GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)

(Deemed to be University, Estd. u/s 3 of UGC Act 1956)

VISAKHAPATNAM**HYDERABAD**BENGALURU

Accredited by NAAC with 'A^{+}' Grade

REGULATIONS AND SYLLABUS

of

BACHELOR OF SCIENCE
(Biotechnology, Chemistry, Microbiology)

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

Website: www.gitam.edu

B.Sc. Degree with Biotechnology, Chemistry, Microbiology

REGULATIONS

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

1.0 ADMISSIONS

Admissions into B.Sc. Degree with Biotechnology, Chemistry, Microbiology program of GITAM (Deemed to be University) are governed by GITAM admission regulations.

2.0 ELIGIBILITYCRITERIA

2.1 A pass in Intermediate 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 B.Sc. Degree with Biotechnology, Chemistry, Microbiology will be based on the marks obtained in intermediate or equivalent examination and the rule of reservation, wherever applicable.

3.0 CHOICE BASED CREDITSYSTEM

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.

4.0 STRUCTURE OF THEPROGRAM

4.1 The program consists of

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

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.
Two credits for three hours of practicals.

4.4 The curriculum of six semesters B.Sc. Degree with Biotechnology, Chemistry, Microbiology program is designed to have a total of **120**credits for the award of B.Sc. Degree with Biotechnology, Chemistry, Microbiology.

5.0 MEDIUM OFINSTRUCTION

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

6.0 REGISTRATION

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

7.0 ATTENDANCEREQUIREMENTS

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 end - semester examination and he/she will not be allowed to register for subsequent semester of study. He/ She have to repeat the semester along with his/her juniors.

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

8.0 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 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.

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

Table 1: Assessment Procedure

S. No.	Component of assessment	Marks allotted	Type of Assessment	Scheme of Examination
1	Theory (CC,DSE,AECC)	40	Continuous evaluation	(i) Two mid semester examinations shall be conducted for 15 marks each. (ii) 5 marks are allocated for quiz. (iii) 5marks are allocated for assignments.
		60	Semester-end examination	The semester-end examination shall be for a maximum of 60 marks.
	Total	100		
2	Theory (SEC)	100	Continuous evaluation	(i) Two mid semester examinations shall be conducted for 30 marks each. (ii) 5 marks are allocated for quiz. (iii) 5 marks are allocated for assignments. (iv) 30 marks are allocated for case study
	Total	100		
3	Practical (PPC)	40	Continuous evaluation	Forty (40) marks for continuous evaluation are distributed among the components: regularity, preparation for the practical, performance, submission of records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the Semester.
		60	Continuous evaluation	Sixty (60) marks for one test towards the end of the semester conducted by the concerned lab Teacher and external examiner appointed by the HoD.
	Total	100		

9.0 REAPPEARANCE

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

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

10.0 SPECIALEXAMINATION

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

11.0 BETTERMENT OFGRADES

A student who has secured only a pass or second class and desires to improve his/her class can appear for betterment examinations only in Theory courses of any semester of his/her choice, conducted in summer vacation along with the special examinations. Betterment of grades is permitted 'only once' immediately after completion of the program of study.

12.0 GRADINGSYSTEM

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

Table 2: Grades & Grade Points

S.No.	Grade	GradePoints	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	-

12.2 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.

13.0 GRADE POINTAVERAGE

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

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

Where

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

13.2 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.

13.3 CGPA required for classification of class after the successful completion of the program is shown in Table3.

Table 3: CGPA required for award of Class

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

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

14.0 ELIGIBILITY FOR AWARD OF THE B.Sc. DEGREE

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

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

14.3 A student shall be eligible for award of the B.Sc. Degree if he/she fulfills all the following conditions.

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

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

15.0 DISCRETIONARY POWER

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

B.Sc. Degree with Biotechnology, Chemistry, Microbiology– Scheme of Instruction

I SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SFC 101	English for Communication-I	AECC	3	-	2	40	60	100
SBT 111	Molecules of Life	CC	4	-	4	40	60	100
SBT 127	Molecules of Life Lab	PPC	-	3	2	100	--	100
SPH 105	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	CC	4	-	4	40	60	100
SPH 125	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab	PPC	-	3	2	100	--	100
SMB 101	Introduction to Microbiology	CC	4	-	4	40	60	100
SMB 121	Practices in Microbiology Lab	PPC	-	3	2	100	--	100

II SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SFC 102	Environmental Science	AECC	3	-	2	40	60	100
SBT 112	Cell Biology and Genetics	CC	4	-	4	40	60	100
SBT 128	Cell Biology and Genetics Lab	PPC	-	3	2	100	--	100
SPH 106	Chemical Energetics, Equilibria & Functional Organic Chemistry	CC	4	-	4	40	60	100
SPH 124	Chemical Energetics, Equilibria & Functional Organic Chemistry Lab	PPC	-	3	2	100	--	100
SMB 100	Bacteriology	CC	4	-	4	40	60	100
SMB 120	Bacteriology Lab	PPC	-	3	2	100	--	100

III SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SBT 211	Enzymology and Metabolism	CC	4	-	4	40	60	100
SBT 227	Enzymology Lab	PPC	-	3	2	100	--	100
SPH 205	Solutions, phase equilibrium, conductance, electro chemistry & functional group Organic Chemistry-II	CC	4	-	4	40	60	100
SPH 225	Solutions, phase equilibrium, conductance, electro chemistry & functional group Organic Chemistry-II Lab	PPC	-	3	2	100	--	100
SMB 201	Microbial Genetics	CC	4	-	4	40	60	100
SMB 221	Microbial Genetics Lab	PPC	-	3	2	100	--	100
SFC 203	English-II	AECC	3	-	2	40	60	100
Choose any one								
SSE 287	Fundamentals of Computers	SEC	2	-	2	100	--	100
SSE 279	Mathematics for Biology	SEC	2	-	2	100	--	100

IV SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
SBT 212	Molecular Biology and rDNA technology	CC	4	-	4	40	60	100
SBT 228	Molecular Biology and rDNA technology Lab	PPC	-	3	2	100	--	100
SPH 206	Coordination chemistry, states of matter & chemical kinetics	CC	4	-	4	40	60	100
SPH 224	Coordination chemistry, states of matter & chemical kinetics Lab	PPC	-	3	2	100	--	100
SMB 200	Food And Dairy Microbiology	CC	4	-	4	40	60	100
SMB 220	Food And Dairy Microbiology Lab	PPC	-	3	2	100	--	100
Choose any one								
SSE 274	Chemical technology & society	SEC	2	-	2	100	--	100
SSE 286	Bioanalytical tools	SEC	2	-	2	100	--	100

V SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
Choose any one								
SBT 341	Plant and Animal Biotechnology	DSE	4	-	4	40	60	100
SBT 343	Industrial Biotechnology	DSE	4	-	4	40	60	100
Choose any one (*corresponding to theory course)								
SBT 325	Plant and Animal Biotechnology Lab	PPC	-	3	2	100	--	100
SBT 327	Industrial Biotechnology Lab	PPC	-	3	2	100	--	100
Choose any one								
SPH381	Analytical methods in chemistry	DSE	4	-	4	40	60	100
SPH383	Green chemistry	DSE	4	-	4	40	60	100
Choose any one ($^{\#}$corresponding to theory course)								
SPH 339	Analytical methods in chemistry Lab	PPC	-	3	2	100	--	100
SPH 341	Green chemistry Lab	PPC	-	3	2	100	--	100
Choose any one								
SMB 341	Medical Microbiology	DSE	4	-	4	40	60	100
SMB 343	Ecology and Agricultural Microbiology	DSE	4	-	4	40	60	100
Choose any one (corresponding to theory course)								
SMB 321	Medical Microbiology Lab	PPC	-	3	2	100	--	100
SMB 323	Ecology and Agricultural Microbiology Lab	PPC	-	3	2	100	--	100
Choose any one								
SSE 373	Pharmaceutical chemistry	SEC	2	-	2	100	--	100
SSE 387	Molecular Diagnostics	SEC	2	-	2	100	--	100

VI SEMESTER

Course Code	Subject	Category	Instruction Hours/week		Credits	Scheme of Instruction		
			L	P		CE	SE	Total Marks
Choose any one								
SBT 342	Marine Biotechnology	DSE	4	-	4	40	60	100
SBT 344	Bioinformatics	DSE	4	-	4	40	60	100
Choose any one (*corresponding to theory course)								
SBT 326	Marine Biotechnology Lab	PPC	-	3	2	100	--	100
SBT 328	Bioinformatics Lab	PPC	-	3	2	100	--	100
Choose any one								
SPH382	Industrial chemicals and environment	DSE	4	-	4	40	60	100
SPH384	Instrumental methods of analysis	DSE	4	-	4	40	60	100
Choose any one ($^{\#}$corresponding to theory course)								
SPH 340	Industrial chemicals and environment Lab	PPC	-	3	2	100	--	100
SPH 342	Instrumental methods of analysis Lab	PPC	-	3	2	100	--	100
Choose any one								
SMB 340	Microbial Physiology and Fermentation Technology	DSE	4	-	4	40	60	100
SMB 342	Immunology	DSE	4	-	4	40	60	100
Choose any one (corresponding to theory course)								
SMB 320	Microbial Physiology and Fermentation Lab	PPC	-	3	2	100	--	100
SMB 322	Immunology Lab	PPC	-	3	2	100	--	100
Choose any one								
SSE 388	Entrepreneurship Design	SEC	2	-	2	100	--	100
SSE 390	Biosafety and IPR	SEC	2	-	2	100	--	100

SEMESTER – I

SFC 101: ENGLISH-I

Hours per week: 03 **Credits: 02**

UNIT- I

The eyes are not here – Ruskin Bond
Pronunciation: Consonants, **Grammar:** Nouns, **Vocabulary:** Roots forms of words**,**
Spelling: Correcting wrong spelling, **Punctuation:** Capitalisation,
Conversation and Role Play: Introducing oneself in formal or social contexts,

UNIT- II

Work Brings Solace – APJ Abdul Kalam

Pronunciation: Monophthongs **Grammar:** Pronouns,
Vocabulary: Prefixes & Suffixes, **Spelling:** using 'un' and 'dis' to complete antonyms**, Punctuation:** Capitalisation,
Conversation and Role Play: starting a conversation/controlling a conversation**,**

UNIT –III

Bangle Sellers – Sarojini Naidu

Pronunciation: Diphthongs **Grammar:** Helping verbs & auxiliary verbs, **Vocabulary:** Homophones, Homographs, Homonyms **Punctuation:** comma & full stop,
Conversation: Describing one's college and course of study, **Writing:** Paragraph writing/ Descriptive Writing,

UNIT -IV

The Merchant of Venice (Extract) – William Shakespeare

Pronunciation: varied pronunciation of some letters of the alphabet**Grammar:** Main verbs & Tenses,
Vocabulary: Collocations, **Punctuation:** Question mark and Exclamation mark,
Conversation: Leaving a message and taking an appointment

UNIT- V Vocabulary building: Synonyms, Antonyms, One Word Substitutes, Phrasal Verbs, Idiomatic Expressions, Foreign Phrases

Text Books:
Part – 1 (English for Enhanced Competence (by Sumit Roy, A.Karunakar, A.Aruna Priya)

Supplementary Reading:

1. Communicative skills for Technical Students, M. Faratullah. Orient Longman
2. Rizvi,MAshraf. ***Effective Technical Communication.*** McGraw - Hill.

SEMESTER – I

SBT 111: MOLECULES OF LIFE

Hours per week: 04 **Credits: 04**

UNIT-I

Structure and Properties of water, intra and intermolecular forces, non-covalent interactions-electrostatic, hydrogen bonding, Vander Waals interactions, hydrophobic and hydrophilic interactions. Disulphide bridges.

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

RECOMMENDED BOOKS:

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

SEMESTER – I

SBT 127: MOLECULES OF LIFE LAB

Hours per week: 03 **Credits: 02**

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. Separation of amino acids by paper chromatography
6. Ultra violet absorption spectra of protein and nucleic acids

RECOMMENDED BOOKS:

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

SEMESTER – I

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

Hours per week: 04 **Credits: 04**

Section A: Inorganic Chemistry-1

UNIT-I

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matterand 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.

UNIT-II

Chemical Bonding and Molecular Structure
Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionicbonding, 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 basisof 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^+.

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.

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.

UNIT-V

Alkenes: (Upto 5 Carbons)*Preparation:*Elimination reactions: Dehydration of alkenes anddehydrohalogenation 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.

RECOMMENDED BOOKS:

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

SEMESTER –I

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

Hours per week: 03 **Credits: 02**

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.

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.

RECOMMENDED BOOKS:

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

SEMESTER –I

SMB 101: INTRODUCTION TO MICROBIOLOGY

Hours per week: 04 **Credits: 04**

UNIT- I

History of microbiology, Spontaneous generation theory.Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Beijerinck, Winogradsky,EdwardJenner,Ivanowski.Germtheoryofdisease,goldeneraofmicrobiology.

UNIT-II

Classification: Whittaker's and Carl Woese's three kingdom classification systems and introduction to Bergey's manual. Prokaryotic and eukaryotic cell organization.Acellular microorganisms (Viruses,Viroids,Prions)andCellularmicroorganisms(bacteria,algae,fungiandprotozoa).

UNIT-III

General characteristics of algae, occurrence, thallus organization, algal cell ultra-structure, pigments, flagella, eyespot food reserves.Vegetative, asexual and sexual reproductions.Economic importance of algae.

UNIT-IV

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cellultra-structure,thallusorganization,typesofsepta,asexualreproduction,typesofspores(asexual and sexual), sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance offungi.

UNIT-V

General characteristics with special reference to *Amoeba, Euglena,* and *Paramecium.*
Virus taxonomy, ICTV, Baltimore, virus structure, and cultivation of virus-Embryonated egg, tissue culture; TMV, lytic and lysogenic cycle (T4 and λ phages).

RECOMMENDED BOOKS:

1.Microbiology: An Introduction (2016) by Tortora *et al.,* 12th Edition Pearson publishers
2.Prescott's Microbiology (2016) by Joanne Willey *et al.,* 10th Edition McGraw-Hill Education
3.Sherris Medical Microbiology, (2018) by Kenneth J. Ryan *et al.,*7th EditionMcGraw-Hill Education
4.Brock Biology of Microorganisms (2015) by Michael T. Madigan (15th Edition), Pearson publishers
5.Algae (2008) by James E. Graham (2nd Edition), Benjamin Cummings
6.The Fungi by Sarah C. Watkinson, Academic Press; 3rdEdition (2016)
7.Fungi: Experimental Methods in Biology (2019) by Ramesh Maheshwari, 2ndEdition, CRC Press

SEMESTER – I

SMB 121: PRACTICES IN MICROBIOLOGY LAB

Hours per week: 03 **Credits: 02**

1. Microbiology Good Laboratory Practices and Biosafety.

2. Principle and applications of important instruments used in microbiology lab (biological safety cabinets,autoclave,bacteriologicalincubator,BODincubator,hotairoven,lightmicroscope,pHmeter and colony counter) used in the microbiology laboratory.

3. Studyof*Rhizopus*,*Penicillium*,*Aspergillus*usingtemporarymounts

4. Studyof*Spirogyra*and*Chlamydomonas*,*Volvox*usingtemporaryMounts

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

RECOMMENDED BOOKS:

1. Laboratory Exercises in Microbiology (2016) by John Harley 8th Edition, McGraw-Hill Education
2. Microbiology: A Laboratory Manual (2016) by James G. Cappuccino 11th Edition Pearson publishers
3. Microbiology: Laboratory Theory and Application (2015) 4th Edition by Michael J. Leboffe, Morton Publishing Company

SEMESTER – II

SFC 102: ENVIRONMENTAL SCIENCE

Hours per week: 03 **Credits: 02**

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)

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

RECOMMENDED BOOKS:

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

SEMESTER – II

SBT 112: CELL BIOLOGY AND GENETICS

Hours per week: 04 **Credits: 04**

UNIT-I

Cell: Introduction and classification of organisms by cell structure. Cell Division: Mitosis and Meiosis: Role of meiosis in life cycles of organisms. Cell cycle and its regulation.

UNIT-II

Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport. Structure and function of Endoplasmic reticulum, Golgi complex, Lysosomes: Ribosomes, Mitochondria, Chloroplasts and Nucleus.

UNIT-III

Cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.
Extracellular Matrix: Composition, molecules that mediate cell adhesion, Endocytosis, Exocytosis membrane receptors for extra cellular matrix.

UNIT-IV

Mendelian genetics: Mendel's experimental design, Law of segregation & Principle of independent assortment. Test and back crosses. Pedigree analysis.
Dominance relationships, Pleiotropy, Multiple alleles, pseudo-allele, essential and lethal genes, Penetrance and Expressivity. Non allelic interactions: epistasis (dominant & recessive). Extra chromosomal inheritance and sex linkage.

UNIT-V

Genetic linkage, crossing over and chromosome mapping.Population genetics: Gene pool, Gene Frequency, Hardy Weinberg law and its limitations.Evolution: Origin of life, theories of organic evolution, Lamarckism and Darwinism,modern synthetic theory.Evolution above species level – micro, macro and mega evolution.Evolutionary genetics.

RECOMMENDED BOOKS:

1. iGenetics: A Molecular Approach by peter J. Russell (2016), Pearson Education
2. The Cell: A Molecular Approach by Geoffery M Cooper, (2013), 6th Edition, Sinauer Associates Inc.
3. Karp's Cell and Molecular Biology: Concepts and Experiments by Janet Iwasa (2016), John Wiley & Sons Inc; 8 edition
4. Cell Biology by Thomas D Pollard (2017), 3rd Revised edition, Elsevier - Health Sciences Division.
5. Principles of Genetics by Peter Snausted (2011), 6th Edition, John Wiley & Sons Inc.
6. Principles of Genetic by Tamarin, (2017), 7th Edition, McGraw Hill Education.
7. Genetics: Analysis and Principles by Robert J Brooker, (2017), 6th Edition, McGraw Hill Education.
8. Genetics: A Conceptual Approach by Benjamin Pierce, (2017), 6th Edition, WH Freeman
9. Concepts of Genetics by William S. Klug, (2013), 10th edition, Pearson Publishers.
10. De Robertis, E.D.P. and De Robertis, E.M.F. 2011.Cell and Molecular Biology.8th Ed. Lippincott, Williams and Wilkins, Philadelphia.

SEMESTER – II

SBT 128: CELL BIOLOGY AND GENETICS LAB

Hours per week: 03 **Credits: 02**

1. Cell division in onion root tip/ insect gonads
2. Permanent and temporary mount of mitosis.
3. Permanent and temporary mount of meiosis
4. Sub cellular fractionation of cell organelles.
5. Study of plasmolysis/deplasmolysis
6. Demonstration of - Barr Body.
7. Karyotyping with the help of photographs
8. Pedigree charts of some common characters like blood group, color blindness and PTC testing.
9. Study of polyploidy in onion root tip by colchicine treatment

RECOMMENDED BOOKS:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons.Inc.

2. Essential Cell Biology Vol 1: Cell Structure (Practical Approach Series). John Davey and Michael Lord, Oxford University Press.

2. Rediscovering Genetics A Laboratory Manual**:** Sunita Joshi and Neeru Dhamija: I.K International Publishing House Pvt. Limited

3. Genetics A Laboratory Manual 2nd edition Gregore Koliantz & Daniel B. Szymanski: Published by: American Society of Agronomy, Crop Science Society of America, 2nd Edition.

SPH 106: CHEMICAL ENERGETICS, EQUILIBRIA &FUNCTIONAL ORGANIC CHEMISTRY

Hours per week: 04Credits: 04

UNIT-I

Section A: Physical Chemistry-1

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*

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

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.

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: KNH2/NH3 (or NaNH2/NH3).

Alcohols: *Preparation:*Preparation of 1º, 2ºand 3ºalcohols: using Grignard reagent, Esterhydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4,acidic dichromate, conc. HNO3). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

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, NaHSO3, NH2-G derivatives. Iodoform test.AldolCondensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation.Clemensen reduction and Wolff Kishner reduction.Meerwein-Pondorff Verley reduction.

RECOMMENDED BOOKS:

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry,* John Wiley & Sons (2014).

2. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.

3. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, New Delhi (1988).

4. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
6. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.
7. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).

SEMESTER –II

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

Hours per week: 03 **Credits: 02**

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.

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

RECOMMENDED BOOKS:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbookof Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.

2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

SEMESTER – II

SMB 100: BACTERIOLOGY

Hours per week: 04 **Credits: 04**

UNIT-I

Microscopy: Bright field microscope, dark field microscope, phase contrast microscope, fluorescencemicroscope,confocalmicroscopy,scanningandtransmissionelectronmicroscope. Stainingtechniques:simpleanddifferentialstaining,Gramandacidfast,spore,capsular,flagellar staining.

UNIT-II

Cellsize,shapeandarrangement,morphologyandultrastructureofbacteria,actinomycetesand mycoplasma. Endospore: structure, formation, stages of sporulation**.** Bacterial growth, binary fission, growth curve, phases of growth, generation time and specific growth rate. Growth measurement:opticaldensity,colonyformingunits,batch,synchronousandcontinuouscultures. Chemostat andturbidostat.

UNIT-III

Physicalmethods:Dryheat-hotairoven,incineration;moistheat:boilingwater,tyndallization, autoclaving,pasteurization,radiation:ionizingandnon-ionizingradiations;filtration.Chemical methods:alcohols,phenols,halogens,quaternaryammoniumcompounds,aldehydes,andgases. Antiseptics anddisinfectants.

UNIT-IV

Nutritional requirement of bacteria, microbiological media- natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichmentmedia.Pureculturetechniques:pourplate,streakplateandspreadplate;preservation and maintenance of pure cultures; cultivation of anaerobicbacteria.

UNIT-V

Identification and characterization of bacterial cultures, and archaea morphological, biochemical, (IMViC, catalase, oxidase, urease, nitrate reductase; sugar fermentations, amylase, protease)metabolic, genetic, ecological, and molecularcharacteristics.

RECOMMENDED BOOKS:

1.Microbiology: An Introduction (2016) by Tortora et al., 12th Edition Pearson publishers

2.Microbiology: A Systems Approach (2017) by Kelly Cowan 5th Edition McGraw-Hill Education

3.Prescott's Microbiology (2016) by Joanne Willey et al., 10th Edition McGraw-Hill Education

4.Sherris Medical Microbiology, (2018) by Kenneth J. Ryan et al.,7th Edition McGraw-Hill Education

5.Microbiology: Principles and Explorations (2015) by Black et al.,9th Edition, Wiley Pulishers

6.Brock Biology of Microorganisms (2015) by Michael T. Madigan (15th Edition), Pearson publishers.

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

SEMESTER – II

SMB 120: BACTERIOLOGY LAB

Hours per week: 03 **Credits: 02**

1. SterilizationofglasswareusingHotAirOvenandassessmentforsterility
2. PreparationandsterilizationofmediumusingAutoclaveandassessmentforsterility
3. Sterilizationofheatsensitivematerialbymembranefiltrationandassessmentforsterility
4. Preparationofdifferentmedia:syntheticmedia,Complexmedia-Nutrientagar,McConkey agar, EMBagar.
5. Simple staining, Negativestaining
6. Gram'sstaining
7. Acid fast staining-permanent slideonly.
8. Capsulestaining
9. Endosporestaining.
10. Isolation of pure cultures of bacteria by streakingmethod.
11. Estimation of CFU count by spread plate method/pour platemethod.
12. Motility by hanging dropmethod.
13. Preservation of bacterial cultures by varioustechniques.

RECOMMENDED BOOKS:

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

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

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

SEMESTER – III

SBT 211: ENZYMOLOGY AND METABOLISM

Hours per week: 04 **Credits: 04**

UNIT –I

Nomenclature and classification of enzymes, Factors effecting enzyme activity: enzyme concentration, substrate concentration, pH, temperature and metal ions. Enzyme assay, units of enzyme activity and specific activity. Michaelis - Menten equation, significance of Km, Vmax.

UNIT-II

Cofactors, coenzymes, metalloenzymes. Enzyme inhibition: Irreversible inhibition and Reversible inhibition - competitive, non- competitive and uncompetitive. Enzyme regulation : allosteric enzymes, zymogen activation, covalent modification and isoenzymes. Overview of Abzyme, ribozyme and enzyme immobilization.

UNIT-III

Glycolysis and its regulation.TCA cycle and its regulation.Electron transport chain and oxidative phosphorylation. Significance of - gluconeogenesis, HMP shunt and glyoxylate cycle. Glycogen synthesis and degradation, Glycogen storage diseases.

UNIT-IV

Synthesis and degradation of Saturated and Unsaturated Fatty acids, Ketone bodies, Synthesis of Triacyl glycerides, Phospholipids and Cholesterol.

UNIT-V

Transamination and oxidative deamination and Urea cycle.Biosynthesis and degradation of phenylalanine and valine.Inborn errors of aminoacid metabolism.Synthesis and degradation of purine and pyrimidine nucleotides.Formation of deoxyribonucleotides.

RECOMMENDED BOOKS:

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

SEMESTER – III

SBT 227: ENZYMOLOGY LAB

Hours per week: 03 **Credits: 02**

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

RECOMMENDED BOOKS:

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

SEMESTER –III

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

Hours per week: 04 **Credits: 04**

UNIT-I

Section A: Physical Chemistry-2

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).

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.

UNIT-III

Section B: Organic Chemistry-3

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.

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.

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.

RECOMMENDED BOOKS:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-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 *7thEd.*, W. H. Freeman.
6. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

SEMESTER –III

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

Hours per week: 03 **Credits: 02**

Section A: Physical Chemistry

Distribution

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

$I_2(aq) + I^-(aq) \quad I_3^-(aq)$
$Cu^{2+}(aq) + xNH2(aq) \quad [Cu(NH3)x]^{2+}$

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 weakacid.
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.

RECOMMENDED BOOKS:

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

SEMESTER – III

SMB 201: MICROBIAL GENETICS

Hours per week: 04 **Credits: 04**

UNIT-I

Organization of genetic material in prokaryotes.Genome organization: *E.coli, Saccharomyces, Tetrahymena.*Structure of genes, types of genes.
Features of T4 phage.Genetic basis of Lytic vs Lysogenic switch of phage λ.

UNIT-II

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast-2 μ plasmid, plasmid-incompatibility, plasmid replication, plasmid amplification, regulation of copy number, curing of plasmids.

UNIT-III

Discovery and mechanism of transformation, conjugation- Hfr and F`strains, interrupted mating technique.Transduction-generalized transduction, specialized transduction, mapping by recombination.

UNIT-IV

Discovery of transposons.Prokaryotic transposable elements – insertion sequences, composite and non-composite transposons, replicative and non-replicative transposition, uses of transposons and transposition.

UNIT-V

Mutations and mutagenesis: definition and types of mutations; physical and chemical mutagens; molecular basis of mutations; functional mutants (loss and gain of function mutants); uses of mutations. Ames test; mutator genes

RECOMMENDED BOOKS:

1. Molecular Biology: Principles and Practice (2015) by Michael M. Cox 2nd Edition, W. H. Freeman publishers
2.Molecular Genetics of Bacteria, (2013) by by Larry Snyder 4th Edition, ASM Press

3.Molecular Cell Biology (2016) by Lodish *et al.,* 8th Edition, W. H. Freeman publishers

4.Genetics: A Molecular Approach (2009) by Peter J Russell (3rd Edition), Pearson

5.Genetics: A Conceptual Approach (2016) 6th Edition W. H. Freeman publishers

6.Microbiology: An Introduction (2016) by Tortora et al., 12th Edition Pearson publishers

7.Microbiology: A Systems Approach (2017) by Kelly Cowan 5th Edition McGraw-Hill Education

8.Prescott's Microbiology (2016) by Joanne Willey et al., 10th Edition McGraw-Hill Education

9.Microbiology: Principles and Explorations (2015) by Black et al.,9th Edition, Wiley Pulishers

10.Brock Biology of Microorganisms (2015) by Michael T. Madigan (15th Edition), Pearson publishers

SEMESTER – III

SMB 221: MICROBIAL GENETICS LAB

Hours per week: 03 **Credits: 02**

1. Preparation of Master and ReplicaPlates
2. Growth curve of E.coli.
3. Mutagenesisusingchemical(HNO_2)andphysical(UV)mutagensonbacterialcells
4. Survival curve of bacteria after exposure to ultraviolet (UV)light
5. Demonstration of BacterialConjugation
6. Demonstration of bacterial transformation andtransduction
7. Demonstration of Amestest
8. Isolationandenumerationofbacteriophages(PFU)fromwater/sewagesampleusing double agar layertechnique

RECOMMENDED BOOKS:

1. Laboratory Exercises in Microbiology (2016) by John Harley 8thEdition, McGraw-Hill Education
2.Microbiology: A Laboratory Manual (2016) by James G. Cappuccino 11thEdition Pearson publishers
3.Microbiology: Laboratory Theory and Application (2015) 4th Edition by Michael J. Leboffe, Morton Publishing Company
4.Cell and Molecular Biology Lab Manual (2011) by Dr. David A Thompson, CreateSpace Independent Publishing Platform
5.Cell and Molecular Biology: A Lab Manual (2013) by K. V. Chaitanya, PHI

SFC 203: ENGLISH-II

Hours per week: 03 **Credits: 02**

UNIT- I

The Open Window : Saki (H.H.Munro)

Pronunciation: Syllabification**, Grammar:** Non-infinite verbs, **Vocabulary:** Simile & Metaphor**, Spelling:** using 'ie' or 'ei', **Punctuation:** semi-colon, **Conversation:** Asking for advice/information,

UNIT- II

The Voice of Humanity – Rabindranath Tagore

Pronunciation: Word Stress, **Grammar:** Adjectives, **Vocabulary:** Oxymoron & Hyperbole**, Spelling:** using 'able' and 'ible', **Punctuation:** Colon & dash, **Group Discussion**

UNIT –III

If – Rudyard Kipling

Pronunciation: Sentence Stress**, Grammar:** Articles, **Vocabulary:** Portmanteau and loan words**, Spelling:** using suffixes, **Punctuation:**Hyphen & dash, **Oral Presentation**

UNIT -IV

Riders to the Sea – JM Synge

Pronunciation – Intonation**, Grammar:** Adverbs, **Vocabulary:** Palindromes**, Spelling:** completing tables with nouns, verbs, adjectives, adverbs **Punctuation:** Inverted comma, **Conversation/Role play:** Appearing for a job interview/conducting a job interview

UNIT- V

Academic Writing: Letter Writing, Paragraph Writing, Essay Writing, Resume Preparation, Dialogue Writing, Precis

Text Books:

Part – 2 (English for Enhanced Competence (by Sumit Roy, A.Karunakar, A.Aruna Priya)

Supplementary Reading:

1. Communicative skills for Technical Students, M. Faratullah. Orient Longman
2. Rizvi,MAshraf. ***Effective Technical Communication.*** McGraw - Hill.

SEMESTER –III

SSE 287: FUNDAMENTALS OF COMPUTERS

Hours per week: 02 **Credits: 02**

Introduction: Characteristics of Computers, Classification of Computers,Binary Number System .Computer Software, Computer languages, Concept of assembler, interpreter, linker and compiler.

Basic computer organization, Processor and Memory, Algorithm, Flow Charts.

Operating Systems: What is an Operating System, Main functions of an Operating system, Some Popular Operating Systems

Data Communications and Computer Networks: Basic Elements of a Communication System, **The Internet:** Brief History, Its basic Services, WWW &browsers, internet search engines, uses of internet.

TEXT BOOK

Computer Fundamentals - PradeepK.Sinha: BPB Publications, 6th Edition

RECOMMENDED BOOKS:

1. Computer Fundamentals- Rajaraman V.

2. Introduction to Computers -Peter Norton.

3. Fundamentals Of Information technology Alexis Leon, Methew Leon, Vikas publications.

SEMESTER –III

SSE 279: MATHEMATICS FOR BIOLOGY

Hours per week: 02 **Credits : 02**

UNIT-I

Functions, limits and continuity, differentiation and integration, maxima and minima and their use in biological problems.

UNIT-II

Differential equation, separable variables, homogeneous, exact and linear equations of second order, applications of differential equations of Biochemistry. Matrices and determinants, characteristic roots and characteristic equation.

RECOMMENDED BOOKS:

1. John .E Frenund's mathematical statistics with application by Irwin Miller and Marylees Miller, Ed. 7th, Pearson -2006.

2. Essential mathematical biology by Nicholas F. Britton; Ed.1st –Springer -2004.

3. Differential calculus by Shanti Narayan, Ed. 30th, S.Chand & Co. Ltd. 2005.

SEMESTER – IV

SBT 212: MOLECULAR BIOLOGY AND rDNA TECHNOLOGY

Hours per week: 04 **Credits: 04**

UNIT-I

Features of DNA Replication, mechanism of DNA replication in prokaryotes and eukaryotes, enzymes and proteins involved in DNA replication, DNA damage and repair

UNIT-II

Transcription mechanism in prokaryotes and eukaryotes, Types of RNA polymerases and promoter-polymerase interactions, DNA-dependent RNA polymerase, RNA transport and editing, inhibitors of transcription and applications of antibiotics.

UNIT-III

Mechanism of translation in prokaryotes and euakryotes, Co-and post translational modifications**,** protein targeting, regulation of gene expression-operon concept, cis-trans elements, DNA methylation, RNAi and gene silencing

UNIT-IV

Genetic engineering molecular tools:Restriction enzymes, DNA ligases, Polymerases, Alkaline phosphatase, Poly nucleotide kinase, Terminal deoxy nucleotide transferase.Cloning vectors: Plasmids, Bacteriophage-derived vectors and artificial chromosomes. Gene Recombination and Gene transfer: Transformation and screening of recombinants.

UNIT-V

Hybridization techniques: Southern and Northern hybridization. Principle and applications of Polymerase Chain Reaction (PCR) and Reverse transcription (RT) PCR.Preparation of Genomic and cDNA libraries, DNAsequencing by chemical, enzymatic and Next Generation Sequencing (NGS) methods, DNA fingerprinting.

RECOMMENDED BOOKS:

1. Recombinant DNA: Genes and Genomes - a Short Course by James D. Watson, (2006) WH Freeman & Co; 3rd edition
2. Lewin's Genes-XII by Jocelyn E. Krebs et al., (2017) Jones and Bartlett Publishers, Inc; 12th edition
3. Principles of Gene Manipulation and Genomics by Primrose & Twyman (2006) 7thed (Oxford).
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Glick et al., (2017) 5th ed ASM Press.
5. Gene Cloning and DNA Analysis: An Introduction by T.A. Brown (2016) 7thed (Wiley-Blackwell).
6. Molecular Biology of the Cell by Bruce Alberts (2014), 6th edition, Garland Science
7. Genomes by T.A. Brown (2017) 4th ed Garland Science Publishers.
8. Molecular Biology of the Gene by Watson et al., (2013) Person Publishers
9. Molecular Cell Biology by Lodish et al., (2016) 8th Edition, WH Freeman publishers

10. Karp's Cell and Molecular Biology: Concepts and Experiments by Janet Iwasa (2016), John Wiley & Sons Inc; 8 edition

SEMESTER – IV

SBT 228: MOLECULAR BIOLOGY AND rDNA TECHNOLOGY LAB

Hours per week: 03 **Credits: 02**

1. Isolation of DNA from Eukaryotic cells.
2. Isolation of Plasmid DNA by alkaline Lysis method
3. Separation of DNA by Agarose gel electrophoresis
4. Purity of isolated DNA by A260/A280 Ratio
5. Isolation of RNA by Trizol method
6. DNA denaturation and Hyperchromic effect
7. Estimation of DNA by DPA method
8. Estimation of RNA by Orcinol method
9. Restriction digestion of DNA
10. Ligation of DNA
11. Polymerase Chain Reaction (PCR)

RECOMMENDED BOOKS:

1. Biotechnology: A laboratory course by Becker J.M.
2. Molecular Cloning: A laboratory manual Vals. 1-3, Sambrook, J.
3. Biochemistry - a lab course by J.M.Becker (Academic Press).
4. Molecular Cloning: A laboratory manual Vals. 1-3, Sambrook, J.

SEMESTER –IV

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

Hours per week: 04 **Credits:04**

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).

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.

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 van der 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).

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.

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.

RECOMMENDED BOOKS:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).

2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry,* Wiley.
7. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
8. Wulfsberg, G. *Inorganic Chemistry,* Viva Books Pvt. Ltd.
9. Rodgers, G.E. *Inorganic & Solid State Chemistry,* Cengage Learning India Ltd., 2008.

SEMESTER –IV

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

Hours per week: 03 **Credits: 02**

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 a 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.

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

RECOMMENDED BOOKS:

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

SEMESTER –IV

SMB 200: FOOD AND DAIRY MICROBIOLOGY

Hours per week: 04 **Credits: 04**

UNIT-I

Intrinsicandextrinsicfactors.Sourceofcontamination-fruits,vegetable,grains,poultry,meat andfish.Preventionandcontrolmeasures.Spoilageofvegetables,fruits,meat,eggs,milk, butter,bread andcannedfoods.Factorsaffectingspoilage.

UNIT-II

Physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging. Chemicalmethodsoffoodpreservation:salt,sugar,organicacids,SO_2,nitriteandnitrates,ethylene oxide, antibiotics andbacteriocins.

UNIT-III

Milkcomposition.Dairystartercultures,fermenteddairyproducts:yogurt,acidophilusmilk,dahi and cheese, other fermented foods, Probiotics: Health benefits, types of microorganisms used, probiotic foods available inmarket.

UNIT-IV

Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins; Food infections: Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni.Microorganisms in food spoilage.

UNIT-V

HazardAnalysisCriticalControlPoints(HACCP),indicesoffoodsanitaryqualityandsanitizers, cultural and rapid detection methods of food borne pathogens in foods and introduction to predictivemicrobiology.

RECOMMENDED BOOKS:

1.Food Microbiology: An Introduction (2017) by Thomas J. Montville *et al.*, 4th Edition, ASM Press

2.Food Microbiology (2015) by Martin R Adams, Royal Society of Chemistry; 4th Edition

3.Food Microbiology: Fundamentals and Frontiers (2012) by Michael P. Doyle 4thEdition, ASM Press

4.Fundamental Food Microbiology (2013) by Bibek Ray, 5thEdition, CRC Press;

5.Food-Borne Infections and Intoxications (Food Science and Technology) (2005), by Riemann *et al.*,Academic Press Inc.

SEMESTER –IV

SMB 220: FOOD AND DAIRY MICROBIOLOGY LAB

Hours per week: 03 **Credits: 02**

1. MBRT of milk samples and their standard platecount.
2. Alkalinephosphatasetesttochecktheefficiencyofpasteurizationofmilk.
3. Isolation of food bornebacteria
4. Isolation of microorganisms from spoiledvegetables/fruits.
5. Isolation of breadmold
6. Preparation ofYogurt/Dahi.
7. Isolation of yeast fromgrapes
8. Platform tests forMilk: organoleptic evaluation- Odor / Smell, GeneralAppearance, Colour, Consistency, Temperature
9. Platform tests forMilk: Clot on boiling test, Alcohol test, Sediment test and Resazurin test.

RECOMMENDED BOOKS:

1.Food Microbiology Laboratory (Contemporary Food Science) (2003) by Lynne McLandsborough 1st Edition, CRC Press

2.Food Microbiology: A Laboratory Manual (2002) by Ahmed E. Yousef, 1st Edition, Wiley-Interscience

SEMESTER –IV

SSE 274:CHEMICAL TECHNOLOGY & SOCIETY

Hours per week: 02 **Credits: 02**

Chemical Technology

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry.Introduction to clean technology.

Society

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants); energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.

RECOMMENDED BOOKS:

John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times* 13th Edition.

SEMESTER –IV

SSE 286: BIOANALYTICAL TOOLS

Hours per week: 02 **Credits: 02**

Chromatographic techniques

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

Electrophoretic techniques

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.

Centrifugation

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.

RECOMMENDED BOOKS:

1. Physical Biochemistry: Principles and Applications by David Sheehan (2009)
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology by Andreas Hofmann and Samuel Clokie (8th edition, 2018)Practical Biochemistry by Keith Wilson and Walker. 5th ed. Cambridge University Press.
3. Biophysical chemistry principles and techniques by Upadyay, Upadyay and Nath (Himalaya publishing).
4. Instrumental methods of chemical analysis by Chatwal and Anand. Ed 5, Himalaya Publishers.
5. Atkin’s Physical Chemistry (10th edition). 2014. Peter Atkins and Julio de Paula, Oxford University Press;.

SEMESTER – V

SBT 341: PLANT AND ANIMAL BIOTECHNOLOGY

Hours per week: 04 **Credits: 04**

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

RECOMMENDED BOOKS:

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

SEMESTER – V

SBT 343: INDUSTRIAL BIOTECHNOLOGY

Hours per week: 04 **Credits: 04**

UNIT- I

Screening, isolation and maintenance of microbes, preservation of isolated pure cultures. Sterilization of media: Batch and Continuous sterilization. Strain selection, Strain improvement: physical and chemical methods

UNIT – II

Bioreactor: design and parts of bioreactor, types of bioreactor, Batch reactor, Continuous reactor, fixed bed reactor, fluidized bed reactor, trickle fermenter. single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up.

UNIT – III

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

UNIT- IV

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Ethanol, hydrogen, microbial electricity, starch conversion processes; Microbialpolysaccharides; Microbial insecticides; anti-cancer agents.

UNIT – V

Microbial products of pharmacological interest, steriod fermentations and transformations.Secondary metabolism – its significance and products.Metabolic engineering of secondary metabolism for highest productivity.Enzyme and cell immobilization techniques in industrial processing.Application of immobilized enzymes in medicine and industry.

RECOMMENDED BOOKS:

1. Modern Industrial Microbiology and Biotechnology, Second Edition **2nd Edition (2017)** byNduka Okafor, Benedict C. Okeke

2. Casida LE. (2016). Industrial Microbiology.2nd edition.New Age International Private Limited.
3. Crueger W and Crueger A. (2017). Cruegers Biotechnology: A Textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
4. Patel AH. (2015). Industrial Microbiology.2nd edition, LAXMI PUBLICATIONS-NEW DELHI.
5. Stanbury PF, Whitaker A and Hall SJ.(2016). Principles of Fermentation Technology.3rded, Butterworth-HeinemannLtd.

SEMESTER – V

SBT 325: PLANT AND ANIMAL BIOTECHNOLOGY LAB

Hours per week: 03 **Credits: 02**

1. Preparation of simple growth nutrient (Knop's medium), full strength, half strength, solid and liquid.

2. Preparation of complex nutrient medium (Murashige & Skoog's medium)

3. Sterilization and preparation of various explants for plant tissue culture.

4. To demonstrate various steps of Micropropagation.

5. Isolation of protoplasts from Leaf.

6. Preparation of animal cell culture media

7. Preparation of single cell suspension cultures from spleen

8. Enumeration of cells in culture by haemocytometer

9. Preparation of glycerol stocks

RECOMMENDED BOOKS:

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

SEMESTER – V

SBT 327: INDUSTRIAL BIOTECHNOLOGY LAB

Hours per week: 03 **Credits: 02**

1. Isolation of antibiotic producing strain from soil samples.
2. Isolation and analysis of actinomycetes from soil samples.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Fermentative production of protease by shake flask method.
5. Fermentative production of amylase by shake flask method.
6. Production of wine / alcohol.
7. Immobilization of bacterial cells.
8. Immobilization of enzyme trypsin.

RECOMMENDED BOOKS:

1. A manual of Industrial Microbiology and Biotechnology by Demain A.L.
2. Immobilization of enzymes and cells: Methods in Biotechnology vol.1 by Bickerstaff G.F.
3. Principle of fermentation technology by Stanbury. 2nd ed. Elsevier.
4. Biotechnology: A laboratory course by Becker J.M.
5. Lab manual in Biochemistry by J.Jayaraman (Wiley Eastern limited).
6. Biochemistry - A lab course by J.M.Becker (Academic Press).

SEMESTER – V

SPH 381: ANALYTICAL METHODS IN CHEMISTRY

Hours per week: 04 **Credits: 04**

UNIT –I

Qualitative and quantitative aspects of analysis:

Evaluation of analytical data, errors, accuracy and precision, methods of their expression,, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UNIT –II

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source,monochromator and detector) for single and double beam instrument;

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator& detector) for single and double beam instrument;

UNIT-III

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation(choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; sources of chemical interferences. Techniques for the quantitative estimation of trace level of metal ions from water samples.

UNIT-IV

Thermal methods of analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation.

Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations.

UNIT-V

Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique.
Mechanism of extraction: extraction by solvation and chelation.
Technique of extraction: batch, continuous and counter current extractions.
Chromatography: Classification, principle and efficiency of the technique.
Mechanism of separation: adsorption, partition & ion exchange.
Development of chromatograms: frontal, elution and displacement methods.

RECOMMENDED BOOKS:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6thEd.*, Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.

3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
7. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974

SEMESTER – V

SPH 383:GREEN CHEMISTRY

Hours per week: 04 **Credits: 04**

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.

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

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

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.

UNIT –V

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

RECOMMENDED BOOKS:

1. Paul T. Anastas and John C. Warner, “Green Chemistry”, Oxford UniversityPress, Indian Ed., 2008.
2. V. K. Ahluwalia and M. Kidwai, “New Trends in Chemistry”, Anamaya Publishers, 2nd Ed. 2007.

3. V. Kumar, “An Introduction to Green Chemistry”, Vishal Publishers, 1st Edition,2007.

4. V. K. Ahluwalia and R. S. Varma, “Green Solvents”, Narosa Publishing, 1st Edition, 2009.

5. V.K.Ahluwalia and Renu Aggarwal, “Organic Synthetic Special Techniques”,Narosa,2nd Ed., 2009.

6. V. K. Ahluwalia, “Green Chemistry - Environmentally Benign Reactions”, Ane books,India, 2006.

7. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).

SEMESTER – V

SPH 339: ANALYTICAL METHODS IN CHEMISTRY LAB

Hours per week: 03 **Credits: 02**

I. Separation Techniques

1. Chromatography:
(i) Separation of mixtures
2. Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.
3. Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.
(i) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.
(ii) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II Solvent Extractions:

(i) To separate a mixture of Ni^{2+}& Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMGcomplex in chloroform, and determine its concentration by spectrophotometry.

(ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.

1. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
2. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.
3. Analysis of soil:

(i) Determination of pH of soil.
(ii) Total soluble salt
(iii) Estimation of calcium, magnesium, phosphate, nitrate

4. Ion exchange:
(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.
(ii) Separation of metal ions from their binary mixture.
(iii) Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of pKa values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.
3. Determination of dissolved oxygen in water.
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex byJob's method.

RECOMMENDED BOOKS:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6thEd.*, Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing

Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age Int. Publisher, 2009.

SEMESTER – V

SPH 341: GREEN CHEMISTRY LAB

Hours per week: 03 **Credits: 02**

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

(II) 1-propanol $\xrightarrow{H_2SO_4/\square}$ 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.

RECOMMENDED BOOKS:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistryexperiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment:A monographInternational Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry,* American Chemical Society (2008).

SEMESTER – V

SMB 341: MEDICAL MICROBIOLOGY

Hours per week: 04 **Credits: 04**

UNIT -I

Normalmicrofloraofthehumanbody-skin,throat,gastrointestinaltract,urogenitaltract.Host pathogen interaction: infection, invasion, pathogen, pathogenicity, virulence, toxigenicity, carriers and their types, opportunistic infections, nosocomial infections.Vertical and horizontal transmission.

UNIT -II

Symptoms, mode of transmission, prophylaxis, diagnosis and control of -respiratorydiseases: *Streptococcus pyogenes*, *Mycobacterium tuberculosis*, gastrointestinal diseases: *Escherichia coli*, *Salmonella typhi*, *Vibriocholerae*,*Helicobacterpylori*,diseasecausedby:*Staphylococcusaureus*,*Bacillusanthracis*,*Clostridium tetani*.

UNIT –III

Symptoms,modeoftransmission,prophylaxis,diagnosisandcontrolof-Polio,Herpes,hepatitis, HIV,Influenza,emergingandreemergingviruses-Ebola,Zikavirus.
Disease cycle, mode of transmission, treatment of Plasmodium, Leishmania and Giardia.

UNIT –IV

Mycoses and types. Symptoms, mode of transmission, prophylaxis, diagnosis and control of-
Cutaneousmycoses:Tineapedis(Athlete'sfoot)Systemicmycoses:Histoplasmosis,Opportunistic mycoses:Candidiasis.

UNIT –V

Collection, transport and culturing of clinical samples. Antimicrobial agents: mode of action: Inhibitorsof-nucleicacidsynthesis;cellwallsynthesis;cellmembranefunction;proteinsynthesis; metabolism. Antibiotic resistance, MDR,MRSA.

RECOMMENDED BOOKS:

1.Microbiology: An Introduction (2016) by Tortora *et al.*, 12th Edition Pearson publishers

2.Prescott's Microbiology (2016) by Joanne Willey *et al.*, 10th Edition McGraw-Hill Education

3.Sherris Medical Microbiology, (2018) by Kenneth J. Ryan *et al.*,7th EditionMcGraw-Hill Education

4.Microbiology: Principles and Explorations (2015) by Black *et al.*,9th Edition, Wiley Pulishers

5.Algae (2008) by James E. Graham (2nd Edition), Benjamin Cummings

6.The Fungi by Sarah C. Watkinson, Academic Press; 3 edition (2016)

7.Fungi: Experimental Methods in Biology by Ramesh Maheshwari, Second Edition, CRC Press

8.Understanding viruses (2016) by Teri shors, Jones and Bartlet Publishers

SEMESTER – V

SMB 343: ECOLOGY AND AGRICULTURAL MICROBIOLOGY

Hours per week: 04 **Credits: 04**

UNIT –I

Microbial ecology-scope, positive microbial interactions- mutualism, protocooperation, commensalism.Negative microbial interactions – competition, antagonism, parasitism, predation, Microbial community development, r and k strategies.

UNIT –II

Airbornetransmissionofmicrobes,airsamplingprinciplesandtechniques.Aquaticmicrobiology-freshwater,marinehabitats.Zonationofwaterecosystems,eutrophication.Potabilityofwater-Microbialassessmentofwaterquality,waterpurification,majorwaterbornediseasesandtheir controlmeasures.

UNIT –III

Soil environment - soil profile.Physico-chemical conditions, sampling techniques, role of microorganisms in organic matter decomposition, biogeochemical cycles – nitrogen cycle, sulphur and phosphorous cycles.Rhizosphere, biochelators, siderophores.

UNIT –IV

Plant pathogens-fungal (white rustsofcrucifers,earlyandlateblightofpotato,Fusariumwilt,powderymildew), bacterial (Citrus canker) and viral (Tobacco mosaic virus,CaMV) disease symptoms, diseasecycle,preventionandmanagement.

UNIT –V

PGPR.Biofertilizers- nitrogen fixing microbes- Rhizobium, Azotobacter, blue green algae, Phosphate solubilizing microorganisms.Mycorrhiza. Biopesticides – Bacillus thuringiensis, Pseudomonas syringae and Beauveria bassiana, NPV. Mycophagy.

RECOMMENDED BOOKS:

1.Microbiology: An Introduction (2016) by Tortora et al., 12thEdition Pearson publishers

2.Microbiology: A Systems Approach (2017) by Kelly Cowan 5thEdition McGraw-Hill Education

3.Prescott's Microbiology (2016) by Joanne Willey et al., 10thEdition McGraw-Hill Education

4.Brock Biology of Microorganisms (2015) by Michael T. Madigan (15thEdition), Pearson publishers

5.Handbook of Microbial Biofertilizers (2006) by Mahendra Rai 1stEdition, CRC Press

6.Algae: An Introduction to Phycology (1996) by Christiaan van den Hoek, 1st Edition, Cambridge University press

7.The Fungi by Sarah C. Watkinson, Academic Press; 3rd Edition (2016).

SEMESTER – V

SMB 321: MEDICAL MICROBIOLOGY LAB

Hours per week: 03 **Credits: 02**

1. Identification of bacteria (E. coli, Pseudomonas, Staphylococcus, Bacillus) using laboratory strainsonthebasisofcultural,morphologicalandbiochemicalcharacteristics:IMViC, TSI, nitrate reduction, urease production and catalasetests.

2. Studyofcompositionanduseofimportantdifferentialmediaforidentificationofbacteria:

EMBAgar,McConkeyagar, Mannitolsaltagar,Deoxycholatecitrateagar,TCBS

3. Study of bacterial flora of skin by swabmethod.

4. Perform antibacterial sensitivity by Kirby-Bauermethod.

5. Determinationofminimalinhibitoryconcentration(MIC)ofanantibiotic

RECOMMENDED BOOKS:

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

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

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

SEMESTER – V

SMB 323: ECOLOGY AND AGRICULTURAL MICROBIOLOGY LAB

Hours per week: 03 **Credits: 02**

1. Isolationofbacteriaandfungifromsoilusingserialdilutionmethod
2. Isolation of Rhizobium from rootnodules
3. MPNtest
4. DO andBOD
5. Observation of rust spots from local leafyvegetables
6. Observation of viralsymptoms
7. VAM fungalobservation
8. Observation and comparison of differentBiofertilizers

RECOMMENDED BOOKS:

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

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

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

4.Handbook of Microbial Biofertilizers (2006) by Mahendra Rai 1st Edition, CRC Press

5.Fungi: Experimental Methods in Biology (2019) by Ramesh Maheshwari, Second Edition, CRC Press

SEMESTER – V

SSE 373: PHARMACEUTICAL CHEMISTRY

Hours per week: 02 **Credits: 02**

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, Paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT-Zidovudine).

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

RECOMMENDED BOOKS:

1. The organic chemistry of drug design and drug action. Richard B Silverman
2. Pharmaceutical biotechnology, concepts and applications. Gary Walsh. Wiley publications.
3. Drug metabolism in drug design and development. Wiley publications.
4. Design of controlled release drug delivery systems. Xiaoling Li. McGraw-Hill publications
5. Applied biopharmaceutics and pharmacokinetics. Leon shargel, Susanna Wu-Pong, Andrew Yo.

SEMESTER – V

SSE 387: MOLECULAR DIAGNOSTICS

Hours per week: 02 **Credits: 02**

Molecular Diagnostics-Scope and importance. Genetic Markers commonly used for forensic analysis. Methods for identification of disease markers, predictive value, diagnostic value.Emerging blood markers for sepsis, cancer and inflammation.

Genomic instability-Mechanism and factors involved. Common fragile sites and methods of induction.Heritable fragile sites. Trinucleotide Repeats. Mechanism of expansion and triplet repeats and related disorders.Genetic linkage maps.Diseases resulting from Chromosomal Aberrations.

Molecular approaches in the is of diseases. DNA Extraction Methodologies, DNA Quantitation, Capillary Electrophoresis. DNA based Techniques in the diagnosis of diseases-Hybridization, PCR and RT PCR. RNA signature based methods in detection of different diseases. Protein and DNA microarrays in diagnosis.ELISA in the detection of diseases. Immunodiagnostic methods for detection of microbial infections-WIDAL and VDRL

RECOMMENDED BOOKS:

1. Medical Biotechnology by Bernard Glick, Terry L delovitch, Cheryl L Patten
2. Molecular biology of the cell. Bruce Alberts, 6th Edition
3. Molecular Cell Biology: Darnell J, Lodish H and Baltimore D
4. An introduction to Human Molecular Genetics by Pasternak et al., Wiley Pubs
5. Human Chromosomes by Miller & Tharman, Springer Publishing Company
6. Genes XII, by Lewin B, Pearson India
7. Elements of medical Genetics by Turnpenny and Ellard, Churchill Livingstone

SEMESTER – VI

SBT 342: MARINE BIOTECHNOLOGY

Hours per week: 04 **Credits: 04**

UNIT –I

Chemical Composition of sea water.Biological features of the marine environment, Estuaries, Tropical shores and brackish water.Biogeo chemical cycles in marine ecosystem.

UNIT –II

General aquaculture practices - fish, shrimp and crab culture practices, induced breeding techniques - Hypophysation and Eyestalk oblation. Management of aquaculture farms – Feeding schedules, feed formulations, wet feeds and dry feeds.Fish byproducts.Economically important aquatic resources.

UNIT-III

Mariculture: Culture of Lobsters, Mussel, Pearls, Oysters and Sea-weeds. Biology of estuaries – Estuarine adaptations, Coral reef communities and conservation methods.

UNIT-IV

Post harvesting and preservation technologies – on board handling, drying and dehydration, salt curing, smoking, marinades, freezing, freeze drying, modified atmosphere packaging. Quality assurance.

UNIT-V

Marine pollution- Causes and preventive measures, Role of government agencies – Role of NABARD and other central government agencies in the upliftment of fisher folk. The Marine Products Exports Development Authority (MPEDA), Integrated coastal zone management, ocean policy and Coastal regulatory zone (CRZ)

RECOMMENDED BOOKS:

1. Elements of Marine Ecology Fourth Edition R.V. Tait F. A. Dipper 1998
2. Marine fisheries ecology by Simon Jennings, Michel J. Kaiser, 2001 by Blackwell Science Ltd, a Blackwell Publishing company
3. Aquaculture: Farming Aquatic Animals and Plants edited by John S. Lucas, Paul C. Southgate (2012), second edition; (Wiley Blackwell)
4. Post-harvest Technology of Fish and Fish Products by K. K. Balachandran, Daya publishinghouse.
5. Marine Fish Culture (1998) By John W. Tucker Jr. Springer publishers
6. Fish and Fisheries (2006) by By B. N. Yadav, DAYA publishing house
7. Induced Fish Breeding: A Practical Guide for Hatcheries (2017) By Nihar Ranjan Chattopadhyay, Acdemic Press.

SEMESTER – VI

SBT 344: BIOINFORMATICS

Hours per week: 04 **Credits: 04**

UNIT -I

Scope of computers in biological research. Anatomy of computers and its accessories, types of computers. Introduction to networks (internet) and its applications.Introduction to Bioinformatics, history of Bioinformatics, branches of Bioinformatics, scope and research areas of Bioinformatics

UNIT -II

Introduction to Biological Databases, Classification of Biological Databases, National Center for Biotechnology Information (NCBI), EMBL Nucleotide Sequence Database (EMBL-Bank), DNA Data Bank of Japan (DDBJ). Protein Information Resource (PIR), UniProt, TREMBL, Protein Data Bank (PDB), Human genome data base.

UNIT -III

Concept of Alignment, Pairwise Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Point Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

UNIT -IV

Methods of Phylogeny- Distance based and character based methods.Software for Phylogenetic Analyses, Consistency of MolecularPhylogenetic Prediction.

UNIT -V

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Introduction to genomics, Genome Annotation: Pattern and repeat finding, Gene identification tools.Introduction to proteomics.

RECOMMENDED BOOKS:

1.Essential Bioinformatics by Jin Xiong, Reprint 2011(Cambridge University Press).
2.Biological Sequence Analysis by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Indian Reprint (Cambridge University Press).
3.An Introduction to Bioinformatics by T. K. Attwood and D. J. Parry-Smith Addison, Reprint 2011 (Wesley Longman, Harlow).
4.Introduction to Bioinformatics by Arthur M. Lesk, 3rd Edition (Oxford University Press).
5.Bioinformatics: Sequence and Genome Analysis by David W. Mount, 2nd Edition (Cold Spring Harbor Laboratory Press).
6.Bioinformatics and Functional Genomics by Pevsner J. (2009). II Edition. Wiley-Blackwell.
7.Discovering Genomics, Proteomics and Bioinformatics by Campbell A. M., Heyer L. J. (2006). II Edition. Benjamin Cummings.

SEMESTER – VI

SBT 326: MARINE BIOTECHNOLOGY LAB

Hours per week: 03 **Credits: 02**

1. Identification of marine fish
2. Collection and identification of marine seaweeds
3. Analysis of sea water: Turbidity, pH., temperature
4. Determination of Dissolved oxygen in sea water
5. Determination of salinity of sea water.
6. Spotters : Cultivable species of finfish and shellfish based on the theory
7. Visit to aquaculture farms, finfish and shrimp hatcheries and processing units
8. Identification of marine zones by photograph / Google earth

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. The Larvae of Indo-Pacific Coastal Fishes: An Identification Guide to Marine fish larvae (2000) by edited by Jeffrey Martin Leis, Brooke M. Carson-Ewat; Brill Publishers
5. Encyclopedia of Fishes (1998) by John R. Paxton, William N. Eschmeyer, 2ndEdition (Natural World Series) Academic Press
6. Analysis of Seawater (1989) By Crompton; Butterworths Publishing house
7. Analysis of Seawater: A Guide for the Analytical and Environmental Chemist (2006) by T.R. Crompton
8. Practical Guidelines for the Analysis of Seawater (2009) by Oliver Wurl; CRC Press

SEMESTER – VI

SBT 328: BIOINFORMATICS LAB

Hours per week: 03 **Credits: 02**

1. Internet Search Engines
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene
3. Understanding and using: PIR, PDB, Swissprot, TREMBL
4. Searching for homologous sequences using BLASTn and interpretation of results.
5. Searching for homologous sequences using BLASTp and interpretation of results.
6. Searching for homologous sequences using FASTAx and interpretation of results
7. Aligning two sequences using Genbank.
8. Multiple sequence alignment using Clustal W
9. Phylogenetic tree construction using NJ and UPGMA methods
10. Phylogenetic tree construction using MP and ML methods

RECOMMENDED BOOKS:

1. Bioinformatics - D.Mount
2. C programming by BalaguruSwamy.
3. Introduction to Bioinformatics by Arthur M.Lesk, Oxford.
4. Programming in C- Yashwant kanitkar

SEMESTER – VI

SPH 382: INDUSTRIAL CHEMICALS AND ENVIRONMENT

Hours per week: 04 **Credits: 04**

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.

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 SO2 , CO2, CO, NOx, H2S. Methods of estimation of CO, NOx, SOx and control procedures.

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.

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.

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.

REFERENCE BOOKS:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers,New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
8. G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
9. A. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).

SEMESTER – VI

SPH 384:INSTRUMENTAL METHODS OF ANALYSIS

Hours per week: 04 **Credits: 04**

UNIT- I

Thermal methods of analysis: Thermo gravimetry - theory, in-strumentation, applications with special reference to CuSO4. 5H2O, CaC2O4.H2O and CaCO3. Basic idea of differential thermal analysis: principle and instrumentation. Difference between TGA and DTA. Differential scanning calorimetry: principle and instrumentation.

UNIT -II

Flame photometry: Theory and instrumentation. Analyses of Na, K, Ca, and Mg.
Atomic Absorption Spectrometer: Theory, instrumentation, chemical and spectral interferences, Applications
Induced couple plasma spectroscopy: Theory, Instrumentation and applications of ICP-OES

UNIT –III

Principles of chromatography: Classification of different chromatographic methods, adsorption and partition isotherms, column capacity, retardation factor, retention time and retention volume, gradient elution, height equivalent theoretical plate (HETP)
High performance liquid chromatography: Theory and instrumentation: pumps, column, detectors-UV detector, refractive index detector, Fluorescence detector, photo diode array detector and applications.
Gas liquid chromatography: Theory and instrumentation: columns (packed and capillary columns), detector: thermal conductivity detector, flame ionization detector, electron capture detector, nitrogen-phosphorus detector, photo ionization detector, and applications.

UNIT IV

Voltametry: Principle of polarography residual current, migration current, diffusion current, half-wave potential, Ilkovic equation. Instrumentation: Dropping mercury electrode (DME), advantages and disadvantages of DME, qualitative and quantitative analysis of inorganic ions - Cu, Pb Cd and Zn. Anode Stripping Voltametry: Principle and instrumentation. Hanging drop mercury electrode, application in the analysis of some selected metals

UNIT V

X-ray Spectroscopy: X-ray spectrometers, energy dispersive and wavelength dispersive techniques, instrumentation, matrix effects and applications.

REFERENCE BOOKS:

1. Instrumental methods of analysis - H.H. Willard, Meritt Jr. and J.A. Dean,CBS Publishers and distributors, 6th edition, 1986.
2. Principles of instrumental analysis – Douglas A. Skoog, F. James Holler and R. Crouch, Cengage Learning, 6th edition, 2006.
3. Vogel's textbook of Quantitative Inorganic analysis - J. Basset, R.C. Denney, G.H. Jeffery and J. Mendham, Prentice Hall, 6th edition, 2000
4. Instrumental methods of Analysis – G.R. Chatwal and S. Anand, Himalaya publishing House, 13th reprint, 1999.

5. Analytical Chemistry – S.Usha Rani, Macmillan India Limited, 2001
6. Instrumental methods of Analysis – Galen S. Ewing, Mcgraw Hill Higher Education, 5th ed., 1985
7. Handbook of Instrumental techniques for Analytical Chemistry, Frank Settle, Prentice Hall, 1997.

SEMESTER – VI

SPH 340: INDUSTRIAL CHEMICALS & ENVIRONMENTLAB

Hours per week: 03 **Credits: 02**

1. Determination of dissolved oxygen 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 (AgNO3 and potassium chromate).
6. Estimation of total alkalinity of water samples ($CO3^{2-}$, $HCO3^{-}$) using double titrationmethod.
7. Measurement of dissolved CO2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

REFERENCE BOOKS:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

SEMESTER – VI

SPH 342:INSTRUMENTAL METHODS OF ANALYSIS LAB

Hours per week: 03 **Credits: 02**

1. Safety Practices in the Chemistry Laboratory
2. Titration curve of an amino acid.
3. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
4. IR Absorption Spectra (Study of Aldehydes and Ketones)
5. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
6. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
7. Separation of Carbohydrates by HPLC
8. Potentiometric Titration of a Chloride-Iodide Mixture
9. Laboratory analysis to confirm anthrax or cocaine
10. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives.
11. Detection of illegal drugs or steroids in athletes
12. Detection of pollutants or illegal dumping

REFERENCE BOOKS:

1. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis,* Cengage Learning India Ed.

2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

SEMESTER – VI

SMB 340: MICROBIAL PHYSIOLOGY AND FERMENTATION TECHNOLOGY

Hours per week: 04 **Credits: 04**

UNIT –I

Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation, Iron uptake. Microbial growth in response to nutrition and energy, EMP pathway and EDP pathway.

UNIT-II

Fermenter design - basic functions of a fermenter for microbial cell culture – alternative vessel design, common measurements and control systems. aeration and agitation antifoaming reagents in fermentation. Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homo fermentative and hetero fermentative pathways), concept of linear and branched fermentation pathways.

UNIT-III

Fermentation process: Definitions of growth, growth kinetics - measurement of microbial growth - generation time and specific growth rate, synchronous growth, diauxic growth curve. Batch culture, Continuous Culture, Fed -Batch culture. Major types of organisms used in fermentation.

UNIT -IV

Media for industrial fermentation, types of media. Product recovery: *In-situ* recovery of products, *ex-situ* recovery of products: Production of enzymes used in food technology by microbial fermentation – amylase, proteases, lipases, glucose isomerase.

UNIT –V

Production of single cell proteins, organic acids - citric acid, vinegar, amino acids – glutamic acid and lysine. Vitamins - riboflavin, Vitamin B12. Antibiotics – penicillin and tetracycline. Acetone and butanol.

REFERENCE BOOKS:

1.Principles of Fermentation Technology (2016) by Peter F Stanbury, 3rd Edition, Butterworth-Heinemann

2.Microbiology and Technology of Fermented Foods (Ift Press) (2006) by Robert W. Hutkins, 1st Edition, Wiley-Blackwell

3.Industrial Microbiology (2016) by KL Benson, CBS Publishers

4.Industrial microbiology (2016) by Casida, New Age International Private Limited

5.Cruegers Biotechnology: A Textbook of Industrial Microbiology (2017) by Wulf Crueger, Medtech Publishers

SEMESTER – VI

SMB 342: IMMUNOLOGY

Hours per week: 04 **Credits: 04**

UNIT-I

Immune System-Characristics of Innate and Adaptive immune systems. Anantomical and Physiological barriers..Cells and Organs of the Immune System.Toll like receptors. Immunogen, Antigen, Hapten, adjuvants, Epitopes.

Unit-II

B cells-Types.B cell receptor.General structure of Antibodies.Structure and functions of different classes of antibodies.Genetic basis of antibody diversity, Affinity maturation. Complement system-Classical, alternate and MBL pathways. Functions of complement system and their regulation.

Unit III

T cells-Types.T cell receptor.MHC restriction.General structure and types of MHC. Role of MHC in the Immune Response and antigen presentation, Cell mediated responses of different T cells.

Unit-IV

Immunological tolerance.Types, characteristics and examples of Hypersensitivity, Autoimmunity, Transplantation-Types of rejection, Graft versus host disease. Disorders of the Immune System, Basic immune response to cancer, Modern Antibody Therapy

Unit-V

Antigen-Antibody Interactions.Double immunodiffusion and single immunodiffusion.Principles of Western blotting and ELISA Principles of Diagnostic tests-VDRL, WIDAL, Preganancy detection. Diagnostic methodologies and limitations in identifying HIV, Salmonella and other infections.

REFERENCE BOOKS:

1.Immunology a short course byBenjamin E and Leskowitz S (Wiley Liss NY)

2.Fundamental Immunology by William E. Paul, Paul, 4th ed. (Garland Science publishers).

3.Immunology by Roit et.al (Harper Row).

4.Kuby Immunology by Judy Owen *et al.,* 7th edition (NY: WH Freeman and Co)

5.Principles of Microbiology and Immunology byDavis et.al.,(Harper).

6.Immunology-understanding of immune system by KlansD.Elgret (.Wiley-Liss.NY,)

7.Cellular and Molecular Immunology by Abul K. Abbas and Andrew H. Lichtman,, 5th ed. (W B. Saunders).

SEMESTER – VI

SMB 320: MICROBIAL PHYSIOLOGY AND FERMENTATION TECHNOLOGY LAB

Hours per week: 03 **Credits: 02**

1. Studyandplotthegrowthcurveof*E.coli*bystandardplatecountmethods.

2. Calculationsofgenerationtimeandspecificgrowthrateofbacteriafromthegraphplotted with the givendata.

3. Effect of temperature on growth of *E.coli*

4. Effect of pH on growth of *E.coli*

5. Effect of carbon and nitrogen sources on growth of*E.coli*

6. Effect of salt on growth of *E.coli*

7. Demonstration of alcoholicfermentation

8. Demonstrationofthethermaldeathtimeanddecimalreductiontimeof*E.coli*.

9. Extracellular activities of micro organisms- amylase, lipase, caseinase

10. Isolation of Antibiotic producing organism

REFERENCE BOOKS:

1.Laboratory Exercises in Microbiology (2016) by John Harley 8th Edition, McGraw-HillEducation
2.Microbiology: A Laboratory Manual (2016) by James G. Cappuccino 11th Edition Pearson publishers.
3.Microbiology: Laboratory Theory and Application (2015) 4th Edition by Michael J. Leboffe, Morton Publishing Company
4. Industrial microbiology (2016) by Casida, New Age International Private Limited

5.Practical Manual on Fermentation Technology (2012) by S. Kulandaivelu, I K International Publishing House

6.Practical Fermentation Technology (2008) by Brian McNeil, Wiley Publishers

SEMESTER – VI

SMB 322: IMMUNOLOGY LAB

Hours per week: 03 **Credits: 02**

1. Identification of human bloodgroups.
2. Total Leukocyte Count of the given bloodsample.
3. Differential Leukocyte Count of the given bloodsample.
4. Separation of serum from the blood sample(demonstration).
5. VDRL andWIDAL
6. Immunodiffusion by Ouchterlonymethod.
7. ELISA
8. Immunoelectrophoresis

REFERENCE BOOKS:

1. Immunology methods manual - The comprehensive source book by Lefkovits. I 6.Manual of clinical laboratory immunology by Rose NR.

2. The experimental foundations of modern immunology by Clark W.R.

SEMESTER – VI

SSE 388: ENTREPRENEURSHIP DESIGN

Hours per week: 02 **Credits: 02**

Entrepreneur characteristics – Classification of Entrepreneurships – Incorporation of Business – Forms of Business organizations –Role of Entrepreneurship in economic development –Start-ups.

Project Formulation and Appraisal : Preparation of Project Report –Content; Guidelines for Report preparation – Project Appraisal techniques –economic – Steps Analysis; Financial Analysis; Market Analysis; Technical Feasibility.

Institutions Supporting Small Business Enterprises**:** Central level Institutions: NABARD; SIDBI, NIC, KVIC; SIDIO; NSIC Ltd; etc. – state level Institutions –DICs- SFC- SSIDC- Other financial assistance.

REFERENCE BOOKS:

1. Arya Kumar, Entrepreneurship, Pearson, Delhi,2012.

2. Poornima M.CH., Entrepreneurship Development –Small Business Enterprises, Pearson, Delhi,2009

3. Michael H. Morris, ET. al., Entrepreneurship and Innovation, Cen gage Learning, New Delhi,2011

SEMESTER – VI

SSE 390: BIOSAFETY AND IPR

Hours per week: 02 **Credits: 02**

Biosafety: Definition of bio-safety, Biotechnology and bio-safety with special emphasis on Indian concerns. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP). Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions

Introduction to IPR: IPR, forms of IPR, Copy right, Trade marks, Geographical indications, Industrial designs and Intellectual property protection. WIPO, EPO. Type of patents.Indian patent act and foreign patents.Infringement of intellectual property rights.

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..

RECOMMENDED BOOKS:

1. Principles of Intellectual Property : N.S. Gopalakrishnan & T.G. Agitha, (2009) Eastern BookCo., Lucknow.
2. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet &Maxweel.
3. Indian Patents Law – Legal & BusinessImplications; Ajit Parulekar and Sarita D' Souza, (2006) Macmillan India Ltd.
4. Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; B.L.Wadehra (2000) Universal law Publishing Pvt. Ltd., India.
5. Law of Copyright and Industrial Designs; P. Narayanan (2010) Eastern law House,Delhi.