School of Biological and Chemical Sciences

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B.Sc. Biotechnology

Prog. Code: 0901BT

(Three year Full Time Graduate Course)

Semester Pattern

Syllabus B.Sc. Biotechnology (Prog Code: 0901BT)

GENERAL INTRODUCTION OF THE DEPARTMENT

MATS School of Biological and Chemical Sciences (MSBCS) was established with a vision to create technocrats in the applied branches of Biological and Chemical Sciences to convey updated scientific knowledge. In the school the performances of the students are constantly monitored by continuous assessment. The School believes in supplementing academic input of students with the help of regular Seminar, Guest Lectures, Industrial/Research Institute visits and encouraging the students to participate in National & International Seminars, Conferences and Workshops.

DEPARTMENT HIGHLIGHTS

- Research focus on frontier of Life Sciences and affordable healthcare
- Highly acclaimed scientists as faculty
- State-of-the-art Lab facilities
- Hand-on training on sophisticated equipments
- Academia – Industry interface
- Multidisciplinary research in affordable healthcare, Agriculture and Food

COURSEDESIGN

The department follows a unique course-design which is contemporary and cutting-edge. It includes modern and advanced papers/ subjects including the papers from Management Science as given in the curriculum matrix

PEDAGOGY

- Chalk Board, LCD and Projector based teaching
- Research based teaching
- Project based learning
- Separate lab bench for each student

FACILITIES

State-of-the-art facilities include:

- Double beam UV- Visible Spectrophotometer, Cooling Centrifuge, Microfuge, Incubators, Microscopes, Laminar flow hoods, Colorimeter, Micro- and regular balance, Electronic Balance Autoclave, Glass distillation apparatus, Computers, Deep freeze, DNA/RNA & Protein Electrophoresis apparatus, Plant Tissue Culture racks with light arrangements, Shakers, BOD incubator & Orbital Shaking Incubator etc
- Microbial cell culture
- Plant tissue culture

FACULTIES

- Well experienced faculties from Academic Institutes and Industries
- Invited lectures by eminent scientists from different countries

B. SC. BIOTECHNOLOGY: SCOPE AND CONTENT

Biotechnology is the research-oriented science including a fusion of biology and technology. This study includes a large variety of subjects including Cellular Genetics, Molecular biology, Plant Diversity, Chemistry, General Microbiology, Animal Sciences, Plant Sciences, Environmental Studies, Computer applications, Biostatistics, Biochemistry, Medical Microbiology & Immunology, Genetic Engineering, Entrepreneurship, Languages English & Hindi, Industrial Biotechnology, Principles of Management, Plant & Animal Biotechnology, Anatomy, Physiology &

Reproductive Biology, Principles of Marketing Project work etc. Biotechnology features the use of living cells and bacteria in the industrial process. Biotechnology can be applied in developing various vaccines, medicines and diagnostics, improving energy production and conservation and increasing productivity.

OBJECTIVES OF THE B.Sc. BIOTECHNOLOGY PROGRAM

1. To impart basic knowledge and skills of various aspects of biotechnology.
2. To train the students for industrial need and to pursue further education.
3. To develop human resource and entrepreneurs in biotechnology with the ability to independently start their own ventures or small biotech units in the field of biotechnology.
4. Understand modern biotechnology - practices and approaches with an emphasis in technology application in pharmaceutical, medical, industrial, environmental and agricultural areas.
5. Become familiar with public policy, bio-safety, and intellectual property rights issues related to biotechnology applications nationally and globally
6. Gain experience with standard molecular tools.
7. Develop skills in teamwork.

ELIGIBILITY FOR ADMISSION:

Interested aspirants for B.Sc. Biotechnology degree need to fulfill the below mentioned eligibility criteria.

- Completion of Higher Secondary (10+2) level of education.
- Physics, chemistry and biology as main subjects at HSC level
- Instead of biology, one may even have had any subject related to biological sciences as one of the main subject of study.

PROGRAM OUTCOME:

1. Graduate will be able to apply knowledge, concepts to solve issues related to their course.
2. Graduate will have ability to identify problems related to their subjects.
3. Graduate will have ability to analyze and derive valid conclusions with fundamental knowledge in their respective subjects.
4. Graduate upon the needs of environment and society, will be able to fulfill the same in the form of solutions within the safety limit of prevalent rules and guidelines.
5. Graduate will have ability to design, conduct experiments, analyze and interpret data for investigating problems in their respective fields.
6. Graduate will have ability to select and apply appropriate tools and techniques.
7. Graduate will have knowledge for assessing societal, health, safety and legal aspects and the duties as responsible citizen of country.
8. Graduate will have the knowledge for the need of sustainable development.
9. Graduate will have the knowledge of ethics and regulatory norms of their respective course.
10. Graduate will have oral, written communications skill along with team spirit.

PROGRAM SPECIFIC OUTCOMES:

1. Application of knowledge and techniques of basic sciences related to biological and chemical sciences.
2. Scale up of biochemical process after designing, optimization and analysis for developing products required for society.
3. Tabulation and interpretation of Biological data using computer software.

CAREER PROSPECTS:

The bio-technology Industry is constantly growing and in the past 10 years, human resources in the field have grown drastically. Today, Indian biotech sector comprises of lot many companies and bio suppliers, generating

ample amounts of revenues. Indian biotech industry comprises of clinical research, new drug discovery, bioinformatics, R&D, biopharmaceuticals etc. Bio-tech industry has rapid growth rate per annum. As there is increasing popularity and explosive growth, there are plenty of opportunities available in Biotechnology field. One can be a Research Scientist, Teacher, Marketing manager, Science Writer, Bioinformatician, Quality Control Officer or Production in-charge in the Food, Chemical and Pharmaceutical industry, Analyst, Environmental / Safety Specialist.

THE MAIN JOB SECTORS ARE AS FOLLOWS:

Biotechnology companies, Health service organizations, Pharmaceutical companies, Universities and Research institute, Horticultural industries, Conservation organizations, Food and drink manufacturers, Water industry, Agricultural industry, Law Enforcement.

ATTENDANCE:

A candidate shall be deemed to have undergone a regular course of study in the University, if he/she has attended at least 60% of the lectures in each subject will be at least 75% in the aggregate of lectures, tutorials and practical in order to be eligible to appear at the Final Examination.

SCHEME OF EXAMINATION, EVALUATION AND DISTRIBUTION OF MARKS:

1. The overall weightage of a course in the Syllabi and Scheme of Teaching & Examination shall be determined in terms of Marks assigned to the course.
2. The evaluation of students in a course shall have two components unless specifically stated otherwise in the Scheme of Teaching & Examination and Syllabi:

(i) Evaluation through a semester-end examination (University Examination Marks)
(ii) Continuous evaluation by the teacher(s) of the course.

		Bachelor's degree/ Under-graduate diploma	Master's degree/ Post-graduate diploma
A.	**THEORY COURSES**		
	(i) Semester-end examination	70%	70%
	(ii) Continuous evaluation by the teachers	30%	30%
B.	PRACTICAL/LABORATORY COURSES		
	(i) Semester-end examination	70%	70%
	(ii) Continuous evaluation by the teachers	30%	30%
C.	DISSERTATION/THESIS		
	(i) Assessment by External Examiner	70%	70%
	(ii) Assessment by Internal Examiner	30%	30%

CONTINUOUS EVALUATION (INTERNAL MARKS)

(i) Theory courses

The division of internal marks will of 50% marks for mid semester examination and 50% of marks for the internal class tests. There shall be three class tests held during each semester. These class tests shall ordinarily be held after 4 weeks, 8 weeks and 12 weeks of teaching in accordance with the University Academic Calendar.

(ii) Practical/Laboratory courses

The total internal marks in practical /Laboratory courses shall be based on performance in the laboratory, regularity, practical exercises /assignments, quizzes, etc. The assessment shall be given at three nearly equi-spaced intervals.

PASSING MARKS:

For undergraduate students, obtaining a minimum of 40% marks in aggregate in each course shall be essential for passing the course and earning its assigned credits. A candidate, who secures less than 40% of marks in a course, shall be deemed to have failed in that course.

GRADING SYSTEM:

For UG:

80% and above – "10 Grade Point" and Letter Grade "O" (Outstanding)

40% and above but below 45% - "Grade Point 4" and Letter Grade "P" (Pass)

For PG:

80% and above – "10 Grade Point" and Letter Grade "O" (Outstanding)

45% and above but below 50% - "Grade Point 4" and Letter Grade "P" (Pass)

PROGRAM DURATION:

The maximum permissible period for completing a program for which the prescribed program duration is **n semesters**, shall be **(n+4)** semesters. All the program requirements shall have to be completed in (n+4) semesters.

ATKT CRITERIA:

ATKT Candidate means a candidate who failed in not more than forty percent of the total number of Core and Core bracket papers, excluding the Practical Examination / Project Work / Viva Voce Examination in the Semester Examination and is appearing in the Examination of same semester again which is organized with the next Semester Examination. Forty percent will be rounded off to higher side in case it is not a whole number. In case a Students fails or was absent in Practical Examination / Project Work / Viva Voce Examination, he/she may be allowed to have ATKT exam on his/her own expenses.

Curriculum Matrix of B.Sc. Biotechnology (Prog Code: 0901BT)						
	SEM I			**Maximum Marks**		**Total Marks**
	Code	**Biotechnology**	**Credit (L+T+P)**	External	Internal	
Discipline Specific Core (DSC)	01BT1101	**Biotech-I:** General Biochemistry	4 (4+0+0)	70	30	100
	01BT1102	**Bioscience-I:** Plant Diversity	4 (4+0+0)	70	30	100
	01BT1103	**Chemistry-I**	4 (4+0+0)	70	30	100
Discipline Specific Core Practical (DSCP)	01BT1204	Lab Course: Biotechnology I	2 (0+0+2)	35	15	50
	01BT1205	Lab Course: Bioscience I	2 (0+0+2)	35	15	50
	01BT1206	Lab Course: Chemistry I	2 (0+0+2)	35	15	50
Abillity Enhancement Compulsory Course (AECC)	09AE1307	Hindi	2 (2+0+0)	35	15	50
	09AE1308	Environmental Studies	2 (2+0+0)	35	15	50
	Total		**22 (16+0+6)**	**385**	**165**	**550**
	SEM II					
Discipline Specific Core (DSC)	01BT2101	**Biotech-II:** General Microbiology	4 (4+0+0)	70	30	100
	01BT2102	**Bioscience-II:** Animal Kingdom	4 (4+0+0)	70	30	100
	01BT2103	**Chemistry-II**	4 (4+0+0)	70	30	100
Discipline Specific Core Practical (DSCP)	01BT2204	Lab Course: Biotechnology II	2 (0+0+2)	35	15	50
	01BT2205	Lab Course: Bioscience II	2 (0+0+2)	35	15	50
	01BT2206	Lab Course: Chemistry II	2 (0+0+2)	35	15	50
Abillity Enhancement Compulsory Course (AECC)	09AE2307	English	2 (2+0+0)	35	15	50
	Total		**20 (14+0+6)**	**350**	**150**	**500**
	SEM III					
Discipline Specific Core (DSC)	01BT3101	**Biotech-III:** Cell and Molecular Biology	4 (4+0+0)	70	30	100
	01BT3102	**Bioscience-III:** Structure, Development and Reproduction in Flowering Plants	4 (4+0+0)	70	30	100
	01BT3103	**Chemistry-III**	4 (4+0+0)	70	30	100
Discipline Specific Core Practical (DSCP)	01BT3204	Lab Course: Biotechnology III	2 (0+0+2)	35	15	50
	01BT3205	Lab Course: Bioscience III	2 (0+0+2)	35	15	50
	01BT3206	Lab Course: Chemistry III	2 (0+0+2)	35	15	50
Skill Enhancement Course (SEC)	09SE3307 OR 09SE3308	Computer Application (09SE3307) **OR** Bioinformatics (09SE3308)	2 (1+1+0)	35	15	50

	Total		**20 (13+1+6)**	**350**	**150**	**500**
	SEM IV					
Discipline Specific Core (DSC)	01BT4101	**Biotech-IV:** Animal Biotechnology and Genetic Engineering	4 (4+0+0)	70	30	100
	01BT4102	**Bioscience-IV:** Medical Microbiology and Immunology	4 (4+0+0)	70	30	100
	01BT4103	**Chemistry-IV**	4 (4+0+0)	70	30	100
Discipline Specific Core Practical (DSCP)	01BT4204	Lab Course: Biotechnology IV	2 (0+0+2)	35	15	50
	01BT4205	Lab Course: Bioscience IV	2 (0+0+2)	35	15	50
	01BT4206	Lab Course: Chemistry IV	2 (0+0+2)	35	15	50
Skill Enhancement Course (SEC)	09SE4307 OR 09SE4308	Biostatistics (09SE4307) **OR** Research Methodology (09SE4308)	2 (1+1+0)	35	15	50
	Total		**20 (13+1+6)**	**350**	**150**	**500**
	SEM V					
Discipline Specific Elective (DSE)	01BT5101 OR 01BT5102	Biotech V(A): Project Work Biotechnology Based (01BT5101) **OR** Biotech V(B): Project Work Microbiology Based (01BT5102)	6	105	45	150
	01BT5103 OR 01BT5104	Bioscience V(A):Plant Physiology (01BT5103) OR Bioscience V(B): Plant Pathology (01BT5104)	4 (4+0+0)	70	30	100
	01BT5105 OR 01BT5106	Chemistry V(A): Chemistry of d-block, Quantum Chemistry and Spectroscopy (01BT5105) **OR** Chemistry V(B):Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy (01BT5106)	4 (4+0+0)	70	30	100
Discipline Specific Elective Practical (DSEP)**	01BT5207	* Lab Course: Bioscience V	2 (0+0+2)	35	15	50
	01BT5208	Lab Course: Chemistry V	2 (0+0+2)	35	15	50
Skill Enhancement Course (SEC)	09SE5309 OR 09SE5310	Intellectual Property Rights (09SE5309) OR Bioethics and Biosafety (09SE5310)	2 (1+1+0)	35	15	50
	Total		**20 (15+1+4)**	**350**	**150**	**500**

	SEM VI					
Discipline Specific Elective (DSE)	01BT6101 OR 01MB6102	Biotech VI(A): Industrial Biotechnology (01BT6101) **OR** Biotech VI(B): Plant Biotechnology (01BT6102)	4 (4+0+0)	70	30	100
	01BT6103 OR 01BT6104	Bioecience VI(A): Anatomy and Physiology (01BT6103) **OR** Bioecience VI(B): Environment and Ecology (01BT6104)	4 (4+0+0)	70	30	100
	01BT6105 OR 01BT6106	Chemistry VI(A): Basic Analytical Chemistry (01BT6105) **OR** Chemistry VI(B): Fuel Chemistry (01BT6106)	4 (4+0+0)	70	30	100
Discipline Specific Elective Practical (DSEP)	01BT6207	Lab Course: Biotechnology VI	2 (0+0+2)	35	15	50
	01BT6208	Lab Course: Bioscience VI	2 (0+0+2)	35	15	50
	01BT6209	Lab Course: Chemistry VI	2 (0+0+2)	35	15	50
Skill Enhancement Course (SEC)	09SE6310 OR 09SE6311	Enterpreneurship (09SE6310) **OR** Principle of Management (09SE6310)	2 (1+1+0)	35	15	50
	Total		**20 (13+1+6)**	**350**	**150**	**500**
Grand Total			**122**	**2135**	**915**	**3050**

NOTE: Each **SEC** paper and **DSE** paper should have **minimum 15 students**

(* Lab Course Biotechnology V is included in the Project work)

L= Lecture, **T**=Tutorial, **P**= Practical, **1 credit = 1 hour of teaching/week, 2 hours of Lab/week**

Coding Pattern : 1st digit denote semester; 2nd digit for type of paper (1-DSC/DSE, 2-Lab/Practical, 3-For others such as AECC/SEC); 3rd & 4th digit for Paper Number

B.Sc. Biotechnology
Semester I: Theory
Biotech-I: General Biochemistry
Code: 01BT1101

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of biochemistry.
2. To train the students to pursue further education.
3. Become familiar with biochemical tools.
4. Gain experience with standard molecular tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals Biochemistry and key principles of Biochemistry.
2. Awareness of the major issue at the forefront of the discipline.
3. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
4. Ability to dissect a problem in to its key features.

Module I

Carbohydrates: General Properties, Types (Monosaccharide, Oligosaccharide and Polysaccharide) and Biological Importance**.**

Monosaccharide: Structure, Occurrence, Reactions and Biological importance of Monosaccharide.

Isomerism: Stereoisomerism and Optical isomerism, Ring Structure and Anomeric forms, Mutarotation.

Derivatives: Derivatives of Monosaccharide, Di and Tri-saccharide.

Important Polysaccharide: Glycogen, Starch and Cellulose.

Module II

Lipids: General Properties and Classification.

Fatty acids: Nomenclature, Classification, Structure and Properties of Saturated and Unsaturated fatty acids. Essential Fatty Acids.

Triacylglycerols: Properties and Characterization of Fats, Hydrolysis, Saponification value, Acid value, Rancidity of fats and Functions.

Biological Significance of Glycerophospholipids, Sphingomyelins and Glycolipids.

Module III

Amino acids: Definition, Classification and Properties of Amino acids.

Peptide bond: Definition, Structure, Solid phase Protein Synthesis in brief, C – terminal and N – terminal Amino acid determination.

Protein: Structure, Types (Primary, Secondary, Tertiary and Quaternary) and Functions.

Module IV

Nucleic Acids: Definition, Structure, Phosphodiester bond and Properties.

Purine and Pyrimidine Bases: Structure and Types, Composition of DNA and RNA, Nucleosides and Nucleotides.

DNA double helix: Watson - Crick Model, Complementary base- pairings, Base staking, Chargaff's rule. Different forms of DNA structure (A, B & Z DNA), Major and Minor groove, Denaturation and Annealing of DNA

RNA: Types of RNA, Secondary and Tertiary structure of t-RNA.

Module V

Porphyrin: General Properties, Structure of Nucleus and Classification.

Metalloporphyrins: Structure of Haemoglobin, Myoglobin, Chlorophyll, Cyanocobalamin and their Biological Importance.

Suggested Readings:

1. Biochemistry: J M Berg, J L Tymoczko and L Stryer.
2. Lehninger Principles of Biochemistry: David L Nelson and Michael M Cox.
3. Biochemistry: D Voet, J Voet and C W Pratt.
4. Biochemistry: U Satyanarayana and U Chakrapani.
5. Textbook of Biochemistry: Edward S West.
6. Fundamentals of Biochemistry: J L Jain, Sunjay Jain and Nitin Jain
7. Harpers Illustrated Biochemistry: Robert K Murray, Daryl K Garner and Peter A Mayes

B.Sc. Biotechnology
Semester I: Theory
Bioscience I: Plant Diversity
Code: 01BT1102

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of plant diversity.
2. To train the students to pursue further education.
3. Become familiar with bioscience tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals Plant Diversity and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
4. Ability to dissect a problem in to its key features.

Module I

Algae: General characters, classification and economic importance; important features and life history of Chlorophyceae – *Volvox, Oedogonium*; Xanthophyceae – *Vaucheria*; Phaeophyceae – *Ectocarpus*; Rhodophyceae – *Polysiphonia*.

Module II

Fungi: General characters, classification and economic importance; important features and life history of Mastigomycotina – *Phytophthora*; Zygomycotina – *Mucor*; Ascomycotina – *Saccharomyces*; Basidiomycotina – *Puccinia*; Deuteromycotina – *Colletotrichum*; geneneral account of Lichens.

Module III

Bryophyta: Outlines of classification and importance of bryophytes. Structure, reproduction and classification of Hepaticopsida (*Marchantia*); Anthocerotopsida (*Anthoceros*), Bryopsida (*Funaria*).

Module IV

Pteridophyta: Important characteristics of Psilopsida, Lycopsida, Sphenopsida and Pteropsida; Structure, reproduction in *Rhynia, Lycopodium, Selaginella, Equisetum* and *Marsilea*. (details not required)

Module V

General features of gymnosperms and their classification.
Structure and reproduction in Cycas and Pinus and Ephedra

Suggested Readings:

- Introduction to botany – Bendre & Kumar
- Botany for degree students – Algae: Vashishtha et al.
- Botany for degree students – Bryophyta: Vashishtha et al.
- An introduction to Pteridophyta – A Rashid
- Angiosperms: G. L Chopra
- Plant Taxonomy: O. P Sharma

B.Sc. Biotechnology
Semester I: Theory
Chemistry I
Code: 01BT1103

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of chemistry.
2. To train the students to pursue further education.
3. Become familiar with chemical tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals Chemistry and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
4. Ability to dissect a problem in to its key features.

Module I

Atomic Structure &Periodic Properties

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, schrodinger wave equation, significance of ψ and ψ^2 , quantum numbers, radial & angular wave functions and probability distribution curves, shapes of s, p, d orbitals, Aufbau and Pauli exclusion principles, Hund's Multiplicity rule, Electronic configuration of the elements. Atomic & ionic radii, ionisation energy, electron affinity. & electro negativity-definition and trends in periodic table with their chemical behaviour.

Module II

Chemical Bonding

Covalent Bond: Valence bond theory and its limitations, various types of hybridization & shapes of simple inorganic molecules .Valence shell electron pair repulsion (VSEPR) theory to NH_3, H_3O^+, SF_4, ClF_3, ICl_2^- and H_2O. M.O. Theory for homonuclear & hetronuclear molecule.

Ionic Solids - Ionic structures, radius ratio & co-ordination number, limitation of radius ratio rule, lattice defects, semiconductors, Lattice energy Born-Haber cyle, solvation energy and solubility of ionic solids, polarizing power & polarisability of ions, Fajan's rule, Metallic bond,

Hydrogen bond, van der Waals forces.

Module III

Structure & Bonding in organic compounds

Hybridization, bond lengths & bond angles, bond energy, localized & delocalized chemical bond, van der Waals interactions, , inductive effect, resonance, hyper conjugation,

Mechanism of Organic Reactions

Homolytic & heterolytic bond breaking, types of reagents-electrophones & nucleophiles. Types of organic reactions. Reactive Intermediates-carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).

Optical isomerism-elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enatiorners, chiral & achiral molecules with two stereogenic centres, diastereomers, threo and erythro diasterleomers, meso compound, resolution of enantiomers,

inversion, retention and racemization. Sequence rules, D -L and R - S notations
Geometric Isomerism. E - Z system ,conformational analysis of ethane and n-butane

Module IV

Alkanes, Alkene,Alkyne, , Cycloalkanes

IUPAC nomenclature, methods of formation. Physical properties and chemical properties of Alkane Alkene, Alkyne and Cycloalkanes

Alkene : Markownikoff's rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, Ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$.

Alkyl halides : Mechanisms of nucleophilic substitution reaction of alkyl halides , SN^1 and SN^2 reaction with energy profile diagrams.

Cycloalkanes: IUPAC nomenclature, methods of formation. Physical and chemical properties. Baeyer's strain Theory and its limitations.

Module V

Arenes and Aromaticity

Nomenclature of benzene derivatives. structure of benzene: molecular formula and Kekule &Dewar structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture.

Aromaticity: The Huckel rule.

Aromatic electrophilic substitution-General reaction mechanism, role of σ and π complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Fiedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction.

Aryl Halides

Methods of formation of aryl halides, their elimination reaction mechanisms of nucleophilic aromatic substitution reactions. Synthesis and uses of DDT and BHC.

Suggested Readings:

1. Basic Inorganic Chemistry, F.A Cotton, G. Wilkinson and P.L Gauss, Wiley.
2. Concise Inorganic Chemistry, J.D. Lee, ELBS.
3. Concepts of models of Inorganic Chemistry, B. Douglas, D. Mc Daniel and J Alexander, John Wiley.
4. Inorganic Chemistry, D.E. Shriver, P.W. Atkins and C.H.L. Angford, Oxford.
5. Inorganic Chemistry, W. W. Porterfield, Addison- Wesley.
6. Inorganic Chemistry, A.G. Sharp, ELBS.
7. Inorganic Chemistry, G.L. Missiles and D.A. Tarr, Prentice Hall.
8. Advanced Inorganic Chemistry, Satyas Prakash.
9. Advanced Inorganic Chemistry, Agarwal & Agarwal.
10. Advanced Inorganic Chemistry, Puri & Sharma, S. Naginchand.
11. Inorganic Chemistry, Madan, S. Chand. Organic Chemistry, Morrison and Boyd, Prentice- Hall
12. Organic Chemistry, L.G. Wade Jr. Prentice-Hall
13. Organic Chemistry, Vol. I, II & III, S.M. Mukherjee, S.P. Singh and R.P. Kapoor,Wiley-eastern
14. Organic Chemistry, EA. Carey, MC Graw Hill
15. Introduction to Organic Chemistry, Struiweisser, Heathock and Kosover, Macmillan.

B.Sc. Biotechnology
Semester I: Practical
Lab Course: Biotechnology I
Code: 01BT1204

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Gain experience with standard molecular tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. Molisch's test for Carbohydrate.
2. Benedict's test- distinguishes between reducing and non-reducing sugars.
3. Barfoed's test- distinguishes between monosaccharides and disaccharides.
4. Iodine test for starch.
5. Ninhydrin test for amino acids.
6. Thiol group test using sodium nitroprusside.
7. Test for indole group using Ehlrich's reagent.
8. Test for hydroxyphenylaniline using Million's test.
9. Iodine value of oil and wax.
10. Acid value of oil and wax.
11. Saponification value of oil and wax.

B.Sc. Biotechnology
Semester I: Practical
Lab Course: Bioscience I
Code: 01BT1205

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Become familiar with tools.
4. Gain experience with standard molecular tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. Study of different algae, with the help of permanent slides and also by cutting sections
2. Study of different Fungi, with the help of permanent slides and also by cutting sections
3. Study of different Bryophytes, with the help of permanent slides and also by cutting sections
4. Study of different Pteridophyta, with the help of permanent slides and also by cutting sections
5. Study of different Gymnosperms, with the help of permanent slides and also by cutting sections.

B.Sc. Biotechnology
Semester I: Practical
Lab Course: Chemistry I
Code: 01BT1206

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge.
2. To train the students to pursue further education.
3. Become familiar with tools.
4. Gain experience with standard molecular tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. Inorganic Chemistry

Semi micro Analysis-cations analysis separation and identification of ions from Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sb^{3+}, $Sn^{2+,4+}$, Fe^{3+}, Al^{3+}, Cr^{3+}. Ni^{2+}, $C0^{2+}$, Zn^{2+}, Mn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH^{4+} and Anions $CO_2/^{3-}$, $SO_2/^{3-}$, S^{2-}, $SO_2/^{4-}$, NO_2^-, NO_3, Cl^- ,Br^-,I^-, CH_3COO^-, $C_2O_2/4^-$, $BO_3/^{5-}$, F^-.

2. Organic Chemistry

i. Calibration of Thermometer
80^0-82° (Naphthalene), 113.5^0-114^0 (Acetanilide), 132.5^0-133^0 (Urea), 1000 (Distilled Water)

ii. Determination of Melting Point
80° -82° (Naphthalene), Benzoic and 121.5^0 -122°, Urea 132.5° -133°, Succinic acid 184.5^0-185^0, Cinnamic acid 132.5^0-133^0, Salicylic acid 157.5^0-158^0 Acetanilide 113.5^0-114^0, m-Dinitrobenze 90^0, p-Dichlorobenzene 52^0 Aspirin 135^0.

iii. Determination of boiling points
Ethanol = 78^0, Cyclohexane 81.4^0, To 110.6^0, Benzene 80^0

iv. Mixed meting point Determination- Urea- Cinnamic acid mixture of various compositions (1: 4, 1: 1, 4: 1)

B. Sc. Biotechnology
Semester I: Theory
Hindi
Code: 09AE1307

Credit: 2
Total Marks: 50 (35+15)

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1 fo|kFkh;k e "k) ,o ifj"dr fgUnh fy[ku dh ;kX;rk inku djukA
2 fofHkUu vxth inuekk dh fgUnh e tkudkjhA
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4 ifl) lkfgR;dkjk dh dforkvk vkj dgkfu;k dk leko'k] ftl fo|kFkh lkfgR; l dHkh mUeDr u gkA
5 fo|kFkh;k d ekf[kd rFkk y[ku e 0;kdkj.k dk eyHkr i;kxA

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Module II & cM ?kj dh cVh
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Module III & vc rk iFk ;gh g
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Module IV & jh< dh gMMh
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Module V & ekud Hkk'kk
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Suggested Readings:

1. ekfyd fgUnh Hkk'kk & Mk- ljLorh oek
2. jpukRed fgUnh Hkk'kk & Mk- ljLorh oek
3. Hkkjrh;rk d vej Loj & Mk- /kut; oek
4. fgUnh 0;kdj.k & gjno okgjh

B.Sc. Biotechnology
Semester I: Theory
Environmental Studies
Code: 09AE1308

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge related environment.
2. To train the students to pursue further education.
3. Become familiar with the environment.
4. Gain experience with standard tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Environmental Studies and key principles of its.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module-I

Definition, Scope and basic principles of ecology and environment.
Ecosystems-concept, types, structure and functional aspects of major ecosystems, food chain, food web, ecological pyramids, productivity in ecosystems, stability and resilience in ecosystem.

Module -II

Environmental Pollution, Definition: Cause, effects and control measure of - Air pollution. water pollution. Soil pollution. Marine pollution. Noise pollution. Thermal pollution. Nuclear hazards.
Solid waste management: Causes, effects and control, measures of urban and Industrial waste. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.

Module – III

Social Issues and the Environment From Unsustainable to Sustainable development. Urban problems related to energy.Water conservation, rain water harvesting, watershed management. Re-settlement and rehabilitation of people, its problems and concerns. Case Studies. Environmental ethics: Issues and possible solutions. Climate change. global warming. acid rain. ozone layer depletion. nuclear accidents and holocaust. Case Studies. Wasteland reclamation. Consumerism and waste products.

Module - IV

Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wild-life Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation.

Module - V

Public awareness. 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. Case Studies.

Suggested Readings:

- Agarwal K.C. 2001 Environmental Biology Nidhi Publ. Ltd. Bikaner
- A Text book of Environmental studies by S .S.Purohit, Shammi,Agrawal.
- Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co.
- Odum, E.P. 1971, Fundamentals of Ecology, W.B. Saunders Co. USA.
- Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.
- Bruinner R.C., 1989, Hazardous Waste Incineration, Mc Graw Hill Inc.
- Clark R.S., Marine Pollution, Clanderson Press Oxford.
- Jadhav H. & Bhosale, V.H. 1995, Environmental Protection and Laws. Himalaya Pub. House. Delhi 284p.

B.Sc. Biotechnology
Semester II: Theory
Biotech-II: General Microbiology
Code: 01BT2101

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of microbiology.
2. To train the students to pursue further education.
3. To be familiar with microbiological tools.
4. To gain experience with standard molecular tools.
5. To increase expertise of the course.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals Biochemistry and key principles of Biochemistry.
2. Awareness of the major issue at the forefront of the discipline.
3. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
4. Ability to dissect a problem in to its key features.
5. Ability to design experiments and understand the limitations of the experimental approach.

Module I

Introduction to Microbiology: Historical and Scope of Microbiology:
Structure of Prokaryotic cells, Morphology and ultra-structure of Bacteria (Flagella, Pili, Cell-wall, spores and nuclear material)
Sterilization techniques: Dry heat, wet heat, radiation, filtration and chemicals.

Module II

Classification of Bacteria: Basic principle and techniques used in bacterial classification. **Culture media**: Types and preparation.
Culture Technique: Isolation of pure culture (spread plate, streak, pour plate). Staining techniques**.**

Module III

Microbial metabolism: Role of ATP in metabolism, aerobic and anaerobic respiration, Assimilation of ammonia, nitrate molecule, nitrogen and sulphate, Fermentation.

Module IV

Eukaryotic Microbes: Fungi- salient features, structure of fungal cell, classification, Reproduction, Fungi of economic importance. Type study- Penicillum, Aspergillus, Yeast, Rhizopus. Protozoa- General Features. Classification and economic importance, *Entamoeba*, *Trypanosoma*, *Plasmodium*.

Module V

Viruses: General account of virus structure, classification of viruses, Various types of viral genomes- double stranded DNA genomes, single stranded RNA genomes, double strands RNA genome, single stranded DNA genomes.

References/Textbooks:

- Textbook of Microbiology: Pelczar, Creig & Chan
- Textbook of Microbiology: Volume I & II Pawar & Daginawala
- Brock's Biology of microorganisms- Madigan & Mctinko
- Microbiology- Katherine Black
- Microbiology Talaro & Talaro
- Microbiology- Presscott et al.
- General Microbiology-Stainer et al.

B.Sc. Biotechnology
Semester II: Theory
Bioscience II: Animal Kingdom
Code: 01BT2102

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of animal kingdom.
2. To train the students to pursue further education.
3. To be familiar with taxonomic study.
4. To increase expertise of the course.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Animal Kingdom and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

Module I

Introduction to Animal kingdom, Major and Minor phyla

Protozoa: General characters, type study: *Plasmodium*; Protozoa and diseases

Porifera: General characters, type study: *Sycon*- Morphology, Different types of cells in *Sycon*, canal system in Porifera.

Coelenterate: General characters, type study: *Obelia* -Morphology of *Obelia* colony, life history.

Helminthes, type study: Liver fluke - Structure, Life cycle

Module II

Annelida: General characters, type study: *Nereis* - Morphology; Digestive, Excretory and Reproductive systems.

Arthropoda: General characters, type study: Cockroach - Morphology; Digestive, Respiratory and Reproductive systems. Economic importance of insects.

Mollusca: General characters; type study: *Pila* - Morphology; Respiratory system.

Echinodermata: General characters, Type study: Star fish - Morphology; Respiratory and Canal system

Module III

General characters of Hemichordate, Chordate and Protochordates;

Origin and classification of chordate.

Module IV

Fishes: General characters, Skin and scales, Migration, Parental care;

Amphibia: General characters parental care, Neoteny;

Reptiles: General characters, Extinct reptiles, Poisonous and non poisonous snakes; Poison apparatus and snake venom

Module V

Birds: General characters, migration, Flight adaptation

Mammals: General characters, aquatic, prototheria and affinities.

Suggested Readings:

- Biological Sciences: Taylor, Green & Stout.
- Concepts in Biology; Enger & Ross.
- Chordate Zoology: Dhami & Dhami.
- Invertebrates: R. L. Kotpal.
- Modern Text Book of Zoology – Vertebrates: R. L. Kotpal.

B.Sc. Biotechnology
Semester II: Theory
Chemistry II
Code: 01BT2103

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Chemistry.
2. To train the students to pursue further education.
3. To be familiar with Chemical tools.
4. To gain experience with standard chemical tools.
5. To increase expertise of the course.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals Chemistry and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I

Mathematical Concept

Logarithmic relations, Curve sketching linear graphs and Calculation of slopes and Intercepts, Maxima and Minima, Differentiation, Partial differentiation and Reciprocity relations. Integration of some useful functions, Basic concepts of Permutation & Combinations, Factorials and Probability.

Computers

General introduction to Computers, Different components of a Computer, Hardware and Software, Input devices; Binary numbers and Arithmetic; Introduction to Computer languages; Programming, Operating systems.

Module II

Gaseous State

Postulates of kinetic Theory of gases, Deviation from ideal behavior, van der Waals equation of state. Critical Phenomena: PV-isotherms of real gases, Continuity of states, Isotherms of van der Waals equation, Relationship between critical constant and van der Waal constant, The Law of corresponding states, Reduced equation of state; Molecular velocities: root mean square, Average & most probable velocities; Qualitative discussions of the Maxwell's distribution of molecular velocities, Collision number, Mean free path and Collision diameter. Liquefaction of gases (Based on Joule's Thompson Effect).

Module III

Liquid State: Intermolecular forces, structure of liquids (A qualitative description).

Structural differences between solids, liquids and gases; Classification of Liquid crystals, structure of smectic, Nematic and Cholestic phases.

Colloidal State

Definition of colloids, Classification and properties-kinetic, Optical and Electrical; Stability of colloids, Protective action, Hardy-Schulz law, Gold number.

Solid State

Definition of space lattice, Unit cell. Laws of crystallography- (I) Law of constancy of interfacial angles (II) Law of rationality of indices (III) Law of symmetry; X-ray diffraction by crystals. Derivation of Bragg's equation. Crystal structure of NaCl, KCl and CsCl

Module IV

s- Block Elements

Comparative study, Diagonal relationships, Salient features of hydrides, Salvation and complexation tendencies including their function in Biosystems and Introduction to Alkyl and Aryls.

p-Block Elements

Comparative Study (including diagonal relationship) of group 13-17 elements, Compounds like hydrides, Oxides, Oxyacids and Halides of groups 13-16.

Module V

p-Block Elements (Hydrides, Nitrides and Interhalogens)

Hydrides of Boron-diborane and higher boranes, Borazine, Borohydrides, Fullerenes, Fluorocarbons, Silicates (Structural principle), Tetra sulfur tetra nitride, Basic properties of halogens, Interhalogens and Polyhalides.

Suggested Readings:

1. Physical chemistry, G. M. Barrow, International student edition, Mc Graw Hill
2. Basic programming with application, V. K. Jain, Tata Mc Graw-Hill.
3. Computers & Common sense., R Hunt & Shelly, Prentice-Hall
4. University general chemistry, C.N.R. Rao, Macmillan.
5. Physical Chemistry, R.A. Alberty, Wiley Eastern.
6. The elements of Physical Chemistry, P. W. Atkin, Oxford.
7. Physical Chemistry thought problems, S.K Dogra & Dogra, Wiley Eastern.
8. Physical Chemistry, B.D. Khosla
9. Physical Chemistry, Puri & Sharma
10. Basic Inorganic Chemistry, F.A Cotton, G. Wilkinson and P.L Gauss, Wiley.
11. Concise Inorganic Chemistry, J.D. Lee, ELBS.
12. Concepts of models of Inorganic Chemistry, B. Douglas, D. Mc Daniel and J Alexander, John Wiley.
13. Inorganic Chemistry, D.E. Shriver, P.W. Atkins and C.H.L. Angford, Oxford.

B.Sc. Biotechnology
Semester II: Theory
English
Code: 09AE2307

Credit: 2
Total Marks: 50 (35+15)

Course Objective:

1. To refresh the previous knowledge of students in the area of grammar. Revise what they already know so that all students come on the same level; and to enhance their skills further.
2. To increase their expertise in the language, which in turn would help them in being better communicators, understand and express themselves better and clearer.
3. To enable students to apply basic principles of grammar both in oral and written communication.
4. To cultivate reading habit through off line study of English literature.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals english.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to have good communicative skill.

Module I

Kabuliwala (Lesson) – Rabindranath Tagore
All the World's a Stage (Poem) – W. Shakespeare
Articles,
Determiners

Module II

What is Communication (An Introduction)
The Communication Process (Communication cycle)
Objectives of Communication (Types)
Barriers of Communication

Module III

Prepositions, Tenses
Pronoun, Adjective, Adverb
Narration

Module IV

Active and Passive voice
Modals
Reading Skills – Précis

Module V

Writing skills – Letter writing, Applications, Official letters
Paragraph writing
Idioms and Phrases
Vocabulary

Suggested Readings:

1. English Grammar and Composition. By: Wren and Martin
2. A Practical English Grammar. By: A J Thompson and A V Martinet
3. Intermediate Grammar Usage and Composition. By: M L Tickoo, A E Subramanium and P R Subramanium

B.Sc. Biotechnology
Semester II: Practical
Lab Course: Biotechnology II
Code: 01BT2204

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Become familiar with tools.
4. Gain experience with standard molecular tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. Use and study of apparatus.
2. Cleaning and sterilization of glasses.
3. Study of light microscopy.
4. Preparation of various culture media.
5. Serial dilution technique and warcup method.
6. Isolation of microorganisms from soil.
7. Isolation of microorganisms from air.
8. Isolation of microorganisms from water.
9. Maintenance of pure culture.
10. Staining of bacteria- gram stain, acid fast, negative and spore staining.
11. Staining of fungi- Lactophenol cotton blue.
12. Micrometery-Use of Ocular and Stage micrometer.
13. Normal microbial flora of skin.
14. Normal microbial flora of Mouth.

B.Sc. Biotechnology
Semester II: Practical
Lab Course: Bioscience II
Code: 01BT2205

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Become familiar with tools.
4. Gain experience with standard molecular tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. Study of Protozoa.
2. Study of Porifera.
3. Study of Coelenterate.
4. Study of Helminths
5. Study of Annelida.
6. Study of Mollusca.
7. Study of Echinodermata.
8. Study of Arthopoda.
9. Study of Fishes.
10. Study of Amphibia.
11. Study of Reptiles.
12. Study of Birds.

B.Sc. Biotechnology
Semester II: Practical
Lab Course: Chemistry II
Code: 01BT2206

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Become familiar with Chemical Science tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. Distribution Law

To study distribution of iodide between water & CCl_4

To study distribution of benzoic acid between benzene & water.

2. Colloids

To prepare arsenious sulphide sol & compare the precipitating power of mono- bi & tri valent anions.

3. Viscosity &. Surface Tension

To determine the of % composition of a given mixture (Non interacting system) by viscosity method.

To determine the viscosity of amyl alcohol in water at different concentrations & calculate the excess viscosity of these solutions.

To determine the % composition of a given binary mixture by surface tension method (acetone & ethyl methyl ketone).

4. Inorganic Chemistry

Semi micro Analysis-cations analysis separation and identification of ions from Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sb^{3+}, $Sn^{2+,4+}$, Fe^{3+}, Al^{3+}, Cr^{3+}. Ni^{2+}, $C0^{2+}$, Zn^{2+}, Mn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH^{4+} and Anions $CO2/3^{-}$, $SO2/3^{-}$, S^{2-}, $SO2/4^{-}$, NO_2^{-}, NO_3, Cl^{-} ,Br^{-},I^{-}, CH_3COO^{-}, $C_202/4^{-}$, $BO3/5^{-}$, F^{-}.

B.Sc. Biotechnology
Semester III: Theory
Biotech-III: Cell and Molecular Biology
Code: 01BT3101

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Cell and Molecular Biology.
2. To train the students to pursue further education.
3. To be familiar with molecular biology tools.
4. To gain experience of standard molecular tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Cell and Molecular Biology and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I

Discovery of cell, The Cell theory. Prokaryotic and Eukaryotic cell – Plant and Animal cell. Cell Membrane, Cellular Reproduction. Techniques in Cell Biology.

Module II

Cell Organelles: Structure and Functions of Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus and Chromosomes.

Module III

Cell Division - Cell cycle, Amitosis, Mitosis and Meiosis. Regulation of cell cycle. Central Dogma: Brief introduction of Structure and Functions of DNA, RNA and proteins.

Module IV

DNA Replication: Prokaryotic and Eukaryotic – Mechanism, Enzymes and accessory proteins involved. DNA Repair.

Module V

Prokaryotic and Eukaryotic Transcription and Translation, Genetic code, Recombination in prokaryotes.

Suggested Readings:

- Cell & Molecular Biology : Gerald Karp
- Cell Biology : C.B. Powar
- Essential Cell Biology : An introduction: Bruce, Alberts, Dennis
- The Cell: A Molecular Approach: Geoffrey M. Cooper
- Cell & Molecular Biology: SC Rastogi
- Cell & Molecular Biology: Robertis & Robertis
- Cell Biology & Genetics: Starr & Taggart
- Molecular Cell Biology: Lodish

- Principles of Genetics – E.J. Gardener, M.J. Simmons and D.P. Snustad, John Wiley & Sons publications
- Stem Cells and Cancer by Rebecca G. Bagley, Beverly A. Teiche
- Elements of Human Cancer By Geoffrey M. Cooper.

B.Sc. Biotechnology
Semester III: Theory
Bioscience III: Structure, Development and Reproduction in Flowering Plants
Code: 01BT3102

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Structure, Development and Reproduction in Flowering Plants.
2. To train the students to pursue further education.
3. To be familiar with plant biology tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Structure, Development and Reproduction in Flowering Plants.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I

The basic body plan of a flowering plant: modular type of growth.
The root system: root apical meristem; differentiation of tissues; modification of roots.

Module II

The shoot system: shoot apical meristem; Anatomy of primary shoot in monocotyledons (*Zea mays*) and dicotyledons (*Helianthus anus*); Secondary Growth, characteristics of growth rings, sapwood and heart wood; secondary phloem; periderm.

Module III

Leaf: origin, development, Structure, arrangement and diversity in size and shape, senescence and abscission.
Flower: Structure and function of anther and pistil. Development of male and female gametophytes.

Module IV

Pollination, self incompatibility, double fertilization, formation of seed, endosperm and embryo; fruit: development and maturation, Seed dormancy, vegetative propagation.

Module V

Diversity of flowering plants: General account of the families Brassicaceae, Fabaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Lamiaceae, and Poaceae.

Suggested Readings:

1. The Embryology of Angiosperms: Bhojwani and Bhatnagar.
2. Anatomy of Seed Plants: Esau, K. John Wiley and Son, USA.
3. Embryology of Angiosperms: Johri, B.M. Springer-Verleg, Berlin.
4. Pollination biology: Kapil, R.P. Inter India Publishers, New Delhi.
5. An Introduction to Embryology of Angiosperms: Maheswari.P
6. Botany for Degree Students: Pandey, B.P. -Diversity of Seed Plants and their Systematics, Structure, Development and Reproduction in Flowering Plants. S. Chand & Company Ltd., New Delhi.

B.Sc. Biotechnology
Semester III: Theory
Chemistry III
Code: 01BT3103

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Chemistry.
2. To train the students to pursue further education.
3. To be familiar with Chemical tools.
4. To gain experience with standard chemical tools.
5. To increase expertise of the course.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals Chemistry and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I

Chemistry of Nobles Gasses

Chemical properties of the noble gasses, chemistry of xenon, structure & bonding in Xenon compounds.
Oxidation and Reduction: Use of redox potential, data-analysis of redox cycle, redox stability in water-frost, Latimer and Pourbaix diagram.

Module II

Chemistry of elements of first transition series

Characteristic properties of d-block elements. Properties of the elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry.
Chemistry of elements of Second and Third transition series: General characteristics comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.

Module III

Alcohol: Classification and nomenclature; Monohydric alcohols, dihydric alcohols, Trihydric alcohols. Nomenclature methods of formation by reduction of aldehydes. Ketones, carboxylic, acids and esters. Hydrogen bonding. Acidic nature, Reactions of alcohols.
Phenols: Nomenclature, structure and bonding, preparation of phenols, acidic character. Comparative acidic strength of alcohols and phenols, resonance stabilization of phenoxide inlono. Reactions of phenols. Mechanism of fries rearrangement claisen rearrangement, Gatterman synthesis, Hauben – Hoesch reaction, Lederer – Manasse reaction and Reimer – Tiemann reaction. **Ethers and Epoxides.**

Module IV

Aldehydes and Ketenes: Nomenclature and structure of the carbonate group. Synthesis of aldehydes and ketones and properties. Condensations. Condensations with ammonia and its derivatives .Wittig reaction, mannish reaction
An introduction to α, β Unsaturated aldehydes and ketones.

Module V

Chemical Kinetics and Catalysis

Chemical kinetics and its scope, rate of reaction, factors influencing, the rate of reaction-concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rate, mathematical characteristics of simple chemical reactions- Zero order, first order, second order, pseudo order, half life and mean life. Determination of the order of the reaction-differential method, method of integration, method of half life period and Isolation method.

Radioactive decay as a first order phenomenon.

Experimental methods of chemical kinetics: Conductometric, Potentiometer, Optical methods, Polarimetry, and Spectrophotometer.

Theories of chemical, kinetics: Effect of temperature on rate of reaction, Arrhenius equation concept of activation energy.

Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant & thermodynamic aspects.

Catalysis: characteristics of catalyzed reactions, classification of catalysis, miscellaneous examples.

Suggested Readings:

1. Basic Inorganic Chemistry, F A Cotton, G. Wilkinson and P L Gauss, Wiley.
2. Concise Inorganic Chemistry, J.D. Lee, ELBS.
3. Concepts of models of Inorganic Chemistry, B. Douglas, D. Mc Daniel and J Alexander, John Wiley.
4. Organic Chemistry, Morrison and Boyd, Prentice- Hall
5. Organic Chemistry, L.G. Wade Jr. Prentice-Hall
6. Fundamentals of Organic Chemistry, Solomons, John Wiley
7. Organic Chemistry, Vol. I, II &III, S.M. Mukherjee, S.P. Singh and R.P. Kapoor, Wiley-eastern (New-Age).
8. Organic Chemistry, EA. Carey, MC Graw Hill
9. The elements of Physical Chemistry, P. W. Atkin, Oxford.
10. Physical Chemistry thought problems, S.K Dogra & Dogra, Wiley Eastern.
11. Physical Chemistry, B.D. Khosla.
12. Physical Chemistry, Puri & Sharma.

B.Sc. Biotechnology
Semester III: Practical
Lab Course: Biotechnology III
Code: 01BT3204

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Become familiar with biotechnological tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. Study of Parts of Microscope
2. To measure the length and breadth of the given cell sample by using micrometer.
3. To prepare permanent slides using the given sections like Stem, Root and Leaf.
4. Study of Mitosis.
5. Study of Meiosis.
6. Preparation of Blood Smear and study of blood cells.
7. Differential counting of white blood cells using Micrometer.
8. Identification of Barr Body in Buccal smear.
9. Identify the different types cells present in the leaf cross section.
10. Extraction of DNA from plants.
11. Extraction of DNA from animal tissues.
12. Extraction of DNA from fungus.
13. Estimation of DNA using Diphenyl amine.

B.Sc. Biotechnology
Semester III: Practical
Lab Course: Bioscience III
Code: 01BT3205

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Become familiar with plant biology tools.
4. Gain experience with standard molecular biology tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. Study of different Angiosperms.
2. Study of commonly occurring dicotyledonous plants to understand the body plan and modular type of growth.
3. Anatomy of primary and secondary growth in monocots and dicots using hand sections or prepared permanent slides.
4. Study of diversity in leaf shape, size, thickness and surface properties and internal structure.
5. Structure of anther, microsprogenesis and pollen grains.
6. Study of *In vitro* pollen germination
7. Simple experiments to study vegetative propagation in plants.
8. Germination of non dormant and dormant seeds.

B.Sc. Biotechnology
Semester III: Practical
Lab Course: Chemistry III
Code: 01BT3206

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Become familiar with Chemical tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. Crystallization of organic compounds.
2. Separation of Phthalic acid from hot Water (using fluted filter paper and stem less funnel), Acetanilide from boiling water, Naphthalene from ethanol, Benzoic acid from water.
3. Decolorization and crystallization using charcoal.
4. Detection of elements (N, S and halogens) and functional groups (Phenolic, Carboxylic, Carbonyl. Esters, Carbohydrates, Amines, Amides, Nitro and Anilide) in simple organic compounds.
5. To determine the specific rate of hydrolysis of methyl ethyl acetate catalyzed by hydrogen ions at room temperature.
6. To study the effect of acid strength on the hydrolysis of an ester.
7. To compare the strengths of HCl & H_2SO_4 by studying the kinetics of hydrolysis of ethyl acetate.

B.Sc. Biotechnology
Semester III: Theory
Computer Application
Code: 09SE3307

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart basic knowledge of Computer.
2. To be familiar with computer hardware and software.
3. To have experience of virtual world.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Computer and key principles of it.
2. Awareness of its major application.
3. Ability to use Computer for biological applications or related problems.

Module I

Computer basics (history, generation, components, I/O devices, memory of computer), Introduction to computer network (LAN, MAN, WAN), Network topologies.

Module II

Internet and it's applications, Email, video conferencing, chatting, blogs, Usenet. Internet protocols (FTP, HTTP). Website, search engines. Advantages and threats in Internet communications.

Module III

MS office, MS word (tools and menus, paragraph, alignment, font, editing). MS PowerPoint (tools and menus, creating slides, transition and custom animation). MS Excel (tools and menus, creating spreadsheet, use of function).

Module IV

Database, Database management system (Introduction, types, functions and features). Introduction to computer graphics, color model, graphic file format.

Module V

Use of computer in biological science, Introduction to bioinformatics, bioinformatics database, importance and use of bioinformatics.

Suggested Readings:

1. Chetan Shrivastava, Introduction to IT, Kalyani Publishers, Delhi.
2. A. Jaiswal, Fundamental of Computer IT Today, Wiley Dreamtech.

B.Sc. Biotechnology
Semester III: Theory
Bioinformatics
Code: 09SE3308

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart basic knowledge of Bioinformatics.
2. To be familiar with biological database.
3. To have experience of databases.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Bioinformatics and key principles of it.
2. Awareness of its major application.
3. Ability to use Computer for biological applications or related problems.

Module I

Computer Basics, Introduction to computer networks, LAN, MAN, WAN & Internet, Internet applications in biological sciences.

Module II

Database concepts: Introduction, Key features; Biological Database: Introduction and Types; Sequence Database: Introduction and Types

Module III

Bioinformatics: Introduction, Bioinformatics databases, Importance of Bioinformatics; Analytical approaches, Components of Bioinformatics.

Module IV

Commercial use of bioinformatics; Bioinformatics in Biological Sciences, Biocomputing, Bioinformatics in the area of genomics, Technical and legal issues, Role of Bioinformatician.

Module V

DNA libraries and ESTs; Pair wise and multiple sequence alignment techniques; Analysis of Gene expression: Overview of microarray analysis.

References:

- Bioinformatics: C. S. V. Murthy
- Introduction to Bioinformatics: Indian Institute of Bioinformatics, New Delhi
- Bioinformatics: Baxavanis
- Bioinformatics: Higgins and Taylors.
- Fundamentals Concepts of Bioinformatics: Dan E. Krane and Michael L. Raymer.

B.Sc. Biotechnology
Semester IV: Theory
Biotech-IV: Animal Biotechnology and Genetic Engineering
Code: 01BT4101

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Animal Biotechnology and Genetic Engineering.
2. To train the students to pursue further education.
3. To be familiar with genetic engineering tools.
4. To gain experience of standard molecular tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Animal Biotechnology and Genetic Engineering and key principles of it.
2. Awareness of the major issues at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I

Animal Biotechnology: Animal Biotechnology- Introduction, History, Scope, Advantages & Disadvantages.
Tissue Culture Media, Applications of Animal Biotechnology

Module II

Cell Culture & Cell Lines, Culture Procedure, Large Scale Cell Culture in Biotechnology, Cell Banking & Scaling up of Cell Culture, Organ Culture- Types & Techniques, Applications in the field of Biotechnology

Module III

Genetic Engineering- Concepts, Tools, Enzymes responsible for Genetic Engineering, Cloning Vectors and their Applications

Module IV

Gene Libraries- Creating & Screening Methods & Its different Techniques
Methods of DNA Technology, Molecular Research Procedures of DNA

Module V

DNA & its Sequencing, Applications of Genetic Engineering in the Field of Agriculture, Industry, Medicine & Diagnostics.

Suggested Readings:

1. Elements of Biotechnology (2nd Edition): P K Gupta
2. Animal Cell Culture: A Practical Approach: R. I. Freshney
3. Methods in Cell Biology(Vol-57): Animal Cell Culture Methods Mather & David Barnes
4. Principles of Genetic Manipulation: Old & Primrose
5. Animal Cell Culture Techniques- Martin Clynes

6. Recombination DNA Technology: Glick
7. Applied Molecular Genetics: Roger L Meisfeld
8. DNA Cloning:- A Practical Approach; A.M. Glover and B.D. Hames, IRL Press, Oxford
9. Genetic Engineering:- An Introduction to Gene Analysis and Exploitation in Eukaryotes: S.M. Kingsam; A.J. Kingsman
10. Recombination DNA : Watson et.al
11. Principles of Gene Manipulation: Old and Primrose
12. Molecular Biotechnology: Glick and Pasternak
13. Gene Cloning: T.A. Brown

B.Sc. Biotechnology
Semester IV: Theory
Bioscience IV: Medical Microbiology and Immunology
Code: 01BT4102

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Medical Microbiology and Immunology.
2. To train the students to pursue further education.
3. To be familiar with Medical Microbiology and Immunology tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Medical Microbiology and Immunology and key principles of it.
2. Awareness of the major issues at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I

History and Major developments in Medical Microbiology. Normal Microbial flora of human body. Host-parasite relationship. Process of infection.

Disease – Types of Disease. Disease Classification. General discussion of all types of Pathogens and development of symptoms. Some common bacterial disease – *Spirochetes, Tryponema, Streptococcal pneumonia, Clostridium tetani,* Tuberculosis, Salmonelossis, Cholera, *Yerisina, Staphylococcus, Corneybacteria.*

Module II

Viral Diseases – Influenza, Hepatitis, HIV, Herpes, Pox, Polio, Adino, Reo. Fungal and Protozoal Diseases – Fungal Diseases – Cutaneous and Sub-Cutaneous Mycoses, Aspergillosis. Protozoal Diseases – Amoebiosis, Malaria, Kalaazar.

Module III: Antimicrobial drugs - synthetic antimicrobial drugs, naturally occur antimicrobial drugs: antibiotics, β lactum antibiotics, antibiotics from prokaryotes, antiviral drugs, antifungal drugs, antimicrobial drug resistance.

Module IV: History and Development of Immunology. Types of Immunity. Cells, Tissues and Organs of Immune system. Antigens- Essential features of antigens. Epitopes, Haptens, Adjutants, Cross reactivity. Antibody- Structure, Types, Properties, Classification and their biological functions. Antigen-Antibody interaction. Clinical assays involving Antigen- Antibody interactions.

Module V: Humoral mediated immune response – B cells; Response of B cells to antigens. Plasma cells, Memory cells. Cell- mediated immune response – T cell Receptors, Role of T helper cells and cytotoxic T cells; Function of MHC complex, Monoclonal antibodies – Production and Function.

Suggested Readings:

1. A text book of Medical parasitology Jayaram Panicker
2. A text book of Microbiology;Chakraborty
3. Medical Microbiology Vol I and II –Mackie and Mc Carthy
4. A text book of Microbiology;R.Ananthnarayanan

- Immunology: Kubey
- Immunology: A short Course; Eli Benjamin, Richard Coico
- Immunology: Roitt et.al
- Fundamentals of Immunology: William Paul
- Essentials of Immunology (6th Edition): Ivan Riot- Blakswell Scientific Publications, Oxford, 1988.

B.Sc. Biotechnology
Semester IV: Theory
Chemistry IV
Code: 01BT4103

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Chemistry.
2. To train the students to pursue further education.
3. To be familiar with Chemical tools.
4. To gain experience with standard chemical tools.
5. To increase expertise of the course.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals Chemistry and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I

Carboxylic Acids: Nomenclature, structure and bonding, Physical properties, acidity of carboxylic acids, effects of substituents on acid strength ,preparation of Carboxylic acids . Reactions of Carboxylic acids. Synthesis of acid chlorides, esters and amides. Reduction of Carboxylic acids .Mechanism of decarboxylation. Methods of formation and chemical reaction of unsaturated mono Carboxylic acids. Di Carboxylic acids: Methods of formation and effect of heat and dehydrating agents.

Carboxylic acid Derivatives: Structure and nomenclature of acids chlorides, esters, amides (Urea) & acid anhydrides.Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

Preparation of Carboxylic acids derivatives, chemical reaction mechanism of esterification and hydrolysis (acidic & basic)

Module II : Organic Compound of Nitrogen:

Preparation of nitroalkanes and nitroarenes. Chemical reaction of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium.

Amino Acids, Peptides, Proteins and Nucleic Acids : Classification, structure and stereochemistry of amino acids .Acid-base behavior, isoelectric point and electrophoresis and reaction of alfa -amino acids.

Structure and nomenclature of peptides .classification of proteins .classical peptide synthesis solid-phase peptide synthesis – structure of peptides and proteins .Levels of proteins structure .Protein denatuaration /renaturation.

Nucleic acids: - Introduction. Constituents of nucleic acids. Ribonucleosides and ribouncleotides.The double helical structure of DNA.

Module III : Thermodynamics – I

Definition of thermodynamics terms: system, surroundings etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work

First Law of Thermodynamics: statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law- Joule – Thompson

coefficient and inversion temperature. Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic condition for reversible process.

Thermo chemistry: standard state, standard enthalpy of formation – Hess's law of heat summation and its applications. Heat of reaction at constant pressure and constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo – chemical data, temperature dependence of enthalpy, Kirchhoff's equation.

Module IV : Thermodynamics – II

Second Law of Thermodynamics: need for the law, different statements of the law. Carnot cycle and its efficiency, carnot theorem. Thermodynamic scale of temperature.

Concept of entropy: entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, Clausius inequality, entropy as acriteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.

Third Law of Thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs & Helmholtz functions, Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of G and A with P, V, and T.

Module V: Chemical Equilibrium:

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Lechatelier's principle. Reaction isotherm and reaction isochore – Clapeyron equation and Clausius – Clapeyron equation, applications.

Phase Equilibrium:

Statement and meaning of the terms – phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system – water, CO_2 and S Systems.

Suggested Readings:

1. Organic Chemistry, Morrison and Boyd, Prentice- Hall
2. Organic Chemistry, L.G. Wade Jr. Prentice-Hall
3. Fundamentals of Organic Chemistry, Solomons, John Wiley
4. Organic Chemistry, Vol. I, II &III, S.M. Mukherjee, S.P. Singh and R.P. Kapoor, Wiley Eastern (New-Age).
5. Organic Chemistry, EA. Carey, MC Graw Hill
6. Introduction to Organic Chemistry, Struiweisser, Heathock and Kosover, Macmillan.
7. Organic Chemistry, P.L. Soni.
8. Organic Chemistry, Bahl & Bahl
9. Organic Chemistry, .Joginder Singh.
10. Physical chemistry, G.M. Barrow, International student edition, MC G.Hill
11. Physical Chemistry, R.A. Alberty, Wiley Eastern.
12. The elements of Physical Chemistry, P. W. Atkin, Oxford.
13. Physical Chemistry thought problems, S.K Dogra & Dogra, Wiley Eastern.
14. Physical Chemistry, B.D. Khosla
15. Physical Chemistry, Puri & Sharma

B.Sc. Biotechnology
Semester IV: Practical
Lab Course: Biotechnology IV
Code: 01BT4204

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Become familiar with biotechnological tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. To Isolate the Genomic DNA from spleen
2. To Estimate the DNA by DPA method.
3. To Estimate the RNA by Orcinol method.
4. To Isolate and Elute the DNA from Given sample by Agarose Gel Electrophoresis
5. To Isolate the Genomic DNA from Rice Plant by GFP Cloning mehtods
6. To Determine the Tm Value (GC) content in Denatured DNA.
7. To Determine the Competent Cell from the given sample.
8. To Transform the foreign DNA from given sample.
9. To Study the Bacterial conjugation by Genetic Engineering process.
10. To Isolate the Plasmid DNA from given sample.

B.Sc. Biotechnology
Semester IV: Practical
Lab Course: Bioscience IV
Code: 01BT4205

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Become familiar with immunobiology tools.
4. Gain experience with standard molecular biology tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. Precipitation reaction: antigen-antibody interaction.
2. Agglutination reactions
3. Radial Immuno diffusion.
4. Antibiotic sensitivity test of given sample.
5. To isolate bacterial flora of skin.
6. To isolate bacterial flora of saliva
7. To isolate normal flora of mouth teeth crevices
8. To determine dental caries susceptibility
9. To estimate the urine bacteria by pour plate (dilution) method
10. To perform VDRL test from the given sample of blood/ serum
11. To perform HBsAg antigen test from the given sample.

B.Sc. Biotechnology
Semester IV: Practical
Lab Course: Chemistry IV
Code: 01BT4206

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Become familiar with Chemical tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

1. To study distribution of iodide between water & CCl_4
2. To study distribution of benzoic acid between benzene & water.
3. Detection of various functional groups(Organic)and derivative preparation.
4. To construct the phase diagram of two component system by cooling curve method.
5. Determination of the transition temperature of the given substance by thermometric/dial metric method.

B.Sc. Biotechnology
Semester IV: Theory
Biostatistics
Code: 09SE4307

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart basic knowledge of Statistics.
2. To be familiar with biostatistics and its application.
3. Become familiar with statistical tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of statistics and key principles of it.
2. Awareness of its major application.
3. Ability to use Computer for biostatistics or related problems.

Module I

Introduction, Biological data, Collection of data, Processing of data, Primary and Secondary data, Frequency distribution – Discrete and Continuous. Cumulative frequency distributions.

Module II

Diagrammatic and graphic representation of data: Advantages, Disadvantages; Types: Line diagram, Bar diagram, Pie Chart, Histogram, Frequency polygon, Frequency Curve.

Module III

Central tendency: Mean, Median, and Mode. Measures of dispersion – Standard Error, Standard deviation and Coefficient of Variations. Random Variable: Expectation and variance.

Module IV

Probability distribution, Mean, Variance, Binomial, Poisson, Normal distribution and standard normal distribution: Area properties, mean, variance.

Module V

Hypothesis Testing, Types of Hypothesis, Types of errors; t-test, F-test; Testing goodness of fit, Chi Square (χ^2) test.

Suggested Readings:

1. Fundamentals of Biostatistics by Khan and Khanum
2. Research Methodology: Methods and Techniques: C R Kothari
3. Fundamentals of statistical by S.P Gupta
4. Statistical Methods by Snedecor and Cochran(8/e)
5. Applied statistics by S.C Gupta and V.K Kapoor

B.Sc. Biotechnology
Semester IV: Theory
Research Methodology
Code: 09SE4308

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart basic knowledge of Research Methodology.
2. To be familiar with research methodology and its application.
3. Become familiar with statistical tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of statistics and key principles of it.
2. Awareness of its major application.
3. Ability to use Computer for biostatistics or related problems.

Module I

Research Methodology: Introduction, Meaning, Objectives of Research, Motivation in Research, Types of Research, Significance of Research, Research Methods versus Research Methodology.

Module II

Research and Scientific Method, Process of Research, Criteria of Good Research, Limitations of Research, Research Problem: Definition, Selection and Techniques.

Module III

Research Design – Meaning, Need for Research Design and Types, Features of good design, Principles of Experimental Design, Literature search.

Module IV

Sampling Techniques: Introduction, Steps in Sampling Design; Types of Sample Design: Random and Non-Random, Sampling and Non-Sampling errors.

Module V

Interpretation, Technique of Interpretation, Report writing: Significance and Different steps, Types; Oral presentation; Research report.

Suggested Readings:

1. Research Methodology: Dr. V Upagade and Dr. Arvind Shende

2. Research Methodology: Methods and Techniques: C R Kothari

B.Sc. Biotechnology
Semester V: Theory
Bioscience V(A): Plant Physiology
Code: 01BT5103

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Plant Physiology.
2. To train the students to pursue further education.
3. To be familiar with plant biology tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Plant Physiology.
2. Awareness of the major issues at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module – I

Plant water relation- Importance of water to plants, imbibition, diffusion, osmosis, water potential; Absorption of water; Ascent of sap; Transpiration - Stomatal physiology , Water stress and its significance ; Translocation in Phloem.

Module – II

Mineral nutrition: Essential macro and micro elements and their role, Mineral uptake, Deficiency symptoms.

Module – III

Photosynthesis: Photosynthetic pigment systems, radiant energy, cyclic and noncyclic electron transport, C3 and C4 pathways, factors affecting photosynthesis, photorespiration,

Module – IV

Respiration: Aerobic and anaerobic, Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway Factors affecting respiration.

Module –V

Growth - measurement of growth, growth curve, Plant growth regulators-Auxins, Gibberellins, Cytokinins, Ethylene Growth regulation, application of hormones in agriculture - Nitrogen fixation in plants**.**

Photomorphogenesis - Photoperiodism, Vernalisation, Phytochrome, Biological clock.

Suggested Readings

1. Plant Physiology: Salisbury and Ross
2. Plant Physiology: Pandey and Sinha Plant Physiology, Ting I.P Addison

3. Plant Physiology: Devlin and Withem
4. Text of Plant Physiology and Biochemistry: S. K. Verma
5. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
6. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
7. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual.

B.Sc. Biotechnology
Semester V: Theory
Bioscience V(B): Plant Pathology
Code: 01BT5104

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Plant Pathology.
2. To train the students to pursue further education.
3. To be familiar with plant biology tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Plant Pathology.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I

Definition and importance of plant pathology. Causes of plant diseases.
Classification of plant diseases according to cause and occurrence.

Module II

Plant Pathogens: **Fungi**-Economic importance and general characteristics.Morphology of different vegetative structures (thallus, mycelium, haustoria etc.), Reproduction, Different types of spores, Levels of parasitism, Nomenclature.

Module III

Classification of fungi with special reference to genera listed under following itemsLife histories of Pythium, Albugo, Erysiphe, Ustilago, Claviceps and Puccinia. Diagnostic characters of the following genera: Phytophthora, Peronospora, Sclerospora, Ustilago, Sphacelotheca, Tolyposporium, Melampsora, Alternaria, Cerospora, Fusarium, Helminthosporium Pyricularia, Rhizoctonia, Colletotrichum.

Module IV

Bacteria: Brief history of bacteria as plant pathogens. Morphology and Cell structure. Vegetative reproduction. Brief outline of classification of plant pathogenic bacteria. A brief account of mycoplasma.

Module V

Viruse: Nature and properties. Transmission of plant virus, Phanerogamic parasites: Cuscuta, Loranthus, Orobanche and Striga.

Suggested Readings

1. Plant Pathology: B P Pandey
2. Plant Pathology: G N Agrios

3. Plant Pathogens and Principles of Plant Pathology : Sanjeev Singh
4. Microbial Plant Pathogens – Detection and Disease Diagnosis: P Narayanaswamy
5. Plant Pathology Concepts and Laboratory Exercises: Robert N Trigiano

B.Sc. Biotechnology
Semester V: Theory
Chemistry V(A): Chemistry of d-block, Quantum Chemistry and Spectroscopy
Code: 01BT5105

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of d-block, Quantum Chemistry and Spectroscopy.
2. To train the students to pursue further education.
3. To be familiar with Chemical tools.
4. To gain experience with standard chemical tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of d-block, Quantum Chemistry and Spectroscopy and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I : Metal Ligand Bonding In Transition Metal Complexes:

Limitations of Valence Bond Theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal field parameters. Thermodynamic and kinetic aspects of metal complexes. A brief outline of thermodynamic stability of metal complexes and factors affecting the stability of square planar complexes.

Module II : Magnetic Properties of Transition Metal complexes:

Types of magnetic behaviour, methods of determining magnetic susceptibility, spin only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes. Electronic spectra of Transition Metal complexes. Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel energy level diagram for d^1 and d^2 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.

Module III:Elementary Quantum chemistry

Black body radiation, Planck's Quantum Law , Photoelectric effect, Bohrs model of Hydrogen atom. Compton effect, De Broglie's hypothesis, Heisenberg's uncertainty principle, Schrödinger's wave equation and its importance, Hamiltonian operators, physical interpretation of wave equation, postulates of Quantum mechanics for particle in a one dimensional box.

Module IV : Spectroscopy 1

Electromagnetic Spectrum: Absorption Spectra Ultraviolet (UV) absorption spectroscopy, absorption laws (Beer Lambert Law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones

Infrared (IR) absorption spectroscopy – molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

Module V : Spectroscopy II

NMR Spectroscopy Proton magnetic resonance(H^1nmr) Spectroscopy, Nuclear shielding and deshielding, chemical shift and molecular structure , spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone. Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques.

Suggested Readings:

1. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson and P. L. Gauss
2. Concise Inorganic Chemistry, J. D. Lee
3. Concepts of models of Inorganic Chemistry, B. Douglas, D. McDaniel & J. Alexander
4. Inorganic Chemistry, A. G. Sharp
5. Advanced Inorganic Chemistry, Satya Prakash
6. Advanced Inorganic Chemistry, Puri & Sharma

B.Sc. Biotechnology
Semester V: Theory
Chemistry V(B): Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy
Code: 01BT5106

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Organometallics, Bioinorganic chemistry and UV, IR Spectroscopy.
2. To train the students to pursue further education.
3. To be familiar with Chemical tools and techniques.
4. To gain experience with standard chemical tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of d-block, Quantum Chemistry and Spectroscopy and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I : Carbohydrates:

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo distereomers, conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D (+) glucose. Mechanism of mutarotation. Structure of ribose and deoxyribose. An introduction to dissacharides (maltose, sucrose and lactose) and Polysaccharides: Starch and Cellulose without involving structure determination.

Module II : Organo metallic Chemistry

Definition, nomenclature and classification of organo metallic compounds. Preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti. A brief account of metal ethylenic complexes and homogenous hydrogenation, mononuclear carbonyls and nature of bonding in metal carbonyls.

Module III : Bioinorganic Chemistry

Essential and trace elements in biological processes, metalloporphyrins with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metals with special reference to Ca^{21}, nitrogen fixation.

Module IV: Spectroscopy 1

Electromagnetic Spectrum: Absorption Spectra Ultraviolet (UV) absorption spectroscopy, absorption laws (Beer Lambert Law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones
Infrared (IR) absorption spectroscopy – molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

Module V: Spectroscopy II

NMR Spectroscopy Proton magnetic resonance(H^1nmr) Spectroscopy, Nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone. Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques.

References:

1. Organic Chemistry Morrison and Boyd, Prentice Hall.
2. Organic Chemistry, L. C. Wade Jr. Prentice Hall
3. Fundamentals of Chemistry, Solomons, John Wiley
4. Organic Chemistry Vol I,II & III, S. M. Mukherjee, S. P. Singh and R. P. Kapoor
5. Organic Chemistry, F.A. Carey, Mc Graw Hill
6. Organic Chemistry, P. L. Soni
7. Organic Chemistry, Bahl & Bahl

B.Sc. Biotechnology
Semester V: Practical
Lab Course: Bioscience V
Code: 01BT5207

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge.
2. To train the students with plant biology tools.
3. Gain experience with standard molecular biology tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

(A) Plant Physiology:

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.

Demonstration experiments (any four)

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

(B) Plant Pathology:

1. Identification of disease symptoms-
   Specimens:
   a. Blast disease in rice
   b. Anthracnose in chilli
   c. Powdery mildew in grapes
   d. Downy mildew in grapes
   e. Canker in citrus
   f. Rust in groundnut
   g. Leaf spot in cowpea
   h. Club root in cabbage
   i. Damping off in chilli

    j. Vascular wilt in brinjal
    k. Die back in chilli
    l. Leaf curl in chilli
    m. Mosaic disease in cucumber
2. Artificial inoculation of pathogens from diseased plant parts to nutrient media.
3. Isolation and identification of pathogen from disease affected plant parts using celotape impression method.
4. Temporary slide preparation of representative genera of disease causing fungi for morphological studies

B.Sc. Biotechnology
Semester V: Practical
Lab Course: Chemistry V
Code: 01BT5208

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. Become familiar with Chemical tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

Chemistry V(A):

Synthesis Analysis

1. Preparation of Sodium trioxalato ferrate(III), $Na_3[Fe(C_2O_4)_3]$ and
2. Determination of its composition by permanganometry.
3. Preparation of Ni-DMG complex, $[Ni(DMG)_2]$
4. Preparation of copper tetra ammine complex, $[Cu(NH_3)_4]SO_4$
5. Preparation of cis and Trans dioxalato diaqua chromate (III) ion.

Gravimetric Analysis

1. Analysis of Cu as CuSCN or CuO, Ni as Ni $(DMG)_2$, Ba as $BaSO_4$ and Fe as Fe2O3

Spectral Analysis

1. Verification of Beer Lambarts Law for $KMnO_4$ and $K_2Cr_2O_7$.
2. Determine the concentration of the given solution of the substance

Chemistry V(B):

Synthesis of Organic Compounds

1. Acetylating of salicylic acid, aniline, glucose and hydroquinone. Benzoylation of aniline and phenol.
2. Preparation of Grignard's reagent.
3. Oxidation- Preparation of benzoic acid from toluene
4. Reduction- preparation of aniline from nitrobenzene, m-nitroaniline from m-dinitrobenzene.
5. Separation of Binary Mixture.

Spectral Analysis

1. Verification of Beer Lambarts Law for $KMnO_4$ and $K_2Cr_2O_7$.
2. Determine the concentration of the given solution of the substance

B.Sc. Biotechnology
Semester V: Theory
Intellectual Property Rights
Code: 09SE5309

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart basic knowledge of Intellectual Property Rights.
2. To be familiar with laws and application of IPR.
3. Become familiar with IPR rules and regulation.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of IPR and key principles of it.
2. Awareness of its major application.
3. Ability to use or apply IPR related guidelines.

Module I

History of IPR in India, Introduction to Intellectual Property; Types of IP; Forms of IPR, Protection of IPR, Benefits and Problems of IPR.

Module II

World Trade Organization (WTO), GATT, TRIPS, World Intellectual Property Rights Organization (WIPO).

Module III

History of Indian Patent System and Law; Patent Authorities, Patent: Requirements, Types, Patentable and Non-Patentable items; Patent file procedures; Patents in India.

Module IV

Plant Breeder's Right (PBR), Requirements of PBR, Farmer's Privilege, Farmer's Right, Need for PBR, Advantages and disadvantages of PBR, ITPGRFA.

Module V

Patent: Living organisms, Biological materials, Importance in biology and biotechnology, Social issues, Controversies.

Suggested Readings:

- Bioethics and Biosafety: M K Satheesh
- Biotechnology and Patent Protection: Beier FK, Crespi RS and Straus
- Intellectual Property Rights on Biotechnology: Singh K
- Biotechnology Expanding Horizons: B D Singh
- Textbook of Biotechnology: R C Dubey

B.Sc. Biotechnology
Semester V: Theory
Bioethics and Biosafety
Code: 09SE5310

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart basic knowledge of Bioethics and Biosafety.
2. To be familiar with laws and application of Bioethics and Biosafety.
3. Become familiar with Bioethics and Biosafety rules and regulation.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Bioethics and Biosafety and key principles of it.
2. Awareness of its major application.
3. Ability to use or apply Bioethics and Biosafety related guidelines.

Module I

Introduction to bioethics, Bioethics and its relation to other branches, Application, Genetically modified food and crops, possible health outcomes, Regulation of GM foods.

Module II

Cloning: Animal and Human Cloning, Reproductive and Therapeutic cloning, Problems and applications, Ethical and legal aspects of cloning.

Module III

Clinical trials, Benefits and risks, Ethical issues involving human participation; Ethical implications of Human Genome project.

Module IV

Biosafety: Introduction, Need, Applications, Levels of biosafety, Biosafety guidelines and regulations framework in India.

Module V

Hazardous materials: Handling and Disposal; Good Laboratory Practices, Good Manufacturing Practices.

Suggested Readings:

- Bioethics and Biosafety: M K Satheesh
- A Textbook of biotechnology: R C Dubey
- Biotechnology: Expanding Horizons: B D Singh.
- Regulatory Framework for GMOs in India: Ministry of Environment and Forest, Govt. of India
- Cartagena Protocol on Biosafety: Ministry of Environment and Forest, Govt. of Inida
- Bioethics: Shaleesha A Stanley

B.Sc. Biotechnology
Semester VI: Theory
Biotech-VI(A): Industrial Biotechnology
Code: 01BT6101

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Industrial Biotechnology.
2. To train the students to pursue further education.
3. To be familiar with industrial biotechnology tools.
4. To gain experience of standard molecular tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Industrial Biotechnology and key principles of it.
2. Awareness of the major issues at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I

Introduction to fermentation, Screening – Primary and Secondary, Strain development, Substrate for industrial fermentation, Fermentation scale up.

Module II

Methods of fermentation, Fermenter systems, Types of Fermenters; Stirring and mixing, Gas exchange and mass transfer, Sterilization of gas and nutrient solutions, Instrumentation.

Module III

Downstream processing; Filtration, Centrifugation; Extraction by salt and solvent precipitation; Chromatographic techniques; Packaging and Storage.

Module IV

Industrial production of Chemicals and Food products; Production Alcohol, Acids, Solvents, Antibiotics, Amino acids; Technology of typical food products.

Module V

Biotransformation, Types of bioconversion reactions; Procedure for biotransformation; Application for Bioconversion.

Suggested Readings:

1. Industrial Microbiology: A H Patel
2. Bioprocess Engineering: Shuler and Kargi
3. Principles of Fermentation Technology: Stanbury et al.
4. Biotechnology: A Text book of Industrial Biotechnology: T D Brock
5. Industrial Microbiology: L E Casida
6. Industrial Microbiology: Prescott and Dunn
7. Microbial Biotechnology: A N Glazer and H Nikaids

B.Sc. Biotechnology
Semester VI: Theory
Biotech-VI(B): Plant Biotechnology
Code: 01BT6102

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Plant Biotechnology.
2. To train the students to pursue further education.
3. To be familiar with plant biotechnology tools.
4. To gain experience of standard molecular tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Plant Biotechnology and key principles of it.
2. Awareness of the major issues at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I

Plant Tissue Culture: Introduction, Terms and definitions. Types of culture, Aseptic Techniques, Tissue culture media and importance of growth regulators (Auxins, Cytokininis and Gibberellins)

Module II

Callus culture, cell suspension culture, Organogenesis and Somatic Embryogenesis – Techniques and applications: Micropropagation, axillary bud, shoot-tip and meristem culture. Somaclonal variations and its applications.

Module III

Haploid Production- Ovary and Anther culture, Somaclonal variation and their significance, *In-Vitro* production of secondary metabolites (biotransformation)

Module IV

Protoplast Culture – isolation, regeneration and viability test, somatic hybridization, protoplast fusion, practical Introduction of somatic hybridization: Various methods for fusing protoplasts,chemical and electrical. Cybrids- definition and application.

Module V

Production of Transgenic plants: Technique of transformation – Physical, Chemical & Biological (*Agrobacterium* mediated) methods. Applications of plant tissue culture in horticulture, agriculture. Edible Vaccines.

Suggested Readings:

- Plant Cell Culture , A practical approach; R. A. Dixon and Gonzalez
- Plant Molecular Biology; Donald, Grieson
- Elements of Biotechnology; P. K. Gupta and Rastogi
- Plant Biotechnology; J. Hammond, P. McGarvey and V. Yusibov
- Introduction to Plant Tissue Culture; Kalyan Kumar De
- Plant Tissue Culture; S. S. Bhojwani
- Plant Cell Culture: D. E. Evans

B.Sc. Biotechnology
Semester VI: Theory
Bioscience-VI(A): Anatomy and Physiology
Code: 01BT6103

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Anatomy and Physiology.
2. To train the students to pursue further education.
3. To be familiar with details of Anatomy and Physiology.
4. To gain experience of structural details.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Anatomy and Physiology and key principles of it.
2. Awareness of the major issues at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I:

Introduction to: Anatomy, epithelial tissue, muscular tissue, nervous tissue. Skeletal System, Structure of bones, types of bones, Bones of cranium, face vertebral column upper and lower limbs.

Module II:

Circulation System: Structure of heart, names and position of main blood vessels. Lymphatic System: Lymph vessels, lymph nodes and lymphoid organs, their structure & functions. Blood composition and function of blood, haemopesis, blood groups; Circulation of blood; Function of heart and blood vessels

Module III:

Digestive systems: Parts of gastrointestinal tract and associated glands; Digestion of food in mouth, stomach & small intestines. Absorption of food, function of liver.
Respiratory System: Parts of Respiratory System Function of lungs; Respiration disorders like anoxia. Dyspnea.

Module IV:

Urinary System: Parts of Urinary System; Excretory Systems: Structure & function of kidney and urinary bladder. Mechanism of urine formation. disorders of kidney.
Nervous System: Parts of brain, spinal cord, peripheral nerves.

Module V: Reproductive System. Male and female reproductive organs; Physiology of reproductive organs. Endocrine System: Various endocrine glands. Thyroid. Adrenal and pituitary glands; Sex glands.

Suggested Readings:

1. Principles of Anatomy and Physiology by Gerard J. Tortora
2. Human Physiology by K Sembulingam and P Sembulingam, Jaypee Publications
3. Text book of Medical Physiology by Arthyur C Guyton, John E. Hall
4. Review of Medical Physiology by William F Ganong
5. Human Physiology by C. C. Chatterjee
6. Fundamentals of Biochemistry: A C Deb
7. Harper's Illustrated Biochemistry: Murrey et al

B.Sc. Biotechnology
Semester VI: Theory
Bioscience VI(B): Environment and Ecology
Code: 01BT6104

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge of Environment and Ecology
2. To train the students to pursue further education.
3. To be familiar with the environment and ecology

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Environment and Ecology and key principles of its.
2. Awareness of the major issues at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.

Module I: The Environment; Physical environment; Biotic environment; Biotic and abiotic interactions. Habitat and niche: Concept of habitat and niche; Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies; concept of metapopulation, demes and dispersal, interdemic extinctions, age structured populations, Diversity Index: Simpson's index, Shannon's index Species interactions.

Module II: Community ecology; Nature of communities; community structure and attributes; Levels of species diversity and its measurements; Edges and ecotones. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax. Ecosystem: Structure and function; energy flow and mineral cycling (CNP); Primary production and decomposition; Structure and function of some Indian ecosystems; Terrestrial (forest, grassland). Aquatic (fresh water, marine, estuarine).

Module III: Environmental Pollution- Sources, effects and bioremediation, Biotechnological methods for Management of pollution; Global climate change; Global warming, Global dimming; Biodiversity-statuses; Monitoring and documentation; Major drivers of biodiversity change; Biodiversity management approaches, Economics of Biodiversity.

Module IV: Principles of conservation; major approaches to management, Indian case studies on conservation/management strategy: Sanctuaries and National Parks, Project Tiger, Biosphere reserves.
Metabolism & effects of Organochlorine, organophosphate and carbamate pesticides; Metabolism & effects of alkaloids, barbiturates, alcohol & cyanides; Metabolism & effects of heavy metal salts; Formation & effects of free radicals; Biochemistry of Detoxification.

Module V: Environmental Monitoring: IGPCC (Inter Government Policy/ Protocol for Climate change); EPA (Environmental Protection Agency); Laws, legislation pertaining to environment; Control, monitoring & surveillance of environment.

Suggested Readings:

1. Environmental management of toxic and hazardous chemical - Madhuraj
2. Environmental Biology - J. L. Blish
3. Fundamental Ecology - Odum
4. Environmental Physiology - Philips G.

5. Toxicology mechanism & analytical methods - Stewarts & Stratman
6. Environmental Impact Assessment: G.N.Vankhede Biotech Publishers, Delhi
7. Ecology and Biogeography of India, Mani, M.S. : 1974. Junk. Publ. The Hague.

B.Sc. Biotechnology
Semester VI: Theory
Chemistry-VI(A): Basic Analytical Chemistry
Code: 01BT6105

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Analytical Chemistry.
2. To train the students to pursue further education.
3. To be familiar with Chemical tools.
4. To increase expertise of the course.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Analytical Chemistry and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I:

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of Significant figures.

Module II:

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators. Determination of pH of soil samples. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Determination of pH, acidity and alkalinity of a water sample. Determination of dissolved oxygen (DO) of a water sample.

Unit III

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. Analysis of preservatives and colouring matter.

Unit IV

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). To compare paint samples by TLC method.

Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Unit V

Analysis of cosmetics: Major and minor constituents and their function. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zincoxide and Calcium carbonate by complexometric titration.

Suggested Readings:

1. Willard, H. H. Instrumental Methods of Analysis, CBS Publishers.
2. Skoog & Lerry. Instrumental Methods of Analysis, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman.
5. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
6. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry 2nd Ed., W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. The Tools of Biochemistry, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall.
10. Vogel, A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Prentice Hall.
11. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).

B.Sc. Biotechnology
Semester VI: Theory
Chemistry-VI(B): Fuel Chemistry
Code: 01BT6106

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Fuel Chemistry.
2. To train the students to pursue further education.
3. To be familiar with Chemical tools.
4. To increase expertise of the course.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals Fuel Chemistry and key principles of it.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

Module I

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Coal*:* Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Module II

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Fuel Gases**:** Large scale production, storage, hazards and uses of coal gas, water gas, producer gas, and oil gas.

Module III

Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Electrochemical Industries

Production of materials like chlorine, caustic soda, sodium chlorate, Batteries –primary and secondary cells, solar cells, fuel cells.

Module IV

Lubricants*:* Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Module V

Paints and Varnishes

Paints & Varnishes**:** Primary constituents of paints, Dispersion medium (solvent), binder Pigments, formulation of paints and varnishes. Requirements of a good paint.

Soaps: Manufacture of soaps by hot and cold process, classification of soap, cleansing of soap and classification of detergents (anionic and cationic).

Suggested Readings:

- E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
- P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- B.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut

B.Sc. Biotechnology
Semester VI: Practical
Lab Course: Biotechnology VI
Code: 01BT6207

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge.
2. To train the students to pursue further education.
3. Become familiar with biotechnological tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

(A) Industrial Biotechnology:

1. Penicillin production and testing of antimicrobial activity.
2. Ethanol production by yeast.
3. Citric acid production by *Asperigillus niger*.
4. Free amino acid production from microorganisms.
5. Alpha-amylase synthesis from microorganisms.
6. Screening for enzyme production from microorganisms.
7. Role of yeast in bread in bread making.
8. Cellulose production from microorganisms.

(B) Plant Biotechnology:

1. Sterilization techniques, identification of tissues from different plant tissues.
2. Preparation of MS media
3. *In vitro* culture imitation from germinated seeds, juvenile and mature shoots, buds.
4. Sub culturing of in vitro grown tissues.
5. In vitro Rooting of micro shoot.
6. Hardening and acclimatization of in vitro regenerated micro plants
7. Induction of callus from different tissues.
8. Organogenesis / somatic embryogenesis from callus.

B.Sc. Biotechnology
Semester VI: Practical
Lab Course: Bioscience VI
Code: 01BT6208

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge.
2. To train the students with bioscience tools.
3. To increase expertise of different tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

Anatomy and Physiology

1. Study of different tissues of mammals
2. Study of digestive system of mammals
3. Study of circulatory system of mammals
4. Study of respiratory system of mammals
5. Study of excretory system of mammals
6. Study of nervous system of mammals
7. Study of endocrine system of mammals
8. Study of reproductive system of mammals
9. Determination of Blood group (ABO and Rh)
10. Differential count of WBC using haemocytometer.
11. Preparation of blood smear and counting of WBC.
12. Estimation of haemoglobin.

Environment and Ecology

1. Determination of B.O.D. of water.
2. Analysis of water for pH, turbidity, colour, total dissolved solids.
3. Identification and estimation of nitrate, arsenic, iron and alkalinity in water.
4. Effect of cleaning and sweeping of floor on microbial population of laboratory.
5. Bacterial Examination of water by Coliform and MPN.
6. Isolation of cellulose degrading organism.
7. Microscopic studies of fresh water algae and protozoans.
8. To check the pollution levels by collection of particulate settled on leaves at various places in the city.
9. Diversity indices from soil and aquatic fauna.
10. Effects of toxicants on blood parameters of fish.

B.Sc. Biotechnology
Semester VI: Practical
Lab Course: Chemistry VI
Code: 01BT6209

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To impart practical knowledge,
2. To train the students to pursue further education.
3. To be familiar with Chemical tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Good quantitative skills such as the ability to accurately and reproducibly prepare reagents for experiments.
2. Ability to dissect a problem in to its key features.
3. Ability to design experiments and understand the limitations of the experimental approach.

Basic Analytical Chemistry

1. Gravimetry

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. Colorimetry

Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound ($KMnO_4$/ $CuSO_4$) and estimate the concentration of the same in a given solution.

3. Complexometric titrations

a) Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.

b) Estimation of total hardness of a given sample of water by complexometric titration.

4. Surface tension measurement (use of organic solvents excluded).

a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

b) Study of the variation of surface tension of a detergent solution with concentration.

Fuel Chemistry

1. Saponification of Fats: Estimation of saponification value of fats.
2. Determination of flash point and fire point by Red wood viscometer.
3. Determination of calorific value of solid and non volatile liquid fuels by Bomb calorimeter.
4. Determination of calorific value of gaseous and non volatile liquid fuels by Boy Gas calorimeter.
5. Determination of proximate and ultimate analysis of coal by using Kjeldahl apparatus.
6. Determination of flash point and fire point by Panskey-marten flash and fire point apparatus.

B.Sc. Biotechnology
Semester VI: Theory
Entrepreneurship
Code: 09SE6310

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To learn basics of Entrepreneurship.
2. To understand statutory requirements on Entrepreneurship.
3. To develop understanding of basic know-how of industrial planning, market assessment, future projections, etc.

Course Outcome:

Skills that students obtain after completion of the course:

1. Implementation of entrepreneurship values
2. Ability to dissect a problem in to its key features.
3. To prepare business plan and its execution according to market available.

Module I: Entrepreneurship: What is Entrepreneurship? Importance and Relevance of Entrepreneurship, Factors influencing Entrepreneurship, Entrepreneurship Development in India, Entrepreneurship Motivation; Distinction between Entrepreneur and Intrapreneur.

Module II: Theories of Entrepreneurship-Economic, Sociological, Psychological. Emergence of Entrepreneurial class, Salient features of Entrepreneurial class. Promotion of Venture; opportunity analysis; idea generation; idea processing and selection External Environment Analysis.

Module III: MARKET ASSESSMENT: Need and Relevance; Tools and Techniques; Method of market survey; Source of market information; Preparation of market survey report; Use of market survey report in selecting the product.

Module IV: BUSINESS PLAN PREPERATION AND PRODUCT FINANCE: Project Report; Need and Relevance; Market Feasibility; Technical Feasibility; Financial Feasibility; Strategic planning; Implementation schedule; Loan Application and Disbursement formation; Other relevant procedures and formalities.

Module V: Entrepreneurial Development programs; Role & Relevance; Role of government in organizing EDPs.

Suggested Readings:

1. Small Scale Industries and Entrepreneurship: Vasant Desai- Himalaya publishing house
2. Rajagopal, Entrepreneurship and Rural Markets
3. Dr. Varshini, Fundamentals of Entrepreneurship
4. Ovmerod A,(1992), 'Textile, Project Management', the textile Institute.
5. Rerry and Franklin, (2002), 'Principals of Management'. AITBS.
6. Acharya B.K. and Gonekan P.B. (1985) 'Marketing and Sale Management',Bombay, Himalaya publication house.

B.Sc. Biotechnology
Semester VI: Theory
Principle of Management
Code: 09SE6311

Credit: 2
Total Marks: 50 (35+15)

Course Objectives:

1. To understand the basic functions of management.
2. To know the basic qualities of a manager so that they can be utilized in practical situation.
3. To develop understanding of basic know-how of industrial planning, market assessment, future projections, etc.

Course Outcome:

Skills that students obtain after completion of the course:

1. To prepare business plan and its execution according to market available.
2. Ability to dissect a problem in to its key features.
3. Apply the basic concepts of management to different situations.

Module I: Introduction to management — Meaning; its nature and purpose; management—science or art- justification; Functions of a manager; Qualities of a manager; Development of Management Thought: Classical, Neo-classical, Scientific Theory, Administrative Theory, Systems Theory & Contingency Theory; Social responsibility of a manager

Module II: Planning— Meaning, Nature & Purpose; Types of Plans; Steps in planning; objectives of planning; Management By Objectives- Meaning; Benefits & Weakness of Management By Objectives; Decision making and its importance; Factors to be considered for making effective decisions

Module III: Organizing-Meaning, Nature & purpose, Process of Organizing; Formal & Informal organizations- Meaning; Organization Structure: Meaning & types; Span of management- Meaning; Factors determining the span of management; Directing- Meaning , Process and Importance

Module IV: Staffing—Meaning and purpose; Process of staffing- Recruitment, Selection, Training, Placement, Performance Appraisal, Compensation and Benefits; leading—Meaning; Ingredients of leadership; leadership behavior & styles**.**

Module V : Controlling-Meaning & purpose, Steps to make an effective control; Control points & standards - Meaning & importance; Requirements of effective control; Control techniques - Meaning & types of control techniques.

Suggested Readings:

- Principles and practices of management by L. M. Prasad
- Management by Robbins
- Essentials of management by Harold Koontz and Heinz Weihrich
- Essentials of management by Koontz and O'donell
- Gupta, C. B., ''Management Concepts and Practices'', Sultan Chand and Sons. New Delhi.