FACULTY OF SCIENCE

SYLLABUS

FOR

B.Sc. (Honors) in Biotechnology (Semester System)
Under the Framework of Honors School System
(Regular Mode)

Choice Based Credit System (CBCS)

1st to 6th Semester

Department of Biotechnology,
Panjab University, Chandigarh

EXAMINATIONS 2019-20

--:O:--
B.Sc. (Honors) in Biotechnology (Semester System)  
Under the Framework of Honors School System

Choice Based Credit System (CBCS)

1\textsuperscript{st} to 6\textsuperscript{th} Semester

EXAMINATIONS 2019-20, 2020-21 & 2021-22
PREAMBLE

The Department of Biotechnology at Panjab University came into existence as Centre for Biotechnology in 1989. In 1994 it was upgraded to full-fledged Department with the support from DBT, Govt. of India. In 2001, the Department was the first one to start B.Sc. (Hons. School) course in Biotechnology in North India and offer five years integrated B.Sc. and M.Sc. (Hons. School) degree in Biotechnology. The Department is supported by DST (FIST & PURSE) and UGC (SAP) grants and has research collaborations with IMTECH Chandigarh, CSIO Chandigarh, PGIMER Chandigarh, ICGEB Delhi, IHBT Palampur, IIIM Jammu, NDRI Karnal and NBGAR Karnal. MoU has been signed with NABI, CIAB Mohali for collaborative research and teaching. Most of the faculty members have been trained abroad and have received prestigious national and international awards. The faculty of the Department publishes research papers in national and international journals of high impact. Most of the students enrolled for Ph.D. in the Department have their own fellowships. Good number of post graduate students qualifies NET (National Eligibility Tests UGC/CSIR) and join Ph.D. programs in premier research institutes of the country. Many students also go abroad to pursue their doctoral or post-doctoral work. Foreign students are also enrolled at PG and Ph.D. level through the cultural exchange program. Annual workshops/symposia/seminars are organized by the Department wherein eminent scientists are invited to deliver lectures and interact with students. The Department acts as a nodal agency to popularize biotechnology among the school and college students.

Vision of the department is to train human resource in the field of biotechnology and carry out research for the welfare of the society with the focus on environmental and health issues.

Major areas of research in the department are cancer epidemiology, cancer epigenetics, microbial and plant biotechnology.
## COURSE STRUCTURE

### SEMESTER I
<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>C 1</td>
<td>BTC-C 1: General Microbiology</td>
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<tr>
<td>C 2</td>
<td>BTC-C 2: Molecular Biology</td>
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<tr>
<td></td>
<td>BTC-AECC 1: English</td>
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<tr>
<td>GE 1*</td>
<td>Recombinant DNA Technology</td>
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<tr>
<td>C 3</td>
<td>BTC-C 3: Biomolecules</td>
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<td>BTC-C 5: Chemistry</td>
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<tr>
<td>C 6</td>
<td>BTC-C 6: Enzymology</td>
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<tr>
<td>C 7</td>
<td>BTC-C 7: Plant physiology</td>
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<tr>
<td>SEC 1</td>
<td>1. Molecular Diagnostics</td>
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<td></td>
<td>2. Basics of Forensic Science (anyone in semester III)</td>
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<tr>
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<td>BTC-C 8: Biochemistry and Metabolism</td>
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<tr>
<td>C 9</td>
<td>BTC-C 9: Bio Analytical Tools</td>
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<td>BTC-C 10: Bioprocess Technology</td>
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<tr>
<td>SEC 2</td>
<td>1. Biostatistics</td>
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<td>2. IPR, Bioethics and Biosafety (anyone in semester III)</td>
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<td>Animal Biotechnology</td>
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<tr>
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<td>BTC-C 11: Animal Biotechnology</td>
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<td>C 12</td>
<td>BTC-C 12: Recombinant DNA Technology</td>
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<tr>
<td>DSE 1 &amp; DSE 2</td>
<td>BTC-DSE 1: Developmental Biology</td>
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<td>C 14</td>
<td>BTC-C 14: Plant Biotechnology</td>
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<td>DSE 3 &amp; DSE 4</td>
<td>BTC-DSE 5: Ecology and Environment Management</td>
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<td>BTC-DSE 6: Microbial Physiology</td>
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<td>BTC-DSE 7: Medical Microbiology</td>
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<td>BTC-DSE 8: Food Biotechnology</td>
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C: Core Courses; GE: General Elective; AECC: Ability Enhancement Compulsory Courses; SEC: Skill Enhancement Courses; DSE: Discipline Specific Elective

*: GE subjects are to be selected by the students from the pool of GE Subjects offered by various Departments of the University.
GENERIC ELECTIVE SUBJECTS (*Offered by Biotechnology Department) for students of other departments

BTC-GE 1*: Recombinant DNA Technology  
BTC-GE 2*: Plant Biotechnology  
BTC-GE 3*: IPR, Bioethics and Biosafety  
BTC-GE 4*: Animal Biotechnology

**SKILL ENHANCEMENT COURSES (any one in semester III)

BTC-SEC 1: Molecular Diagnostics  
BTC-SEC 2: Basics of Forensic Science

**SKILL ENHANCEMENT COURSES (any one in semester IV)

BTC-SEC 3: Biostatistics  
BTC-SEC 4: IPR, Bioethics and Biosafety

**DISCIPLINE SPECIFIC ELECTIVES (any two in semester V)

BTC-DSE 1: Developmental Biology  
BTC-DSE 2: Environmental Biotechnology  
BTC-DSE 3: Bioinformatics  
BTC-DSE 4: Genetics

**DISCIPLINE SPECIFIC ELECTIVES (any two in semester VI)

BTC-DSE 5: Ecology and Environment Management  
BTC-DSE 6: Microbial Physiology  
BTC-DSE 7: Medical Microbiology  
BTC-DSE 8: Food Biotechnology

* Generic Elective courses offered by Department of Biotechnology for students of other Departments under CBCS programme.

** Offered by Department of Biotechnology for own students only. Courses under these will be offered only if a minimum of 10 students opt for the same.
B.Sc. (Honors) in Biotechnology (Semester System) Under the Framework of Honors School System

Choice Based Credit System (CBCS)

1st Year
(SEMESTER I & SEMESTER II)

COURSE STRUCTURE

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B.Sc. (Honors) in Biotechnology (Semester System)  
Under the Framework of Honors School System

Choice Based Credit System (CBCS)

SEMESTER I
OUTLINES OF TESTS

OBJECTIVE OF THE COURSE
To teach the fundamental concepts of Biotechnology and their applications. The syllabus pertaining to B.Sc. (Honors) Biotechnology (3 Year course & 6 Semesters) in the subject of Biotechnology under Honors School Framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills according to UGC module for CHOICE BASED CREDIT SYSTEM pertaining to B.Sc. Honors (Biotechnology).

Semester I

CORE COURSE (BIOTECHNOLOGY)
Theory Papers:
Core Course-1 (BTC-C 1) General Microbiology 100 Marks (4 credits)
Core Course-2 (BTC-C 2) Molecular Biology 100 Marks (4 credits)

Practicals:
Core Course-1 Practical (BTC-C 1 Lab): General Microbiology 50 Marks (2 credits)
Core Course-2 Practical (BTC-C 2 Lab): Molecular Biology 50 Marks (2 credits)

GENERIC ELECTIVE (BIOTECHNOLOGY)
Theory Papers:
Each student from other disciplines may opt any two of the Generic Electives (GE) offered by the Science Departments of Panjab University out of following:

Generic Elective -1 (BTC-GE 1) 100 Marks (4 credits)

Practicals:
Generic Elective -1 Practical (BTC-GE 1 Lab) 50 Marks (2 credits)

ABILITY ENHANCEMENT COMPULSARY COURSE FOR BIOTECHNOLOGY STUDENTS
Theory Papers:
Each student of Biotechnology Department has to opt one Ability Enhancement Compulsory Course (AECC) of the following:

1. English Communication (AECC 1) 50 Marks (2 credits)

650 Total Marks (26 Total credits)
GENERIC ELECTIVE

☐ Course under these will be offered only if a minimum of 10 students opt for the same
☐ Students of Biotechnology will opt for GE from course offered by other Department under CBCS programme.

CORE COURSES

BTC-C 1 (General Microbiology) course will be taught by Department of Microbiology under IBMSER programme.

BTC-C 2 (Molecular Biology) course will be taught by Department of Biotechnology under IBMSER programme.

EVALUATION

1. There shall be one Mid Term Examination of 20% Marks (20 Marks) in each semester.
2. End-semester examination will be of 80% of total Marks (80 Marks).
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% Marks (10 Marks). The final examination will be of 80% Marks (40 Marks).

Pattern of end-semester question paper

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt five questions.
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
(iii) The remaining eight questions will have Four Units comprising two questions from each Unit.
(iv) Students will attempt one question from each unit and the compulsory question.

Computation of Semester Grade Point Average (SGPA)

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SGPA=Total Credit point in the semester/total credits

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CORE COURSES (BIOTECHNOLOGY)
SEMESTER I
Total Lectures: 60
Credits: 4

Objective: To give an overview of fundamental and applied aspects of microbiology viz. history, microbial world and its diversity, taxonomy nomenclature, growth kinetics, metabolism, microbial genetics, antimicrobial agents and role of microorganisms in human health, environment, food and industries.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I
(15 Periods)

Introduction of Microbiology and Microbial Systematics
History and Development of Microbiology as a discipline, Scope and relevance Microscopy and observation of microbes: Light microscopy: bright field microscope, dark field microscope, phase contrast microscope, fluorescence microscope. Electron microscopy: The transmission electron microscope, Scanning electron microscope.
Systems of classification:
Binomial Nomenclature, Whittaker’s five kingdom and Carl Woese’s three kingdom classification systems and their utility. Numerical taxonomy, Phylogenetic and serotype classification. Difference between prokaryotic and eukaryotic microorganisms

UNIT II
(15 Periods)

Diversity of Microbial World
General characteristics of different microbes groups:
Acellular microorganisms (Viruses, Viroids, Prions)
Cellular microorganisms.
2a Bacteria: Characteristics of bacteria and occurrence: Prokaryotic bacterial cell structure and function; nutrition; growth kinetics. General principles of bacterial genetics, mutations, gene transfer and recombination
2b Algae: General characteristics of algae including occurrence, structure, reproduction. Applications in agriculture, industry, environment and food.
2c Fungi: General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, reproduction and applications in industry, agriculture, environment and food
2d Protozoa: General characteristics with special reference to Amoeba, Paramecium, Plasmodium, Leishmania and Giardia.
UNIT III  
(15 Periods)

**Microbes in Human Health & Environment**

**Medically important pathogens & beneficial microorganism:** Normal microflora of human body & its role in health. Causative agents for common human diseases, beneficial microorganisms counter acting the human pathogens and their interaction with the host. Antimicrobial chemotherapy: Drugs and their mechanism of action, antibiotic resistance and its transmission.

**Environmental microbiology:** microorganisms used as biodeterioration and bioremediation (e.g., hydrocarbons in oil spills). Water, air and sewage microbiology-an overview.

UNIT IV  
(15 Periods)

**Microbes in Industry and Foods**

**Industrial Microbiology:** Primary and secondary metabolites, types of fermentations and microbes producing important industrial products through fermentations. Batch, continuous and fed-batch cultivation. Genetic engineering of industrial microbes.

**Food and Dairy Microbiology:** Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non dairy based fermented food products) and probiotics. Microorganisms in food spoilage and food borne infections.

**BTC-C 1 General Microbiology**

**PRACTICALS**

Credits : 2

1. General Introduction and familiarization to important microbiological instruments in the laboratories.
2. Introduction to microscopes and their working.
3. Microorganisms are ubiquitous: Finger printing.
4. Introduction to sterilization: Dry heat and moist heat and filtration.
5. Simple staining, Gram staining, negative staining, cell wall staining, capsule staining, flagellar staining, acid fast staining, spore staining.
6. Preparation of media (nutrient broth and nutrient agar) for the growth of microorganisms.
7. General Methods: Pour plating, spread plating, streaking and dilutions.
8. Determine the size of bacteria.
9. Motility of bacteria: Hanging drop and soft agar
10. Isolation of microorganisms from different sources: Soil, curd, root nodules, sore throat.
11. Bacterial CFUs in mineral water bottle.
12. Phenol coefficient: To study the antibacterial effect of various chemical compounds.
13. To study the antibacterial effect of antibiotics.
SUGGESTED READING


SEMESTER I

BTC –C 2: (Molecular Biology) - To be taught by the Department of Biotechnology

THEORY

Total Lectures: 60
Credits: 4

Objective: To impart in depth knowledge of i) essential processes of replication, transcription and translation, ii) structure of DNA and mRNA iii) DNA damage and repair iv) regulation of gene expression

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I

DNA structure and replication
DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, the replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II

DNA damage, repair and homologous recombination
UNIT III (17 Periods)

Transcription and RNA processing

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains
Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5’ cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV (18 Periods)

Regulation of gene expression and translation

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, Posttranslational modifications of proteins

BTC-C2: (Molecular Biology)
PRACTICALS Credits: 2

1. Model building of different nucleotides and making A-T ,G-C pairs
2. Preparation of solutions for Molecular Biology experiments.
3. Isolation of chromosomal DNA from bacterial cells.
4. Estimation of DNA,RNA and Proteins
5. Agarose gel electrophoresis of genomic DNA
6. SDS polyacrylamide gel electrophoresis of protein samples
7. Study of lac operon

SUGGESTED READING

GENERIC ELECTIVE SUBJECTS
(*Offered by Biotechnology Department) for students of other departments
SEMESTER I

BTC-GE 1*: Recombinant DNA Technology
Objective: Recombinant DNA Technology refers to the process of manipulating the characteristics and functions of the original genes of an organism. The objective of this process is to introduce new physiological and physical features or characteristics. The students will learn the mechanism of introducing genes from one organism into the other and the potential implications of doing so.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I
(15 Periods)
Introduction to genetic engineering. Why gene cloning and DNA analysis is important? Molecular tools and applications- restriction enzymes, Restriction and modification system, restriction mapping. ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Vectors Systems (plasmids, λ phage biology and its vectors, M13 phage and its vectors, cosmid, phagemid, artificial chromosomes, Transformation, Microinjection, Electroporation,

UNIT II
(15 Periods)
Isolation and purification of DNA from bacteria, plants, animals and soil. Preparation and comparison of genomic and cDNA library, different strategies of gene cloning, linkers, adapters and homopolymer tailing, screening of recombinants: gene inactivation and blue white selection, Southern and Northern hybridization. Gene identification: Nucleic acid hybridization, immuno screening, functional complementation, DNA sequencing

UNIT III
(15 periods)
Gene expression: expression vectors with respect to different promoters (lac, tac, T5, T7, lamda), signal sequences (omp), tags (His, GST, MBP and IMPACT), selection of host with respect to promoter, Processing of recombinant proteins: soluble proteins, inclusion body, Protein refolding, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).
UNIT IV  
(15 periods)

Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR. Random and site-directed mutagenesis, PCR based cloning, Reporter assay, RNase protection assay, DNA fingerprinting, application of genetic engineering in animals and plants, Safety measures and regulations for recombinant work.

BTC –GE 1: (Recombinant DNA Technology)

PRACTICALS  
Credits: 2

1. Isolation of chromosomal DNA from plant cells
2. Qualitative and quantitative analysis of DNA using spectrophotometer
3. Plasmid DNA isolation
4. Restriction digestion of DNA
5. Making competent cells
6. Transformation of competent cells.
7. Replica plating and Blue white selection
8. Southern blotting
9. Demonstration of PCR

SUGGESTED READING

B.Sc. (Honors) in Biotechnology (Semester System)
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SEMESTER II
**Semester II**

**CORE COURSE (BIOTECHNOLOGY)**

**Theory Papers:**
- Core Course-1 (BTC-C 3) Biomolecules 100 Marks (4 credits)
- Core Course-2 (BTC-C 4) Cell Biology 100 Marks (4 credits)

**Practicals:**
- Core Course-1 Practical (BTC-C 3 Lab): Biomolecules 50 Marks (2 credits)
- Core Course-2 Practical (BTC-C 4 Lab): Cell Biology 50 Marks (2 credits)

**GENERIC ELECTIVE (BIOTECHNOLOGY)**

**Theory Papers:**
Each student from other disciplines may opt any two of the **Generic Electives (GE)** offered by the Science Departments of Panjab University out of following:

- Generic Elective -(BTC-GE 2) 100 Marks (4 credits)

**Practicals:**
- Generic Elective -1 Practical (BTC-GE 2 Lab) 50 Marks (2 credits)

**ABILITY ENHANCEMENT COMPULSORY COURSE FOR BIOTECHNOLOGY STUDENTS**

**Theory Papers:**
Each student of Biotechnology Department has to opt one **Ability Enhancement Compulsory Course (AECC)** of the following:
- Environmental Science (AECC 2) 50 Marks (2 credits)

**GENERIC ELECTIVE**
- [ ] Course under these will be offered only if a minimum of 10 students opt for the same
- [ ] Students of Biotechnology will opt for GE from course offered by other Department under CBCS programme.

**CORE COURSES**

- **BTC-C 3** (Biomolecules) course will be taught by Department of Biochemistry under IBMSER programme.
- **BTC-C 4** (Cell Biology) course will be taught by Department of Biophysics under IBMSER programme.

**EVALUATION**

1. There shall be one Mid Term Examination of 20% Marks (20 Marks) in each semester.
2. End-semester examination will be of 80% of total Marks (80 Marks).
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% Marks (10 Marks). The final examination will be of 80% Marks (40 Marks).
Pattern of end-semester question paper

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt five questions.

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CORE COURSES (BIOTECHNOLOGY)

SEMESTER II
Objective: To familiarize the students with major biomolecules namely carbohydrates, lipids, proteins and nucleic acids which are important for the structural organization and functions of the cells. The course encompasses the overall perspective on the biomolecules their characteristic properties and organization in carrying out all the living functions which constitute the life.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT 1 (15 Periods)
Carbohydrates

Introduction: Scope of Biochemistry and Molecular Biology. Molecular logic of living systems.
Water: Physical properties and hydrogen bonding of water, structure of liquid water, other properties of hydrogen bonding, solvent properties of water, ionization of water, ion product of water: The pH scale, Acids and Bases, Acid-Base indicators, Buffers.
Carbohydrates: Definition and classification, Families of monosaccharides, Stereoisomerism of monosaccharides, Mutarotation and the anomic forms of D-glucose. Action of acids and bases on monosaccharides. Structure and functions of important derivatives of monosaccharides, disaccharides, polysaccharides (Glycans); storage polysaccharides, structural polysaccharides.

UNIT II (15 Periods)
Lipids


UNIT III (15 Periods)
Proteins

**Peptide Bonds:** Rigid and planar nature of the peptide bond. Structure and function of some naturally occurring polypeptides. Chemical synthesis of polypeptide.

**Proteins:** Structural levels Primary, Secondary, Super Secondary structure (motifs) of proteins, Tertiary and Quaternary structures of proteins structure. Determination of primary structure of proteins.

**UNIT IV**

**Nucleic acids**


**Porphyrins:** Porphyrin nucleus and classification of porphyrins. Important porphyrins occurring in nature. Detection of porphyrins spectrophotometrically. Bile pigments – chemical nature and their physiological significance.

**BTC-C 3: Biomolecules**

**PRACTICALS**

1. Preparation of standard solution of HCl/ H₂SO₄.
2. Preparation of buffers of known molarity and pH.
3. Estimation of saponification value of fat/oil.
4. Estimation of iodine value of fat/oil.
5. Titration curve of an amino acid and determination of its pKa and isoelectric pH.
6. Isolation of casein from milk.
7. Isolation of starch from potato/gluten from wheat.
8. Qualitative tests for carbohydrates.
9. Qualitative tests for amino acids.
10. Separation of amino acids by thin layer chromatography.

**SUGGESTED READING**

Objective: Cell Biology deals with every detail of a cell including structure, function (cell physiology) and chemistry. It studies cell structure, cell composition, cell organelles and the interaction of cells with other cells and the larger environment in which they exist. The subject shall also provide an understanding of the survival strategies of organisms. The module on radiation biology will help to explore and gain insight into radiation-induced biological responses at molecular, cellular and tissue levels.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I

The organization of Cell

Introduction to Cell: Discovery of Cell, Shape & Size of cell, General organization of prokaryotic and eukaryotic cells

Structure and functions of various organelles:

Plasma Membranes: Theories regarding molecular architecture of plasma membranes. Chemical composition of biological membranes, structural specialization of the cell surface, extraneous coats of cell membranes.

Nucleus: Nuclear envelope- its structure, pore complex, nucleo-cytoplasmic interaction, nucleolus- structure and functions.


Ribosomes-nature of association with ER, distribution, macromolecular organization, origin and functions, protein synthesis.

Golgi complex: Morphology, chemical composition, role in cell secretion and acrosome formation, relationship with other cell organelles, polysaccharide synthesis, protein sorting and export from the Golgi apparatus.

Mitochondria: Structure, role in cellular metabolism, biogenesis of mitochondrial RNA and DNA, intra-mitochondrial protein synthesis. Functions of mitochondria.

Lysosomes: Cytological and biochemical characterization of lysosomes, lysosome formation, lysosomal polymorphism in relation to cytolysis, role in cell aging, cell autophagy and phagocytosis.

Peroxisomes: Peroxisome assembly, biochemical characterization of peroxisomes, functions of peroxisomes, physiological role of peroxisomes.
UNIT II

Cell Dynamics

**Cell growth and Division:** Overview of cell cycle, Cell division (mitosis and meiosis), Intra cellular control of cell cycle events, Cell growth, cell proliferation and Apoptosis, Apoptotic pathways-Intrinsic and extrinsic, role of caspases in apoptosis

**Membrane dynamics:** Membrane composition, membrane models, Transport of ions and molecules through cell membranes, Types of transport across cell membrane, passive diffusion, facilitated diffusion and protein mediated transport, active transport, basic principles of membrane potential, resting membrane potential, recording of membrane potential (patch-clamp), role of ion channels.

UNIT III

**Tools and Techniques in Cell Biology**

**Microscopy:** Light microscopy, Phase contrast microscopy, Dark field microscopy, polarizing microscopy, confocal microscopy, Electron Microscopy, Flow cytometry & cell sorting, specimen preparation for light and electron microscopy, Microtomes and Embedding, shadow casting, Negative & Positive staining, Freeze drying and free substitution, Chemical basis of staining.

**Cell Fractionation:** Centrifugation- types of centrifuges, principle and different types of centrifuges, differential or gradient centrifugation.

UNIT IV

Radiation Biology


**BTC-C4: Cell Biology**

**PRACTICALS**

Credits : 2

1. Visualization of animal and plant cells.
2. Staining and visualization of mitochondria by Janus green stain.
3. Identification of various stages of mitosis in onion root tip.
4. To study the polysaccharides by PAS staining technique in various tissue sections.
5. To study the osmotic fragility of RBCs in the blood.
6. To study the transport of phosphate in yeast cells.

**SUGGESTED READING**

GENERIC ELECTIVE SUBJECTS
(*Offered by Biotechnology Department) for students of other departments
SEMESTER II

BTC-GE 2*: Plant Biotechnology
Objective: The aim is to teach set of in vitro techniques, methods and strategies related to plant biotechnology. Students will learn how to create genetic variability for the improvement of crops, to improve the state of health of planted material and to increase the number of desirable germplasms for conservation and breeding experiments.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I
(15 Periods)
Introduction, Cryo and organogenic differentiation, Types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT II
(20 Periods)
Anther culture, Microspore culture andogenesis, Embryo culture, embryo rescue and synthetic seeds, Shoot-tip culture; rapid clonal propagation and production of virus-free plants.

Significance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT III
(15 Periods)
Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclature, methods, applications basis and disadvantages.

UNIT IV
(10 Periods)
Cryopreservation, slow growth and DNA banking for germ plasm conservation Arid and semi-arid plant biotechnology Role of plant tissue culture and biotechnology in agriculture, medicine and human welfare, prospects of genetic engineering of plants.
BTC –GE 2: (Plant Biotechnology)

PRACTICALS

Credits: 2

1. Preparation of simple growth nutrient (Knop’s medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog’s medium)
3. To selection, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation.

SUGGESTED READING

B.Sc. (Honors) in Biotechnology (Semester System)  
Under the Framework of Honors School System  

Choice Based Credit System (CBCS)  

2nd Year  
(SEMESTER III & SEMESTER IV)  

COURSE STRUCTURE

<table>
<thead>
<tr>
<th>SEMESTER III</th>
<th>SEMESTER IV</th>
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<tbody>
<tr>
<td><strong>C 5</strong></td>
<td><strong>C 8</strong></td>
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<tr>
<td>BTC-C 5: Chemistry</td>
<td>BTC-C 8: Biochemistry and Metabolism</td>
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<td><strong>C 7</strong></td>
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<tr>
<td>BTC-C 7: Plant Physiology</td>
<td>BTC-C 10: Bioprocess Technology</td>
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<tr>
<td><strong>SEC 1</strong></td>
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<tr>
<td>BTC-SEC 1: Molecular Diagnostics</td>
<td>BTC-SEC 3: Biostatistics</td>
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<tr>
<td>BTC-SEC 2: Basics of Forensic Science (Any one in semester III)</td>
<td>BTC-SEC 4: IPR, Bioethics and Biosafety (Any one in semester IV)</td>
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<tr>
<td><strong>GE 3</strong></td>
<td><strong>GE 4</strong></td>
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<tr>
<td>IPR, Bioethics and Biosafety</td>
<td>Animal Biotechnology</td>
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</tbody>
</table>
B.Sc. (Honors) in Biotechnology (Semester System)  
Under the Framework of Honors School System  

Choice Based Credit System (CBCS)  

SEMESTER III
Semester III
CORE COURSE (BIOTECHNOLOGY)

Theory Papers:
- Core Course-1 (BTC-C 5) Chemistry 100 Marks (4 credits)
- Core Course-2 (BTC-C 6) Enzymology 100 Marks (4 credits)
- Core Course-3 (BTC-C 7) Plant Physiology 100 Marks (4 credits)

Practicals:
- Core Course-1 (BTC-C 5 Lab) Chemistry 50 Marks (2 credits)
- Core Course-2 (BTC-C 6 Lab) Enzymology 50 Marks (2 credits)
- Core Course-3 (BTC-C 7 Lab) Plant Physiology 50 Marks (2 credits)

SEC: SKILL ENHANCEMENT COURSES (BIOTECHNOLOGY)

Theory Paper:
Each Biotechnology student may opt any one of the Skill Enhancement Courses offered by the Department of Biotechnology, Panjab University out of following:

Skill Enhancement Course-1 (BTC-SEC 1) 50 Marks (2 credits)

GENERIC ELECTIVE (BIOTECHNOLOGY)

Theory Papers:
Each student from other disciplines may opt any one of the Generic Electives (GE) offered by the Science Departments of Panjab University out of following:

Generic Elective -1 (BTC-GE 3) 100 Marks (4 credits)

Practicals:
Generic Elective -1 Practical (BTC-GE 3 Lab) 50 Marks (2 credits)

CORE COURSES
- BTC-C 5 (Chemistry) will be taught by Department of Chemistry.
- BTC-C 6 (Enzymology) & BTC-C 7 (Plant Physiology) will be taught by Department of Biotechnology.

SKILL ENHANCEMENT COURSE (SEC)
- Course under these will be offered only if a minimum of 10 students opt for the same
- Each Biotechnology student may opt any one of the Skill Enhancement Course (SEC 1) offered by the Department of Biotechnology, Panjab University.

GENERIC ELECTIVE
- Course under these will be offered only if a minimum of 10 students opt for the same
- Students of Biotechnology will opt for GE from course offered by other Department under CBCS programme.
EVALUATION

1. There shall be one Mid Term Examination of 20% Marks (20 Marks) in each semester.
2. End-semester examination will be of 80% of total Marks (80 Marks).
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% Marks (10 Marks). The final examination will be of 80% Marks (40 Marks).

Pattern of end-semester question paper

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt five questions.
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
(iii) The remaining eight questions will have **Four Units** comprising two questions from each Unit.
(iv) Students will attempt one question from each unit and the compulsory question.

**Computation of Semester Grade Point Average (SGPA)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
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<td>X= (Marks%/10)</td>
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\text{SGPA} = \frac{\text{Total Credit point in the semester}}{\text{total credits}}
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**Grade and Grade Points:**

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</table>
CORE COURSES (BIOTECHNOLOGY)

SEMESTER III
Semester III
BTC –C 5: (Chemistry)

THEORY

Total Lectures: 60

Credits: 4

Objective: To study the concepts of chemical thermodynamics, chemical equilibrium and their applications, to study about compounds of carbon, their sources, mechanism of reactions and utility in daily life and to study concepts of stereochemistry and spectra of organic molecules.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I
(15 Periods)

CHEMICAL THERMODYNAMICS AND CHEMICAL EQUILIBRIUM

Objectives and limitations of Chemical Thermodynamics, State functions, thermodynamic equilibrium, work, heat, internal energy, enthalpy.


Third law of thermodynamics: Absolute entropies.


UNIT II
(15 Periods)

Chemical Equilibrium:

General characteristics of chemical equilibrium, thermodynamic derivation of the law of chemical equilibrium, Van’t Hoff reaction isotherm. Relation between Kp, Kc and Kx. Temperature dependence of equilibrium constant-Van’t Hoff equation, homogeneous & heterogeneous equilibria, Le Chetaliuer’s principle.
Compounds of carbon

Differences in chemical and physical behaviour as consequences of structure. Discussion (with mechanism) of reactions of hydrocarbons’ ranging from saturated acyclic and alicyclic, unsaturated dienes and aromatic systems.
Huckel rule; as applied to 4n+2 systems. Industrial sources and utility of such compounds in daily life for medicine, clothing and shelter.

UNIT III

STEREOCHEMISTRY


UNIT IV

SPECTRA OF ORGANIC MOLECULES

Electronic spectra of diatomic molecules. Introduction to Infrared, Ultraviolet/Visible and Proton NMR Spectroscopy. Use of these spectroscopic techniques in identification of various functional groups. Structure elucidation of simple organic molecules.

SUGGESTED READING

BTC –C 5: (Chemistry)

PRACTICALS

Credits: 2

1. Analysis of the given mixture containing six radicals with at least one interfering (PO₄ 3-Oxalate, Tartarate).
2. Volumetric Analysis:
   a. Acid-Alkali/Base: Involving use of one of one indicator and two indicators.
   b. Oxidation-Reduction: KMnO₄/K₂Cr₂O₇ Titrations.

Semester III
BTC –C 6: (Enzymology)

THEORY

Total Lectures: 60

Credits: 4

Objective: To learn the basic principles of enzymology to know how enzymes functions in the biological systems and strategies/applications of enzyme technology in industries.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Unit I

(20 Periods)

Introduction to Enzymes: Definition, historical perspectives, systematic nomenclature & classification, significance of numbering system, coenzyme, cofactors.

Specificity of enzyme action: Types of specificity, hypothesis (lock-and-key, induced fit, strain or transition-state stabilization), Investigation of active site structure: By trapping of enzyme-substrate complex, use of substrate analogues, enzyme modification by chemical procedures affecting amino acid side chains, treatment with proteases and site-directed mutagenesis, by studying the effect of changing pH. Mechanism of action of serine protease, lysozyme and chymotrypsin, GPDH, aldolase, RNAse, Carboxypeptidase and alcohol dehydrogenase.

Unit II

(15 Periods)

Enzyme kinetics: Factors affecting enzyme activity (Enzyme concentration, substrate concentration, pH, temperature and reaction time etc.).


Enzyme inhibition, determination of Ki, suicide inhibitors. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid base, nucleophilic and covalent catalysis.
Unit III  (13 Periods)


Unit IV  (12 Periods)

Enzyme immobilization/modification/applications

Immobilization of microbial enzymes- Immobilized enzymes and their comparison with soluble enzymes. Methods viz. adsorption, entrapment & membrane confinement, covalent bonding and their analytical, health & industrial applications. Properties of immobilized enzymes. Enzyme electrodes. Site directed mutagenesis & Enzyme engineering- Adding disulfide bonds, changing asparagines to other amino acids, reducing free sulphydryl residues, increasing enzyme activity, modifying enzyme specificity (selected examples).

Artificial enzymes, degradation of unnatural substrates and catalytic antibodies. Clinical and industrial applications of enzymes– Detergent, food, leather, dairy and medicine industries.

BTC –C 6: (Enzymology)

PRACTICALS

Credits: 2

1. Extraction of enzymes from bacteria/plants and check their activity.
2. Effect of pH on the activity of enzyme and pH stability.
3. Effect of temperature on the activity of enzyme and thermostability.
4. Effect of reaction time on the activity of enzyme.
5. Effect of metals on the activity of enzyme.
6. Calculation of kinetic parameters such as Km, Vmax, Kcat
7. Immobilization of enzymes and check their usability.
8. Differentiation of isozymes by gel electrophoresis.

SUGGESTED READING


**Semester III**

**BTC-C 7: (Plant physiology)**

**THEORY**

**Total Lectures: 60**

**Credits: 4**

**Objective:** This course will deal with various processes such as plant taxonomy, water relations, mineral nutrition, photosynthesis, respiration, nitrogen metabolism and end up with growth control by hormones and plant adaptation to various stresses. Practical skills will be imparted to the students through critically designed practicals related to the subject.

**Instructions for the Paper Setters and Examiners:**

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

**UNIT I**

(10 Periods)

**Anatomy**

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

**UNIT II**

(12 Periods)

**Plant water relations and micro & macro nutrients**

Plant water relations: Importance of water to plant life, Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration, stomata & their mechanism of opening & closing, mechanisms of loading and unloading of photoassimilates. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

**UNIT III**

(20 Periods)

**Carbon metabolism and assimilation of mineral nutrients**

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point. Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants, Sulphur, phosphate and cation assimilation in plants.
UNIT IV (18 Periods)

Growth and development

Growth and development: Definitions, phases of growth, growth curve, physiological effects and mode of action of phytohormones (auxins, cytokinins, gibberellins, abscissic acid and ethylene)
Embryo development and seed germination, seed dormancy, concept of photoperiodism and vernalization.

BTC-C 7: (Plant physiology)

PRACTICALS

Credits: 2

2. Preparation of stained mounts of anatomy of monocot and dicot’s roots.
3. Preparation of stained mounts of anatomy of monocot and dicot’s stem.
4. Preparation of stained mounts of anatomy of monocot and dicot’s leaf.
5. Demonstration of plasmolysis by Tradescantia leaf peel.
6. Demonstration of opening & closing of stomata
7. Demonstration of guttation on leaf tips of grass and garden nasturtium.
8. TS section cutting of stems and analysis of cytoplasmic streamings.
9. Test for minerals present in plant tissues.
10. Separation of photosynthetic pigments by paper chromatography.
11. Demonstration of aerobic respiration.

SUGGESTED READING

SKIL ENHANCEMENT COURSES (Offered by Biotechnology Department) *for biotechnology students only* SEMESTER III

<table>
<thead>
<tr>
<th>BTC-SEC 1: Molecular Diagnostics</th>
<th>BTC-SEC 2: Basics of Forensic Science</th>
<th>Any one in semester III</th>
</tr>
</thead>
</table>


Objective: The objective of this course is learning and understanding how molecular techniques that were studied in other classes can be developed and utilized in diagnosis and sold in diagnostic kits. Students will cover the principles of Molecular Diagnosis which is the process of identifying a disease by studying molecules, such as proteins, DNA, and RNA, in a tissue or fluid. Molecular diagnostics is a new discipline that captures genomic and proteomic expression patterns and uses the information to distinguish between two or more conditions at the molecular level.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I (15 Periods)
Enzyme Immunoassays:

UNIT II (15 Periods)

UNIT III (18 Periods)

UNIT IV (12 Periods)
GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.
SUGGESTED READING

BTC-SEC 2: (Basics of Forensic Science)  
THEORY

Total Lectures: 60  
Credits: 2

Objective: The objective of the paper is to introduce the scientific principles involved in forensic science and to understand techniques of identifying various physical evidences found at crime scenes such as firearms, ammunition, handwriting and DNA fingerprinting.

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Unit I  
(15 Periods)

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Unit II  
(15 Periods)

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.
Unit III  (15 Periods)

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of fingerprint as science for personal identification,

Unit IV  (15 Periods)


SUGGESTED READING

GENERIC ELECTIVE SUBJECT
(*Offered by Biotechnology Department) for students of other departments
SEMESTER III

BTC-GE-5*: IPR, Bioethics and Biosafety
Objective: This course will also make the students aware of the a) law pertaining to biotechnology, how to apply for national/international patent, Biotech agreements between various countries etc.(b) ethical issues concerned with the field of Biotechnology, (c) bioterrorism and (d) ways to handle/dispose-of biohazard material.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I (15 Periods)

UNIT II (20 Periods)

UNIT III (10 Periods)
Biosafety – Introduction to biosafety and health hazards concerning biotechnology, The Cartagena protocol on biosafety. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

UNIT IV (15 Periods)
Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies. Bioterrorism, Social and ethical implication of biological weapons

BTC-GE 5: (I.P.R., Bioethics & Biosafety)
PRACTICALS Credits: 2

1. Searching of Patent databases
   a. Indian Patent office
   b. USPTO
   c. WIPO

2. Drafting and filing of Patent application. a. In India
   b. In USA
   c. Under PCT
3. Case studies on the patent infringements and revocations
4. Case studies on compulsory licensing.
5. Understanding the Structure and working of Biosafety and Bioethical committees.
6. Drafting and filing application for biosafety and bioethical clearance.

SUGGESTED READING
B.Sc. (Honors) in Biotechnology (Semester System) Under the Framework of Honors School System

Choice Based Credit System (CBCS)

SEMESTER IV
Semester IV

CORE COURSE (BIOTECHNOLOGY)

Theory Papers:
- Core Course-1 (BTC-C 8) Biochemistry and Metabolism 100 Marks (4 credits)
- Core Course-2 (BTC-C 9) Bio Analytical Tools 100 Marks (4 credits)
- Core Course-3 (BTC-C 10) Bioprocess Technology 100 Marks (4 credits)

Practicals:
- Core Course-1 (BTC-C 8 Lab) Biochemistry & Metabolism 50 Marks (2 credits)
- Core Course-2 (BTC-C 9 Lab) Bio Analytical Tools 50 Marks (2 credits)
- Core Course-3 (BTC-C 10 Lab) Bio Process Technology 50 Marks (2 credits)

SEC: SKILL ENHANCEMENT COURSES (BIOTECHNOLOGY)

Theory Paper:
Each Biotechnology student may opt any one of the Skill Enhancement Courses offered by the Department of Biotechnology, Panjab University out of following:

- Skill Enhancement Course-2 (BTC-SEC 2) 50 Marks (2 credits)

GENERIC ELECTIVE (BIOTECHNOLOGY)

Theory Papers:
Each student from other disciplines may opt any one of the Generic Electives (GE) offered by the Science Departments of Panjab University out of following:

- Generic Elective -1 (BTC-GE 4) Animal Biotechnology 100 Marks (4 credits)

Practicals:
Generic Elective -1 Practical (BTC-GE 4 Lab) 50 Marks (2 credits)

650 Total Marks (26 Total credits)

CORE COURSES

- BTC-C 8 (Biochemistry and Metabolism), BTC-C 9 (Bio Analytical Technique) & BTC-C 10 (Bioprocess Technology) will be taught by Department of Biotechnology.

SKILL ENHANCEMENT COURSE (SEC)

- Course under these will be offered only if a minimum of 10 students opt for the same
- Each Biotechnology student may opt any one of the Skill Enhancement Course (SEC 2) offered by the Department of Biotechnology, Panjab University.

GENERIC ELECTIVE

- Course under these will be offered only if a minimum of 10 students opt for the same
- Students of Biotechnology will opt for GE from course offered by other Department under CBCS programme.
EVALUATION

1. There shall be one Mid Term Examination of 20% Marks (20 Marks) in each semester.
2. End-semester examination will be of 80% of total Marks (80 Marks).
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% Marks (10 Marks). The final examination will be of 80% Marks (40 Marks).

Pattern of end-semester question paper

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt five questions.
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
(iii) The remaining eight questions will have Four Units comprising two questions from each Unit.
(iv) Students will attempt one question from each unit and the compulsory question.

Computation of Semester Grade Point Average (SGPA)

<table>
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<td>X= (Marks%/10)</td>
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SGPA=Total Credit point in the semester/total credits

Grade and Grade Points:

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<td>4</td>
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</tbody>
</table>
Objective: To introduce the concepts underlying the cellular biochemistry, understanding how these processes are integrated to carry out highly coordinated cellular functions and understand the resulting disease processes. Practical skills will be imparted to the students through critically designed practicals related to the subject.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Unit I (15 periods)
Nitrogen Metabolism: Reduction and assimilation of atmospheric nitrogen, Biosynthesis and degradation of amino acids; amino acids as precursors of heme; biogenic amines; biosynthesis and degradation of nucleic acids. Nucleic acid biosynthesis and degradation.
Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methylmalonic acidemia (MMA), homocystinuria and Hartnup’s disease.

Unit II (15 periods)
Metabolism: Metabolic pathways, biochemical reaction mechanism, energy rich metabolites. Carbohydrate metabolism: Biosynthesis and degradation of carbohydrates; feed pathways for glycolysis; Kreb’s cycle, enzymes of Kreb’s cycle, amphibolic nature of the Kreb’s cycle; Kreb’s cycle regulation of carbohydrate metabolism. Disorders of carbohydrate metabolism like diabetic ketoacidosis, hyperosmolar coma, and hypoglycemia,

Unit III (15 periods)
Lipid Metabolism: Biosynthesis and degradation of fatty acids; metabolism of triacylglycerols; cholesterol metabolism, complex lipids. β oxidation, peroxisomal oxidation, ω oxidation, ketone bodies metabolism, ketoacidosis. Biosynthesis of plasmalogens, sphingolipids and glycolipids, lipid storage diseases.

Unit IV (15 periods)
Vitamins and Hormones: Types of vitamins – structure of water soluble vitamins and their coenzyme derivatives, Fat soluble vitamins Deficiency symptoms and dietary sources. Steroid Hormones: structure and importance.
**Peptide Hormones:** structure and function of important peptide hormones. Hormone mediated signalling and hormone disorders like diabetes, addison’s disease, osteoporosis

**ESSENTIAL READING**

**FURTHER READINGS**

**BTC –C 8 (Biochemistry and Metabolism)**

**PRACTICALS**
2. Preparation of normal and molar solutions.
3. Determination of blood glucose
4. Determination of vitamin C concentration in lemon juice
5. TLC analysis of carbohydrates, lipids
6. Estimation of vitamin A
7. Determination of amino acid in solution using ninhydin reagent.
8. Determination of DNA concentration
9. Ammonium sulphate fractionation of proteins from plants
10. Assay of salivary amylase

**BTC –C 9 (Bio Analytical Tools)**

**THEORY**

Total Lectures: 60

**Objective:** To understand the principles and instrumentations to investigate the biological properties and functions of the biomolecules/macromolecules.

**Instructions for the Paper Setters and Examiners:**

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

**UNIT I**

Microscopy: Fixation and staining, simple, compound, phase contrast microscopy, florescence, electron microscopy (TEM and SEM), and atomic force microscopy.
Spectroscopy: Absorption and emission - UV, Visible, IR, NMR, ORD/CD, atomic absorption and plasma emission spectroscopy, X-ray diffraction.

UNIT II (10 Periods)

Potentiometry: Fundamentals of Potentiometry, pH scale, pH calculation, pH measurement, reference electrodes, glass electrode, metal electrode and buffer solutions.

Centrifugation techniques: Basic principle of centrifugation, different types of centrifuges and their uses, preparative and analytical ultra-centrifuges, types of rotors: swing bucket and fixed angle rotors, separation by differential and density gradient centrifugation.

UNIT III (15 Periods)

Protein purification and analysis: Defining the purpose of purification and analysis, source of biological material, extraction, clarification and concentration of proteins, specific activity, criteria of purity.

Purification and analysis based on physical properties (chromatography techniques): Principle, operations and applications of Affinity chromatography, ion exchange chromatography, hydrophobic interaction chromatography, size exclusion chromatography, gas chromatography, HPLC, thin layer chromatography.

UNIT IV (20 Periods)

Separation and analysis by electrophoresis: General principle, support media, types of electrophoresis, polyacrylamide gel (native and SDS-PAGE), iso electric focusing, 2D-PAGE, Western blotting. Agarose-gel electrophoresis, pulse field gel electrophoresis.

Radioisotopy: Principles and applications of tracer techniques in biology, radioactive isotopes and half life of isotopes, Autoradiography, Liquid scintillation spectrometry.

BTC –C 9 (Bio Analytical Tools)

PRACTICALS Credits: 2

1. Preparation of buffers of different pH & concentration.
2. Labs visit to know types, functions and applications of spectrophotometers/colorimeter.
3. Determine the absorption spectra of a biological sample with single/double beam spectrophotometer & verification of Beer’s Lambert law.
5. Native gel electrophoresis of proteins
6. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
7. Labs visit to know types, functions and applications of centrifuges and how to convert RPM to RCF?
8. Demonstration of the sub-cellular fractions of rat liver cells by audio visual aids.
9. To identify amino acids in a given sample by TLC.
11. Demonstration of working of SEM/TEM.

SUGGESTED READING


**Semester IV**

**BTC –C 10 (Bioprocess Technology)**

**THEORY**

**Total Lectures: 60**

**Credits: 4**

**Objective:** The students will be exposed to the fermentation technology, types of fermentations, design of fermenters and the energetics of microbial growth in fermenters. They will be introduced to the upstream and downstream processing. Practical skills will be imparted to the students through critically designed practicals related to the subject.

**Instructions for the Paper Setters and Examiners:**

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

**UNIT I**

(15 Periods)


**UNIT II**

(20 Periods)

Design of bioprocess vessels—Significance of Impeller, Baffles, Sparger; Types of culture/production vessels—Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing—Media preparation, inocula development and sterilization.

**UNIT III**

(15 Periods)

Introduction to oxygen requirement in bioprocess; heat and mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control. Energetics of microbial growth in fermenters: Reaction rates, transport phenomenon in reactors, and energy flow.
UNIT IV
(10 Periods)

Introduction to downstream processing, product recovery and purification. Microbial production of ethanol, amylase, lactic acid, penicillin, single cell proteins and baker’s yeast.

BTC –C 10 (Bioprocess Technology)

PRACTICALS

Credits: 2

1. Isolation of industrially important lipolytic microorganisms from natural resource.
2. Batch fermentation using shake-flask for ethanol production by Saccharomyces cerevisiae.
3. Determination of growth pattern, cell number and wet mass of Saccharomyces cerevisiae culture during shake-flask fermentation.
5. Assay for product formation during shake flask fermentation.

SUGGESTED READING

SKIL ENHANCEMENT COURSES (Offered by Biotechnology Department) *for biotechnology students only* SEMESTER IV

<table>
<thead>
<tr>
<th>BTC-SEC 3: Biostatistics</th>
<th>BTC-SEC 4: IPR, Bioethics and Biosafety</th>
<th>Any one in semester IV</th>
</tr>
</thead>
</table>


Semester IV
SKILL ENHANCEMENT COURSES (any one in semester IV)
BTC-SEC 3: (Biostatistics)

THEORY

Total Lectures: 60 Credits: 2

Objective: To teach a) applications of statistics in the field of biology, b) concepts of probability, averages, distributions, tests of deviations, correlation and linear regression and c) to design experiments and analysis of results by tests of significance or analysis of variance.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I
(12 Periods)
Statistical population, sample from population, random sample. Tabular and graphical presentation, Measures of central tendency, mean and standard deviation of grouped and ungrouped data, probability, relative frequency, distribution, binomial, poisson and normal distributions. Measures of Skewness and Kurtosis.

UNIT II
(18 Periods)
Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Tests of deviations, F and Z residuals, precision, measure of precision, probable error of function, rejection of observations

UNIT III
(18 Periods)
Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV
(12 Periods)
Design of experiments, randomization, replication, local control, completely randomized and randomized block design Correlation and Regression. Emphasis on examples from Biological Sciences.

SUGGESTED READING
BTC-SEC 4: (I.P.R., Bioethics & Biosafety)

THEORY

Total Lectures: 60

Credits: 2

Objective: This course will also make the students aware of the a) law pertaining to biotechnology, how to apply for national/international patent, Biotech agreements between various countries etc. (b) ethical issues concerned with the field of Biotechnology, (c) bioterrorism and (d) ways to handle/dispose-of biohazard material.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I (15 Periods)

UNIT II (20 Periods)

UNIT III (10 Periods)
Biosafety – Introduction to biosafety and health hazards concerning biotechnology, The Cartagena protocol on biosafety. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

UNIT IV (15 Periods)
Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies. Bioterrorism, Social and ethical implication of biological weapons

SUGGESTED READING
GENERIC ELECTIVE SUBJECT (*Offered by Biotechnology Department) for students of other departments
SEMESTER IV

BTC-GE 4*: Animal Biotechnology
Objective: The major emphasis of this course is to introduce the students to the fields of Animal cell-culturing and their importance to mankind. The students will also learn the techniques involved in organ/animal cloning and biodiversity conservation.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I
(10 Periods)

Equipments and materials for animal cell culture technology. Primary and established cell line cultures. Introduction to the balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements. Measurement of viability and cytotoxicity, cryopreservation

UNIT II
(10 Periods)


UNIT III
(20 Periods)


UNIT IV
(20 Periods)


BTC –GE4: (Animal Biotechnology)

PRACTICALS

1. Fumigation of cell culture lab, sterilization of glassware and equipment
2. Preparation of cell culture media and trypsin solution
3. Observation of adherent (Fibroblastic, epithelial) and suspension cultures (Lymphoblast)
4. Cell counting by haemocytometer and plating of cells at 40%, 60% and 80% confluency.
5. Subculturing
6. Cryopreservation of cell lines
7. Revival of frozen stocks of cell lines
8. Estimation of cell viability by dye exclusion (Trypan blue).
SUGGESTED READING
B.Sc. (Honors) in Biotechnology (Semester System)
Under the Framework of Honors School System

Choice Based Credit System (CBCS)

3rd Year
(SEMESTER V & SEMESTER VI)

COURSE STRUCTURE

<table>
<thead>
<tr>
<th>SEMESTER V</th>
<th>SEMESTER VI</th>
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<tbody>
<tr>
<td>C 11</td>
<td>BTC-C 11: Animal Biotechnology</td>
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<tr>
<td>C 12</td>
<td>BTC-C 12: Recombinant DNA Technology</td>
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<tr>
<td>DSE 1 &amp; DSE 2</td>
<td>BTC-DSE 1: Developmental Biology</td>
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<td>BTC-DSE 2: Environmental Biotechnology</td>
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<td>BTC-DSE 3: Bioinformatics</td>
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<td>BTC-DSE 4: Genetics (Any two in Semester V)</td>
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</table>

C: Core Courses; DSE: Discipline Specific Elective
Semester V

CORE COURSE (BIOTECHNOLOGY)

Theory Papers:
Core Course-1 (BTC-C 11) Animal Biotechnology 100 Marks (4 credits)
Core Course-2 (BTC-C 12) Recombinant DNA Technology 100 Marks (4 credits)

Practicals:
Core Course-1 (BTC-C 11 Lab) Animal Biotechnology 50 Marks (2 credits)
Core Course-2 (BTC-C 12 Lab) Recombinant DNA Technology 50 Marks (2 credits)

DSE: DISCIPLINE SPECIFIC ELECTIVES (BIOTECHNOLOGY)

Theory Paper:
Each Biotechnology student may opt any two of the Discipline Specific Electives offered by the Department of Biotechnology, Panjab University out of following:

Discipline Specific Electives-1 (BTC-DSE 1) 100 Marks (4 credits)
Discipline Specific Electives-2 (BTC-DSE 2) 100 Marks (4 credits)

Practicals:
Discipline Specific Electives-1 (BTC-DSE 1 Lab) 50 Marks (4 credits)
Discipline Specific Electives-2 (BTC-DSE 2 Lab) 50 Marks (4 credits)

600 Total Marks (24 Total credits)

DISCIPLINE SPECIFIC ELECTIVES

☐ Course under these will be offered only if a minimum of 10 students opt for the same
☐ Each Biotechnology student may opt any two of the Discipline Specific Electives offered by the Department of Biotechnology, Panjab University.

CORE COURSES

☐ BTC-C 11 (Animal Biotechnology) and BTC-C 12 (Recombinant DNA Technology) will be taught by Department of Biotechnology.

EVALUATION

1. There shall be one Mid Term Examination of 20% Marks (20 Marks) in each semester.
2. End-semester examination will be of 80% of total Marks (80 Marks).
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% Marks (10 Marks). The final examination will be of 80% Marks (40 Marks).
Pattern of end-semester question paper

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt five questions.
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
(iii) The remaining eight questions will have **Four Units** comprising two questions from each Unit.
(iv) Students will attempt one question from each unit and the compulsory question.

**Computation of Semester Grade Point Average (SGPA)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
<th>Grade Point</th>
<th>Credit Point</th>
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<tbody>
<tr>
<td>4+2=6</td>
<td>X= (Marks%/10)</td>
<td>6X</td>
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</table>

SGPA=Total Credit point in the semester/total credits

**Grade and Grade Points:**

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<tr>
<th>Letter Grade</th>
<th>O</th>
<th>A⁺</th>
<th>A</th>
<th>B⁺</th>
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<td>7</td>
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<td>4</td>
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</tbody>
</table>
CORE COURSES (BIOTECHNOLOGY)

SEMESTER V
Objective: The major emphasis of this course is to introduce the students to the fields of Animal cell-culturing and their importance to mankind. The students will also learn the techniques involved in organ/animal cloning and biodiversity conservation.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I (10 Periods)
Equipments and materials for animal cell culture technology. Primary and established cell line cultures. Introduction to the balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements. Measurement of viability and cytotoxicity, cryopreservation.

UNIT II (10 Periods)

UNIT III (20 Periods)

UNIT IV (20 Periods)

BTC –C 11: (Animal Biotechnology) PRACTICALS

Credits: 4
1. Fumigation of cell culture lab, sterilization of glassware and equipment
2. Preparation of cell culture media and trypsin solution
3. Observation of adherent (Fibroblastic, epithelial) and suspension cultures (Lymphoblast)
4. Subculturing
5. Cell counting by haemocytometer and plating of cells at 40%, 60% and 80% confluency.
6. Cryopreservation of cell lines
7. Revival of frozen stocks of cell lines
8. Estimation of cell viability by dye exclusion (Trypan blue) and dye uptake (fluorescein diacetate) test
9. Determination of the IC50 value of a drug using MTT assay

SUGGESTED READING

Semester V
BTC-C 12: (Recombinant DNA Technology)

THEORY

Total Lectures: 60  
Credits: 4

Objective: Recombinant DNA Technology refers to the process of manipulating the characteristics and functions of the original genes of an organism. The objective of this process is to introduce new physiological and physical features or characteristics. The students will learn the mechanism of introducing genes from one organism into the other and the potential implications of doing so.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I  
(15 periods)


UNIT II  
(15 periods)

Isolation and purification of DNA from bacteria, plants, animals and soil. Preparation and comparison of genomic and cDNA library, different strategies of gene cloning, linkers, adapters and homopolymer tailing, screening of recombinants: gene inactivation and blue white selection, Southern and Northern hybridization. Gene identification: Nucleic acid hybridization, immuno screening, functional complementation, DNA sequencing
UNIT III (15 periods)

**Gene expression:** expression vectors with respect to different promoters (lac, tac, T5, T7, lamda), signal sequences (omp), tags (His, GST, MBP and IMPACT), selection of host with respect to promoter, Processing of recombinant proteins: soluble proteins, inclusion body, Protein refolding, Therapeutic products produced by genetic engineering-bLOOD proteins, human hormones, immune modulators and vaccines (one example each).

UNIT IV (15 periods)

Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT-(Reverse transcription) PCR. Random and site-directed mutagenesis, PCR based cloning, Reporter assay, RNase protection assay, DNA fingerprinting, application of genetic engineering in animals and plants, Safety measures and regulations for recombinant work.

**BTC –C 12: (Recombinant DNA Technology)**

**PRACTICALS**

Credits: 2

1. Isolation of chromosomal DNA
2. Qualitative and quantitative analysis of DNA
3. Plasmid DNA isolation/ analysis
4. Restriction digestion pattern of chromosomal and plasmid DNA/ size determination
5. Isolation and purification of DNA fragment from agarose gel
6. Ligation of restriction enzyme digested DNA fragments and vector
7. Preparation of competent cells
   a. For heat shock method
   b. Electrocompetent cells
8. Transformation of competent cells by heat shock method and electroporation/ transformation efficiency
9. Demonstration of alpha complementation and blue white selection
10. Conformation of recombinant plasmid
    i. By plasmid migration
    ii. Fragment analysis by restriction digestion
11. Southern blotting
12. Primer designing and demonstration of PCR

**SUGGESTED READING**

**DSE: DISCIPLINE SPECIFIC ELECTIVES (BIOTEchnology)**  
(Offered by Biotechnology Department) *for biotechnology students only*  
SEMESTER V

<table>
<thead>
<tr>
<th>BTC-DSE 1: Developmental Biology</th>
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<tr>
<td>BTC-DSE 2: Environmental Biotechnology</td>
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<tr>
<td>BTC-DSE 3: Bioinformatics</td>
<td>Any two in semester V</td>
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<tr>
<td>BTC-DSE 4: Genetics</td>
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</tbody>
</table>
Objective: This course has been designed to make the students understand a) the basic aspects of cell cycle and cell division, b) the principles of development processes and c) the development processes in various animal models, progressing from morphogenesis to organogenesis.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I
Gametogenesis, Fertilization and Early embryonic development

UNIT II
Embryonic Differentiation
Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting. Control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT III
Organogenesis
Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

UNIT IV
Morphogenesis and organogenesis in animals
Cell aggregation and differentiation in Dictyostelium discoideum; axes and pattern formation in Drosophila melanogaster. Organogenesis – vulva formation in Caenorhabditis elegans; environmental regulation of normal development; regeneration in vertebrates, sex determination.
BTC-DSE 1: Developmental Biology

PRACTICALS

Credits: 2

1. To prepare a slide for different stages for mitosis in onion root tip
2. To study the process of meiosis in barley bud
3. Study of life cycle of *C. elegans* from videos/photographs
4. Study of life cycle of *Dictyostelium discoideum* cells from videos/photographs
5. Study of the developmental stages of *Drosophila* from videos/photographs.

SUGGESTED READING


Semester V

DISCIPLINE SPECIFIC ELECTIVE (any two in semester V)

BTC-DSE 2: (Environmental Biotechnology)

THEORY

Total Lectures: 60

Credit: 4

Objectives: To understand the importance and types of environmental pollution, detection of mutagens. Biotechnological approaches to tackle environmental pollution. Practical skills will be imparted to the students through critically designed practicals related to the subject.

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Unit-I

(15 Periods)

Introduction: Historical importance.
Environment pollution and its types.
Impact of pollution on health

Unit-II

(15 Periods)

Treatment of waste water treatment, removal of nitrogen and phosphorus, disinfection.
Treatment of polluted air containing volatile toxic gases and biofiltration.
Introduction to toxicology including genetic toxicology, common assays to detect genotoxic compounds
Use of genetic engineering techniques in genetic toxicology.
Unit-III

Solid waste management by composting, vermicomposting, sanitary landfills, treatment of hazardous and bio-medical waste, management of E-waste Methanogenesis

Biodegradation of organic pollutants (organic solvents, pesticides)
Bioremediation (In situ and ex situ approaches)

Unit-IV

Remediation of metal contaminated soil and aquatic systems by microorganism and plants, mechanism of metal resistance and detoxification Biomining and bioleaching

Plastic menace, biodegradable plastics.
Biosafety levels

ESSENTIAL READINGS

FURTHER READINGS

BTC-DSE 2: (Environmental Biotechnology)

PRACTICALS
1. Estimation of dissolved oxygen in water samples
2. Determination of BOD in polluted water sample
3. Determination of COD in polluted water
4. Estimation of Chlorine in water samples
5. Detection of coliform bacteria in water samples
7. Estimation of SOX concentration.
8. Isolation of pesticide degrading micro organisms from soil
9. Biosorption of dyes from effluents by biomass and its recycling
BTC-DSE 3: (Bioinformatics)

THEORY

Total Lectures: 60
Credits: 4

Objective: This course lays emphasis on the role of computational tools in the field of biotechnology. The students will be exposed to various data basis pertaining to DNA, RNA and protein sequences

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I
(10 Periods)
History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II
(20 Periods)
Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT III
(20 Periods)
Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT IV
(10 Periods)
Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

BTC-DSE 3: (Bioinformatics)

PRACTICALS
Credits: 2

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,
3. Protein information resource (PIR)
4. Understanding and using: PDB, Swissprot, TREMBL
5. Using various BLAST and interpretation of results.
6. Retrieval of information from nucleotide databases.
7. Sequence alignment using BLAST.
8. Multiple sequence alignment using Clustal W.
SUGGESTED READING

BTC-DSE 4: (Genetics)
THEORY

Total Lectures: 60 Credits: 4

Objective: To develop basic skills in eliciting a genetic history, constructing a pedigree, examining, genetic evaluation and genetic counseling and to develop attitudes required for managing genetic diseases and birth defects.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I (15 Periods)


UNIT II (15 Periods)

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes. Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition—unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences-VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA. Genetic organization of prokaryotic and viral genome. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT III (15 Periods)

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of

UNIT IV

(15 Periods)

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

BTC-DSE 4: (Genetics)
PRACTICALS

Credits: 2

1. Probability distribution test.
2. To test the ‘Goodness of fit’ of the data using the Chi- Square statistical method.
3. Processing of human blood for chromosomal separation and karyotyping:
   b) sample processing and culturing
   c) arresting the cells at metaphase
   d) chromosome isolation
   e) slide preparation and staining with Giemsa
   f) visualizing and analysing the chromosomes
4. To arrange the human karyotype and identify the chromosomal disorders.
5. To explore the utility of OMIM search tool for human genetic diseases.
6. Nucleotide sequence search for the genetic diseases using the BLAST tool.

SUGGESTED READING

B.Sc. (Honors) in Biotechnology (Semester System) Under the Framework of Honors School System

Choice Based Credit System (CBCS)

SEMESTER VI

CORE COURSE (BIOTECHNOLOGY)

Theory Papers:
Core Course-1 (BTC-C 13) Immunology 100 Marks (4 credits)
Core Course-2 (BTC-C 14) Plant Biotechnology 100 Marks (4 credits)

Practicals:
Core Course-1 (BTC-C 13 Lab) Immunology 50 Marks (2 credits)
Core Course-2 (BTC-C 14 Lab) Plant Biotechnology 50 Marks (2 credits)

DSE: DISCIPLINE SPECIFIC ELECTIVES (BIOTECHNOLOGY)

Theory Paper:
Each Biotechnology student may opt any two of the Discipline Specific Electives offered by the Department of Biotechnology, Panjab University out of following:

Discipline Specific Electives-3 (BTC-DSE 3) 100 Marks (4 credits)
Discipline Specific Electives-4 (BTC-DSE 4) 100 Marks (4 credits)

Practicals:
Discipline Specific Electives-3 (BTC-DSE 3 Lab) 50 Marks (4 credits)
Discipline Specific Electives-4 (BTC-DSE 4 Lab) 50 Marks (4 credits)

600 Total Marks (24 Total credits)

DISCIPLINE SPECIFIC ELECTIVES

- Course under these will be offered only if a minimum of 10 students opt for the same
- Each Biotechnology student may opt any two of the Discipline Specific Electives offered by the Department of Biotechnology, Panjab University.

CORE COURSES

- BTC-C 13 (Immunology) and BTC-C 14 (Plant Biotechnology) will be taught by Department of Biotechnology.

EVALUATION

1. There shall be one Mid Term Examination of 20% Marks (20 Marks) in each semester.
2. End-semester examination will be of 80% of total Marks (80 Marks).
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% Marks (10 Marks). The final examination will be of 80% Marks (40 Marks).

**Pattern of end-semester question paper**

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt five questions.

(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.

(iii) The remaining eight questions will have Four Units comprising two questions from each Unit.

(iv) Students will attempt one question from each unit and the compulsory question.

**Computation of Semester Grade Point Average (SGPA)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
<th>Grade Point</th>
<th>Credit Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+2=6</td>
<td>X=(Marks%/10)</td>
<td>6X</td>
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SGPA=Total Credit point in the semester/total credits

**Grade and Grade Points:**

<table>
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<tr>
<th>Letter Grade</th>
<th>O</th>
<th>A+</th>
<th>A</th>
<th>B+</th>
<th>B</th>
<th>C</th>
<th>P</th>
<th>F</th>
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<tr>
<td>Grade Point</td>
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<td>9</td>
<td>8</td>
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<td>6</td>
<td>5</td>
<td>4</td>
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CORE COURSES (BIOTECHNOLOGY)

SEMESTER VI
Total Lectures: 60

Objectives: To learn the fundamental working knowledge of the basic principles of immunology and immunological techniques in prognosis/diagnosis.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I (20 Periods)

Cells of the immune system: Regulation of hematopoiesis and differentiation, blood composition and biochemical constituents of erythrocytes, leucocytes and platelets. Important plasma proteins and their functions. Lymphocyte trafficking, B-lymphocytes, T-lymphocytes (Cytotoxic T-cell, helper T-cell, suppressor T-cells), macrophages, dendritic cells, Natural killer cells and lymphocyte activated killer cells, eosinophils, neutrophils & mast cells.

B-cell generation, activation, and differentiation: B-cell maturation, B-cell activation and proliferation, Humoral response, regulation of the immune effector response.

UNIT II (15 Periods)
T-cells maturation, activation and differentiation: Structure and function of T-cell receptor, rearrangements of TCR genes, TCR diversity, TCR signalling. T-cell maturation and the thymus, thymic-selection of the T cell-repertoire, T-cell activation, T-cell differentiation, cell death and T-cell populations.

Organs of the immune system: Structure and functions of primary lymphoid organs (thymus, bone marrow) and secondary lymphoid organs (lymph nodes, spleen and various mucosal associated lymphoid tissues), Lymph and lymphatic system.

Antigens: Molecular basis of immunogenicity and antigenicity, factors effecting immunogenicity, nature of immunogen, epitopes (B-cell epitopes, T-cell epitopes), haptans and antigenicity, pattern recognition receptors. Chemical nature and mode of action of Adjuvants.

UNIT III (13 Periods)
Antibodies: Basic structure of antibodies as revealed by chemical and enzymatic methods, antibody binding site, antigen determinants on Immunoglobulins, different classes and their characteristics, structure in relation to function. The B-Cell receptor and the immunoglobulin super family.

Definition, nature, production methodology, advantages, disadvantages and applications of monoclonal and polyclonal antibodies.

UNIT IV (12 Periods)

Antigens-Antibody interactions: Strength of Ag-Ab interactions, cross reactivity, precipitation, reaction, passive bacterial agglutination and haemagglutination, Radioimmunoassay, enzyme linked immunosorbent assay (ELISA), western blotting, immunofluorescent assay, flow cytometry and fluorescence, alternative to Ag-Ab interaction, Immuno-electron microscopy.

MHC & Antigen presentation: Organization Major Histocompatibility complex (MHC) and inheritance, MHC molecules and genes, genetic map, cellular distribution, regulation of MHC expression, and disease susceptibility and immune responsiveness.

Self MHC restriction of T Cells, role of Antigen – processing cells, Antigen processing and presentation pathways: Cytosolic pathway, endocytic pathway, cross presentation of exogenous antigens and presentation of non-peptide antigens.

BTC –C 13 (Immunology)

PRACTICALS

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.
9. Rocket immuno-electrophoresis to determine the concentration of antigen in the test sample.
10. SDS-PAGE of serum proteins.

SUGGESTED READING

Objective: The aim is to teach set of in vitro techniques, methods and strategies related to plant biotechnology. Students will learn how to create genetic variability for the improvement of crops, to improve the state of health of planted material and to increase the number of desirable germplasms for conservation and breeding experiments.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I (15 Periods)
Introduction to Plant tissue culture: historical background, Cell differentiation and organogenesis,
Plant culture media and its components
Types of culture and their applications/advantages: Seed, Embryo, Micropropagation, Organs, Cell and Protoplast culture. Auxiliary bud proliferation, Meristem and shoot tip culture, bud culture, organogenesis, embryogenesis.

UNIT II (20 Periods)
Somatic embryogenesis, embryo rescue and synthetic seeds,
Anther culture, Microspore culture androgenesis, Significance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT III (15 Periods)
Protoplast isolation and fusion, Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations.
Somaclonal variations: induction of variations in culture, applications and disadvantages of somaclonal variations.

UNIT IV (10 Periods)
Cryopreservation, slow growth and DNA banking for germplasm conservation
Arid and semi-arid plant biotechnology
Role of plant tissue culture and biotechnology in agriculture, medicine and human welfare, prospects of genetic engineering of plants.
BTC –C 14: (Plant Biotechnology)
PRACTICALS

Credits: 2

1. Preparation of simple growth nutrient (knop’s medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog’s medium)
3. Sterilization and culturing of Nodal segment on MS media.
4. Significance of growth hormones in culture medium.
5. Embryo excision and culturing on media
6. Culturing of meristem tip for production of pathogen free plants.
7. Anther and ovule culture for production of haploid plants.
8. Isolation of single cells and its culturing in liquid medium
10. Endosperm culture for triploid plant production
11. Protoplast isolation for culturing and fusion.

BTC –C 14: (Plant Biotechnology)
PRACTICALS

Credits: 2

10. Preparation of simple growth nutrient (knop’s medium), full strength, half strength, solid and liquid.
11. Preparation of complex nutrient medium (Murashige & Skoog’s medium)
12. To selection, Prune, sterilize and prepare an explant for culture.
13. Significance of growth hormones in culture medium.
14. To demonstrate various steps of Micropropagation.

SUGGESTED READING

DSE: DISCIPLINE SPECIFIC ELECTIVES (BIOTECHNOLOGY) (Offered by Biotechnology Department) \textit{for biotechnology students only}

SEMESTER VI

| BTC-DSE 5: Ecology and Environment Management |
| BTC-DSE 6: Microbial Physiology               |
| BTC-DSE 7: Medical Microbiology              |
| BTC-DSE 8: Food Biotechnology                |

\textit{Any two in semester VI}
Semester VI
DISCIPLINE SPECIFIC ELECTIVE (any two in semester VI)

BTC-DSE 5: (Ecology and Environment Management)

THEORY

Total Lectures: 60

Credits: 4

Objective: To understand the ecological interactions of plant, microbial, animal systems and ecosystems at local and regional scales. Practical skills will be imparted to the students through critically designed practicals related to the subject.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I
(12 Periods)


UNIT II
(20 Periods)


UNIT III
(18 Periods)


UNIT-IV
(10 Periods)

Environmental biotechnologies, biotechnologies in protection and preservation of environment. Bioremediation, waste disposal.

BTC-DSE 5: (Ecology and Environment Management)
PRACTICALS

Credits: 2

1. Classification and Characteristics of Weeds
2. To understand the trophic levels in terrestrial and aquatic ecosystems
3. To study physical and chemical characteristics of sand, silt, and loamy soils
4. Qualitative analysis of plant populations
5. Analysis of haphazard and random area sampling methods in different plant communities
6. Plant Community – Data Analysis
7. Isolation and phenotypic analysis of microbial population in the rhizosphere
8. To study the negative interactions in microbes
SUGGESTED READING


**BTC-DSE 6: (Microbial Physiology)**

**THEORY**

Total Lectures: 60

Credits: 4

**Objective:** This course will enlighten the students with the world of microbes i.e. organisms invisible to human eye. It is a basic course in which students will learn the a) history of microbiology, b) types of microbes, c) metabolic processes of energy generation and utilization

**Instructions for the Paper Setters and Examiners:**

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

**UNIT I**

(12 Periods)

Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

**UNIT II**

(13 Periods)

Microbial Growth. Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxie growth curve. Measurement of microbial growth. Measurement of cell numbers, cell mass and metabolic activity
UNIT III  
(15 Periods)


UNIT IV  
(20 Periods)

Phototrophic metabolism. Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation, Calvin cycle and reductive TCA cycle.

BTC-DSE 6: (Microbial Physiology)

PRACTICALS

Credits: 2

1. To study and plot the growth curve of E. coli using turbidometric method and to calculate specific growth rate and generation time.
2. To test the omnipresence of micro organisms
3. Gram staining of the bacterial culture and microscopic examination.
4. To purify the bacterial culture using streaking and spread plating methods.
5. Examination of bacterial motility in liquid culture.
6. Serial dilutions and viable cell count
7. Staining of bacterial spore.
8. Methods of short term and long term culture preservation.

SUGGESTED READING

**Objectives:** The increasing incidence of microbial infections worldwide is being compounded by the rapid evolution of drug-resistant variants and opportunistic infections by other organisms. This course will provide comprehensive knowledge and practical training in the spread of microorganisms (predominantly bacterial, viral and fungal pathogens), disease causation and diagnosis and treatment of pathogens significant to public health.

**Instructions for the Paper Setters and Examiners:**
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

**UNIT I**
(18 Periods)
Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels. Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S. aureus*, *S. pyogenes*, *B. anthracis*, *C. perferinges*, *C. tetani*, *C. botulinum*, *C. diphtheriae*, *M. tuberculosis*, *M. leprae*.

**UNIT II**
(15 Periods)
Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E. coli*, *N. gonorrhoea*, *N. meningitidis*, *P. aeruginosa*, *S. typhi*, *S. dysenteriae*, *Y. pestis*, *B. abortus*, *H. influenzae*, *V. cholerae*, *M. pneumoniae*, *T. pallidum*, *M. pneumoniae*, *Rickettsiae*, *Chlamydiae*.

**UNIT III**
(12 Periods)
Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

**UNIT IV**
(15 Periods)
BTC-DSE 7: (Medical Microbiology)
PRACTICALS

Credits: 2

1. Isolation of normal microflora of human body.
2. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
3. To perform antibacterial testing by Kirby-Bauer method.
4. To prepare temporary mounts of Aspergillus and Candida by appropriate staining.
5. Staining methods: Gram’s staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

SUGGESTED READINGS

BTC-DSE 8: (Food Biotechnology)

THEORY

Total Lectures: 60

Objective: This course enlightens the students about the role of biotechnology in the Food Sector. The major emphasis is on a) the role of microbes in the preparation of traditional food, alcoholic beverages and single cell proteins; b) microbial diseases spread through foods and their detection techniques c) various strategies used for preservation of foods.

Instructions for the Paper Setters and Examiners:
Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Unit I
(15 Periods)

1. History background
2. Composition of food
3. Growth of microorganisms in food: Intrinsic and extrinsic factors
4. Traditional fermented foods: Bread, cocoa, coffee, tea, sauerkraut, cheese, butter, yoghurt, meat, fish, etc.

Unit II
(15 Periods)

1. Alcoholic beverages: Beer, wine and whisky
2. Value addition products: High fructose syrup, invert sugars etc.
3. Edible fungus: Mushrooms
Unit III
(15 Periods)

1. Single cell proteins: Spirulina, yeast *etc.* as food supplements
2. Improvement of food resources: Golden rice, Potato *etc.*
3. Food and water borne disease: Gastroenteritis, Diarrhea, Shigellosis, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis *etc.*

Unit IV
(15 Periods)

1. Food borne intoxications: Staphylococcal, Bacillus, Clostridium *etc.*
2. Detection of food borne pathogens.
3. Food preservation and storage

Suggested Readings


BTC-DSE 8: (Food Biotechnology)
PRACTICALS

Credits: 4

1. Estimation of casein content of milk
2. Estimation of lactose concentration in milk
3. Determination of pasteurization of milk by Alkaline phosphatase test
4. To check the microbial load in milk by Methylene blue dye reduction test
5. To enumerate microorganisms in food samples by Direct Microscopic Count
6. Isolation of Lactic Acid Bacteria from curd