNIT-I

Nanomaterials: Introduction, examples of nanomaterials – quantum dots, metal nanoparticles, magnetic nanoparticles, carbon nanotubes and nanowires. Introduction to "Top – Down" and "Bottom – Up" approaches of synthesis of nanomaterials. Synthesis of nanostructures using Sol – gel process. Biological products of nanoparticles using fungi, bacterial, yeast and actinomycetes.

Learning outcomes:

By the end of the course, the student will be able to:
- Learn about different nanocomposite materials
- Learn the synthesis of nanomaterials by different approaches

UNIT-II

Characterization of nanomaterials: nanoscale probes: X-ray crystallography, Mossbauer spectroscopy, infrared spectroscopy, Raman spectroscopy, scanning electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy and scanning probe microscopy.

Learning outcomes:

By the end of the course, the student will be able to:
- Learn about the devices used to analyse the nanomaterials
- Understand the importance of XRD and TEM in determination of particles size and shape

UNIT-III

Protein based nanostructures: chemistry and structure of S-Layers, self-assembly, recrystallisation methods, lipid chips. Magnetosomes: magnetotactic bacteria, magnetic crystals in magnetosomes, biochemistry and gene expression in magnetosome formation, applications of magnetosomes. Bacteriorhodopsin: structure, function, properties and applications.

Learning outcomes:

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

- Learn about the S layer producing archaea and their applications
- Understand the deposition of magnetite or gregite as magnetosome in magnetotactic bacteria
- Learn the mechanism of light derived ATP synthesis by Bacteriorhodopsin protein

UNIT-IV

DNA based nanostructures: DNA- protein nanostructures: oligonucleotide- enzyme conjugates, DNA – streptavidin conjugates, multifunctional protein assembly, DNA – protein conjugates in microarray technologies. DNA – based metallic nanowires and networks: Template design, DNA as biomolecular template, metallization, gold cluster – oligonucleotide conjugates, DNA nanowires, metal cluster labels with platinum, palladium, tungstanates and iridium.

Learning outcomes:

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

- Learn about the protein nucleic acid nanobased conjugates and their applications
- Learn the process of DNA based template design and metallization by metal cluster labels.

UNIT-V

Nanometals in medicine: introduction to nanocarriers, interactions of nanocarriers with blood stream, cellular targeting, biological and chemical reagents for cell – specific targeting. Biodistribution of liposomes, dendrimers and nanoparticles, toxicity of nanoparticles, drug deliver, tissue regeneration, cancer detection, luminescent nanoparticles probes for bioimaging and diagnostics.

Learning outcomes:

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

- Learn about the applications of nanoparticles in drug delivery and tissue /cell specific targeting as nanocarriers.
- Learn the importance of nanoparticle probes for bio-imaging and diagnostics.

RECOMMENDED BOOKS:

1. Nano chemistry: A chemical approach to nanomaterials by O Geoffrey *et al.,* Royal Society of Chemistry Publication.
2. Nanobiotechnology: Concepts, Applications and Perspectives by CM Niemeyer & CA Mirkin,
   Wiley-VCH publishers.
3. Nanobiotechnology II: More concepts and Applications' by CM Niemeyer & CA Mirkin, Wiley– VCH publishers.
4. Nanobiotechnology by PC Trivedi, 1st Edition, Pointer Publishers.
5. The hand book of Nanomedicine by KK Jain, 2nd Edition, Humana Press.

SBT 545: MOLECULAR MODELLING

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

Preamble:

Molecular modelling encompasses all theoretical and computational methods, used to model or mimic the behavior of molecules. This subject helps to study molecular systems ranging from small chemical systems to large biological molecules and material assemblies. Molecular modelling is a rapidly developing discipline and has benefitted from the dramatic improvements in computer hardware and software of recent years.

Course Objectives:

This course will give a broad overview of modelling isolated molecules through simple atomic and molecular liquids to polymers, biomolecules and solids. The objective of the course is to teach various methods are used in the fields of computational chemistry, drug design and computational biology.

UNIT-I

Representation of chemical compounds - Nomenclature, Representation of 2D and 3D structures, Molecular surfaces, Molecular graphics.
Molecular Modelling Methods - Outline, Advantages and Disadvantages of Molecular Mechanics, Semi-Empirical, Ab-Initio & Density Functional Theory.

Learning Outcomes:

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

- Understand representations of molecules in various dimensions through molecular graphics software.
- Outline the theories in molecular modelling and apprehend the pros and cons during the modelling process.

UNIT-II

Force Fields – Definition & Features, Functional Forms – Bond stretching, Angle bending, Torsional terms, Out-of-plane bending, Cross-terms, Electrostatic, Vander Waals & Hydrogen Bonding interactions. Force fields for small molecules and biomolecules.

Learning Outcomes:

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

- Fathom various features that need to be considered for force field generation.
- Framework different functional forms that play an important role in molecular modelling process.

UNIT-III

Semi empirical based Models, Schrodinger equation, Born-Oppenheimer approximation, Hartree - Fock approximation and LCAO approximation.

Learning Outcomes:

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

- Understand the significance of various functional equations that play an important role in quantum mechanics.
- Appreciate the motion of atomic nuclei and electrons in a molecule can be broken into electronic and nuclear components by different approximation methods.

UNIT-IV

Energy Minimization – Statement of Problem, Derivative and Non-Derivative Methods, Simulation Methods- Time Averages, Ensemble averages, Molecular Dynamics Methods, Monte Carlo Methods, Differences between MD and MC, Conformational Analysis.

Learning Outcomes:

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

- Outline the energy minimization methods that can be applied during the modelling process.
- Distinguish between the molecular dynamics and montecarlosimulation methods.

UNIT-V

Protein Structure Prediction Methods- Homology Modelling, Fold recognition methods, Ab-Initio prediction. Protein Structure Comparison & Alignment, Structural Alignment Methods and Structural quality assurance.

Learning Outcomes:

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

- Model the proteins using various methods in the presence and absence of template molecules.
- Validate the modelled proteins and check the structural quality of the proteins

RECOMMENDED BOOKS:

1. Molecular Modelling: Principles & Applications by Andrew R Leach, 2nd Edition, Pearson Education.
2. Chemoinformatics by J Gasteiger& T Engel, Reprint 2006, Wiley Publishers.
3. Computational Biochemistry & Biophysics by OM Becker, AD McKerell Jr., B Roux & M Watanabe, 1st Edition, CRC press.
4. Structural Bioinformatics by J Gu& PE Bourne, 2nd Edition, Wiley-Blackwell.

SBT 547: BIOSAFETY, BIOETHICS AND IPR

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

Preamble:

This course explains about different safety measures designed and adopted in research laboratories. Gives a comprehensive overview about bioethics to be followed in biological research. This course also gives an idea and understanding on Intellectual property rights and various guidelines prepared by various regulatory authorities.

The course objectives:

The objective of this course is to provide basic knowledge on intellectual property rights and their critical role in research and product development. The objective also includes to make the student understand about biosafety and risk assessment of products derived from biotechnology and regulation of such products. This course also helps to understand various 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).Biosafety regulation: handling of recombinant DNA products and process in industry and in institutions

Learning outcomes: Student will

- Be able to Understand risk assessment and enumerate different biosafety measures
- Be able to explain good laboratory and manufacturing practices
- Understand Biosafety regulation

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

Learning outcomes: Student will

- Be able to describe national and international regulations as specified by different 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.

Learning outcomes: Student will

- Be able to analyze ethical conflicts in biological sciences
- Understand bioethics in healthcare
- Analyze the role of artificial reproductive technologies and prenatal diagnosis and 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.

Learning outcomes: Student will

- Know about IPR and various forms of IPR
- Get knowledge about patents and patent act
- Get an idea about infringement of intellectual property right

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.

Learning outcomes: Student will

- Get an idea about novelty, anticipation, utility etc.
- Get knowledge about filing a patent
- Get an idea about Commercialization and Licensing and describe about different case studies.

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 ed.
3. Indian Patents Law – Legal &BusinessImplications by AjitParulekar& Sarita D' Souza, McMillan India Ltd.
4. Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications
5. by BL Wadehra, Universal law Publishing Pvt. Ltd., India.
6. Law of Copyright and Industrial Designs by P Narayanan, Eastern law House, Delhi.
7. Bioethics: An Anthology byH Kuhse& MA Malden, Blackwell.

SBT 521: FOOD BIOTECHNOLOGY LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

This course has been designed to train students with basic hands-on information of food analysis that will give practical experience of how to apply them in food industry.

Course Objectives:

Is to understand the use of enzymes in the basic processes of food industry. Is to determine the quality of food by various biochemical parameter analysis.

1. Testing of physical and chemical properties of food sample or beverages (Acidity, pH, TSS, moisture and colors).
2. Quantitative tests for sugars, proteins, amino acids, fats and oils in food stuffs.
3. Enzymes in food sample (Milk and potatoes)
4. Determination of ascorbic acid content in food sample.
5. Determination of calcium/ phosphorus/ iron in food sample.
6. Estimation of β carotene / chlorophyll / anthocyanin in vegetables.
7. Estimation of antioxidants / polyphenols in food sample.
8. Determination of adulterants in milk and milk products.
9. Milk cooking: preparation of milk products.
10. Preparation of mango jam / pickle / guava jelly / frozen prawn.
11. Demonstration of estimation of minerals using atomic absorption spectrophotometer (AAS)
12. Survey of preserved foods available in the local markets to study methods of preservation, preservatives used, shelf life, cost and form of availability.
13. Visits to food processing units or any other organization dealing with advanced methods in food microbiology.

Learning outcomes:

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

- Learn to analyse quality of different processed and raw food
- Train in Various aspects of food processing and different processes used for different type of food products.
- Co-relate enzymes used in various branches of food and feed industry
- Explain mechanism of action of enzymes used in specific processes

RECOMMENDED BOOKS:

1. Food Microbiology, Frazier, McGraw-Hill Inc.
2. Modern Food microbiology by Jay James, Aspen Publishers.
3. Experimental Biochemistry by BSashidhar Rao & Vijay Deshpande, IK International Pvt. Ltd.
4. Introductory Practical Biochemistry by SK Sawhney & Randhir Singh.
5. Manual of clinical microbiology by Murray.
6. Food analysis theory and practice by Pomeranz, CBS publishers.
7. A hand book of Analysis and quality control for fruit and vegetable products by Rangannna S, Tata McGraw-Hill Publishing company limited, New Delhi.
8. Techniques of food Analysis by Andrew LWinton & Katebarber Winton, Agronios, Jodhpur, 2001.

SBT 523: AQUACULTURE AND MARINE BIOTECHNOLOGY LAB

Hours per week	**: 06**	**End examination**	**: 40 Marks**
Credits	**: 03**	**Sessional**	**: 60 Marks**

Preamble:

This course has been designed to impact basic skills in aquatic environmental biotechnology for environmental protection and remediation and teach basic techniques which can be used for identifying marine microorganisms for health management.

Course Objectives:

To conduct basic aquatic environmental biotechnology experiments and design experiments which can be useful in bioremediation in aquatic environment. Is to enumerate the bacteria present in the fish and prawn samples.

1. Determination of Turbidity, pH and temperature of sea water
2. Collection and identification of marine seaweeds
3. Determination of DO of sea water
4. Determination of BOD of sea water
5. Determination of salinity of sea water.
6. Estimation of heavy metals (Cu and Hg)
7. Removal of heavy metal by algal biosorbent
8. Isolation of bacteria from fish samples
9. Isolation of bacteria from prawn samples
10. Visit to aquaculture farms, finfish and shrimp hatcheries and processing units.

Learning outcomes:

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

- Identify various microorganisms present in marine fish and prawn samples
- calculate the DO, BOD and several parameters of sea water and fresh water samples

RECOMMENDED BOOKS:

1. Seaweeds of India (2009) by By Bhavanath Jha, C.R.K. Reddy, Mukund C. Thakur, M. Umamaheswara Rao Springer Publishers
2. Common Seaweeds of India (2010) By Dinabandhu Sahoo, IK International.
3. The Diversity of Fishes: Biology, Evolution, and Ecology (2009) By Gene Helfman, Bruce B
   Collette, Douglas E Facey& Brian W Bowen, 2nd Edition, Wiley Blackwell.
4. Analysis of Seawater (1989) by Crompton, Butterworths Publishing house.
5. Analysis of Seawater: A Guide for the Analytical and Environmental Chemist (2006) by TR Crompton
6. Practical Guidelines for the Analysis of Seawater (2009) by Oliver Wurl, CRC Press.

X SEMESTER

SBT592: PROJECT WORK AND SEMINAR

Credits : 08 **End evaluation : 300 Marks**

The student should submit a project report by the end of the X 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.

DEPARTMENT OPEN ELECTIVE

SOE 831: FUNDAMENTALS OF BIOTECHNOLOGY

Hours per week	**: 03**	**End examination**	**: 60 Marks**
Credits	**: 03**	**Sessional**	**: 40 Marks**

Preamble:

Biotechnology is the broad area of biology involving living systems and organisms to develop or make products. It encompasses wide range of procedures for modifying living organisms according to human purposes like improvements in agriculture, livestock, genetic engineering, plant tissue culture .etc.

Course Objectives:

The objective of this course is to provide theoretical knowledge of genetic material with its composition and various cloning vectors used in rDNA technology. This course enables investigation of molecular biological techniques for transfer of genes, checking their presence through various methods and sequencing them.

UNIT-I

Biotechnology introduction, Nature of genetic material, organization of genetic material in prokaryotes and eukaryotes, fine structure of the gene and different kinds of genes. Isolation of DNA and cDNA synthesis.

Learning Outcomes:

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

- Learn about the salient features of genes and their organization.
- Acquire basic knowledge about the isolation process of different forms of DNA.

UNIT-II

Cloning vectors - salient features, plasmid vectors, phage vectors, phagemids, cosmids, viral vectors, artificial chromosomes - BAC and YAC. Enzymes used in genetic engineering, Ligation of DNA to vectors – cohesive end, blunt end, homopolymer tailing, linkers and adaptors.

Learning Outcomes:

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

- Gain knowledge of various biological cloning vectors.
- Acquire basic knowledge about the enzymes required in rDNA technology.

UNIT-III

Gene transfer techniques- transformation, transfection, microinjection, electroporation, lipofection and biolistics. Reporter gene assay, selection and expression of rDNA clones. Principles and concepts of electrophoretic techniques- native PAGE, SDS – PAGE, agarose gel electrophoresis and two dimensional gel electrophoresis,

Learning Outcomes:

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

- Comprehend various gene transfer techniques and their importance.
- Acquire basic knowledge about the electrophoretic techniques and their applications in genetic engineering.

UNIT-IV

Polymerase chain reaction, its variations and their applications. Construction of genomic and cDNA libraries. Blotting techniques-Northern, Southern, and Western.

Learning Outcomes:

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

- Learn about the salient features of PCR and its variants.
- Attain knowledge about the blotting techniques and their use.

UNIT-V

DNA sequencing-Chemical and enzymatic methods, Salient features of Human genome project. Applications of genetic engineering in agriculture, animal husbandry, medicine and industry.

Learning Outcomes:

By the end of this Unit, the student will be

- acquainted with the DNA sequencing strategiesusing wet-lab techniques.
- Aware of applications of genetic engineering in various fields.

RECOMMENDED BOOKS:

1. Principles of Gene Manipulation by Old & Primrose, 6th Edition, Blackwell 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 analysis: An introduction by TA Brown, 6th Edition, Blackwell publishers.
4. Instrumental methods of chemical analysis by Chatwal &Anand, 5th Edition, Himalaya Publishers.
5. Recombinant DNA technology by JD Watson, 2nd Edition, Scientific American Books.
6. Plant Biotechnology by A Slater, NW Scott & MR Fowler, 2nd Edition, Oxford University press.
7. Biotechnology by U Satyanarayana, 3rd Edition, Books and Allied Sciences Publishers

DEPARTMENT OPEN ELECTIVE

SOE 833: FUNDAMENTALS OF PLANT BIOTECHNOLOGY

Hours per week : 03 **End examination: 60 Marks**
Credits : 03 **Sessional : 40 Marks**

Preamble:
This course has been designed to enrich students to understand basic principles and impart theoretical knowledge on various techniques of plant tissue culture and plant genetic transformation and their application in crop improvement. This course helps students to learn Fundamental of Plant Biotechnology and assist student to focus on multidisciplinary research in plant sciences.

Course Objectives:
To impart theoretical knowledge on various techniques of plant biotechnology like tissue culture, plant genetic transformation, molecular markers, biofertilizers and their application in Agri -biotech industries.

UNIT-I

Plant tissue culture. Composition of culture media, Plant growth hormones, Cellular totipotency, Aseptic tissue transfer, Somatic embryogenesis and organogenesis, Initiation and maintenance of callus, Suspension cultures.

Learning outcomes:
By the end of the course, the student will be able to:
- Gain fundamental knowledge in media preparation and the role of nutrients in plant growth and development.
- Develop and understand the establishment of *in vitro* cultures
- Understand the action and significance of Phytohormones in Plant tissue culture

UNIT-II

Micropropagation, Axillary bud, Shoot-tip and meristem culture, Embryo culture. Production of haploids. Principles of protoplast isolation. Somatic hybridization: Various methods for fusing protoplasts- chemical and electrical. Cybrids and their applications.

Learning outcomes:
By the end of the course, the student will be able to:
- Gain knowledge in various techniques of Plant tissue culture and their applications.
- Acquire knowledge on various explant development through *in vitro* practices
- Know the concepts of somatic hybridization, cybrids and their applications

UNIT-III

Modes of gene delivery in plants: *Agrobacterium* mediated gene transfer, Ti and Ri plasmids, Particle bombardment, PEG, microinjection. Screening and selection of transformants, Identification of transgenic plants.

Learning outcomes:
By the end of the course, the student will be able to:
- Understand various methods of gene transfer in plants and their advantages and limitations.

- Develop and understand various strategies followed in screening and selection of plant transformants
- Gain knowledge in methods of identification of transgenic plants.

UNIT-IV

Development of genetically engineered transgenic plants: Bt cotton, golden rice, herbicide tolerance, disease resistance, insect resistance. Abiotic stress tolerance. Edible vaccines.

Learning outcomes:
By the end of the course, the student will be able to:
- Gain knowledge in transgenic technology and their applications to overcome biotic and abiotic stress.
- Learn the techniques involved nutritional enhancement of crops and also in molecular pharming.

UNIT-V

Molecular markers (RFLP, RAPD, AFLP, SSR) and their applications, Plant secondary metabolites - types and applications, Biofertilizers- Blue green algae, Azolla, Rhizobium, Mycorrhiza (VAM).

Learning outcomes:
By the end of the course, the student will be able to:
- Learn key principles of molecular markers and secondary metabolites types and applications.
- Understand the mode of action of various biofertilizers and enhancement of crop yield by its application.

RECOMMENDED BOOKS:

1. Plant Biotechnology: The genetic manipulation of plants by A Slater, NW Scott & MR Fowler, 2nd Edition, Oxford University press.
2. Biotechnologies of Crop Improvement, Volume I: Cellular Approaches by SS Gosal & SH Wani, Reprint 2018, Springer.
3. Plant Breeding principles & Methods by BD Singh, Reprint 2015, Kalyani Publishers.
4. Plant Cell and Tissue Culture by JW Pollard & JM Walker, Springer Publishers.
5. Agricultural biotechnology by SS Purohit, 3rd Edition, Agrobios Publications.
6. An Introduction to Plant Tissue Culture by MK Razdan, 3rd Edition, Oxford and IBH Publishing.
7. Introduction to Plant Biotechnology by HS Chawla, 3rd Edition, Oxford and IBH Publishing.
8. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Glick & Pasternak, 4th Edition, ASM Press.