

B.Sc. Biotechnology

Semester-I

BTP101 – Cell Biology and Genetics

Part A: Cell Biology

Unit1 Cell as a Basic unit of Living Systems.

Discovery of cells, The Cell theory.

Ultra structure of an eukaryotic cell (both plant and animal cells)

(3 hrs)

Unit 2 Surface Architecture

Structural Organization and functions of plasma membrane and cell wall of eukaryotes.

(4 hrs)

Unit 3 Cellular Organelles

Structure and function of cell organelles-Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Lysosomes, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, nucleolus, nucleoplasm and chromatin). Vacuole, Cytosol and Cytoskeletal structures. (Microtubules, Micro filaments and intermediate filaments).

(12 hrs)

Unit 4 Chromosomes

Discovery, morphology and structural organization-centromere, secondary constriction, telomere, chromonema, euchromatin and heterochromatin, chemical composition and karyotype.

Ultrastructure: Single stranded and multi stranded hypotheses, folded-fiber and nucleosome models. Special types of chromosomes: Salivary gland and Lampbrush chromosomes.

(6 hrs)

Unit 5 Cell Division

Cell cycle, mitosis and meiosis

(4 hrs)

Unit.6 Cell Motility

Amoeboid, ciliary and flagellar movements.

(2 hrs)

Unit 7 Cell Senescence and Programmed Cell Death

(2 hrs)

PART B: GENETICS

Unit 1.

Structure of DNA and RNA -a brief account

- (2 hrs)
- Unit 2. Mendelism**
Mendel's work, Laws of heredity, Test cross, Incomplete dominance and simple problems. (3 hrs)
- Unit 3. Interaction of Genes**
Supplementary factors: Comb pattern in fowls.
Complementary genes: Flower colour in sweet peas.
Multiple factors-Skin colour in human beings.
Epistasis: Plumage colour in poultry.
Multiple allelism: Blood group in human beings. (4 hrs)
- Unit 4. Sex Determination in Plants and animals**
Concept of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types. (2 hrs)
- Unit 5. Linkage and Crossing Over**
Coupling and repulsion hypothesis- Linkage in maize and Drosophila, Mechanism of crossing over and its importance. Chromosome mapping – linkage map in maize. (4 hrs)
- Unit 6. Chromosomal Variations**
A general account of structural and numerical aberrations, Chromosomal evolution of wheat and cotton. (4 hrs)
- Unit 7. Cytoplasmic Inheritance**
Plastid inheritance in Mirabilis, Petite characters in yeast and Kappa particles in Paramoecium. (2 hrs)
- Unit 8. Mutations**
Types: spontaneous and induced, Mutagens: Physical and chemical, Mutation at the molecular level. Mutations in plants, animal and microbes for economic benefit of man. (4 hrs)
- Unit 9. Human Genetics**
Karyotype in man, Inherited disorders-Allosomal (Klinefelter syndrome and Turner's Syndrome), Autosomal (Down syndrome and Cri-Du-Chat syndrome). (2 hrs)

BTP 102-Cell Biology and Genetics

Total units allotted: 15

1. Use of micrometer and calibration, measurements of onion cells and yeast 2 units
2. Cell division : Mitotic and meiotic studies in grasshopper testes, onion root tips and flower buds. 4 Units.
3. Chromosomes : Mounting of polytene chromosomes 1 Unit
4. Buccalsmear – Barr bodies. 1 Unit

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| 5. Karyotype Analysis – Man and Onion
Man Normal and Abnormal -Down and Turner’s syndromes
(with the help of slides) | 2 Units |
| 6. Simple genetics problems (Problem on Interaction of genes) | 1 Unit |
| 7. Isolation of chloroplast and mitochondria | 2 Units |
| 8. Vital Staining of mitochondria | 1 unit |
| 9. Blood smear –differential staining | 1 Unit |

EACH STUDENT IS REQUIRED TO SUBMIT 5 PERMANENT SLIDES
(MITOSIS & MEIOSIS- at least two from each)

SEMESTER II

BTP201- Microbiology and Biostatistics

Part A: Microbiology

Unit 1: Introduction and Scope of Microbiology

Definition and history of microbiology, contribution of Antony Van Leeuwenhoek , Louis Pasteur , Robert Koch, Joseph Lister, and Alexander Fleming.

Importance and Scope of Microbiology as a modern science.

Branches of Microbiology

5 Hour

Units 2- Microscopy

Construction and working principal of different types of microscope- Compound , Dark field, Phase contrast. Fluorescence and Electron (Scanning and Transmission)

Unit 3-Microbial Techniques

A) STERILISATION : Principal and applications of

- a. Physical Method : Autoclave, Hot air oven, Laminar airflow, Seitz filter, Sintered glass filter, and membrane filter.
- b. Chemical Method: Alcohol, Aldehydes, Phenols, Halogens and Gaseous agents. 5 hours
- c. Radiation Method: UV rays and Gamma rays.

B) STAINS AND STAINING TECHNIQUES: Principals of staining, Types of stains- Simple stains, Structural stains and Different stains

Unit 4. Microbial Taxonomy

Concept of microbial species and strains, classification of bacteria based on – morphology (shape and flagella), staining reaction , nutrition and extreme environment. 4 hours

Units 5. General Account of Viruses and Bacteria

A. VIRUSES – Structure and Classification

Plant viruses – CaMV
Animal viruses-hepatitis B
Bacterial virus- lambda phage

B. BACTERIA- Ultra structure of a bacterial cell (both Gram positive and Gram negative) including endospore and capsule. 8 hours

Unit 6. Eukaryotic microorganisms

Salient features, classification and reproduction of fungi, mycoplasma and algae.

4 hours

Unit 7. Pathogenic Microorganisms

A. Bacterial diseases of man- Tetanus, Tuberculosis, Pneumonia and Cholera

B. Viral disease , AIDS (HIV)

6 hours

Unit 8 – Microbial Metabolism

A. Respiration: EMP, HMP and ED Pathways, kreb's cycle, Oxidative Phosphorylation

B. Bacterial Photosynthesis: Photosynthetic apparatus in Prokaryotes, Photophosphorylation & Dark reaction

6 hours

PART B-BIOSTATISTICS**Unit 1. Importance and application**

Tabulation and Classification of data, Frequency distribution and Graphical distribution of data

2 hours

Unit 2. Measures of Central tendencies

Mean, Median, Mode and their properties

3 hours

Unit 4. Hypothesis Testing

Concept and problems of probability, Binomial, Poisson, Normal Distribution and their application

3 hours

Unit 6. Different models of data presentation with special reference to biological samples.

2 hours

BTP 202- Microbiology

1. Safety measures in microbiology laboratory
2. Cleaning and sterilization of glass ware. 1 Unit
3. Study of instruments: Compound microscope, Autoclave, Hot air oven. pH meter , Laminar airflow and centrifuge. 2 Units
4. Staining Techniques. Simple, Negative staining, Gram staining, Endospore staining and fungi staining 4 Units
5. Media preparation: Nutrient agar, MRBA and Nutrient broth 2 Units
6. Isolation of bacteria and Fungi from soil, air and water- dilution and pour plate methods 2 Units
7. Estimation of Microorganisms- Total count (haemo cytometer) 1 unit
8. Antibiotic sensitivity test- paper disc method 1 unit
9. Biochemical tests- starch hydrolysis, catalase & gelatin liquefaction.

10. Study of <i>Rhizobium</i> from root nodules of legumes	1 unit
	1 unit

SEMESTER III

BTP 301- Biochemistry and biophysics

PART A : BIOCHEMISTRY

BIOMOLECULES

UNIT 1: Amino Acids

Classification and Properties.

Unit 2: Proteins

Classification based on structure and function, structural organization of proteins (primary, secondary, tertiary and quaternary structures)

(10 hours)

Unit 3. Enzymes

Introduction, classification, enzyme kinetics, factors influencing enzyme activity, co-enzymes and co-factor

(8 hours)

Unit 4. Carbohydrates

Structures, properties and classification, Carbohydrates as a source of energy. (5 hours)

Unit 5. Lipids

Structures, properties, classification and functions.

4 hours

Unit 6. Vitamins

Water soluble and fat soluble Vitamins. Dietary source

4 hours

Unit 7. Hormones

Steroids hormones – structure and importance in brief

3 hours

PART B- BIOPHYSICS

Unit 1. Scope and development of Biophysics

1 hour

Unit 2. pH and buffer concept.

2 hours

Unit 3. Chemical bonding- Ionic bond, covalent bond, hydrogen bond and peptide bond.

Vander Waals forces, Principal of thermodynamics.

4 hours

Unit 4. Analytical techniques.

Principal and Applications of

a) Chromatography(Paper, thin-layer, column and GLC)

b) Centrifugation (RPM and G, Ultra centrifugation)

7 hours

Unit 5. Spectroscopic techniques

UV, visible spectroscopy, X-ray crystallography, NMR, IR, fluorescence & atomic absorption

4 hours

Unit 6. Isotopes

Types, their importance in biological studies, measure of radioactivity, GM counters & Scintillation counting.

4 hours

BTP 302-BIOCHEMISTRY

1. Preparation of buffers- Citrate and Phosphate	1 unit
2. Estimation of reducing sugars- Glucose, Maltose and Lactose by DNS, S.J. and Somoji's Methods	4 units
3. Estimation of Proteins by Biuret and Lowry's method	3 units
4. Assay of enzyme activity –Amylase	2 units
5. Separation of sugar by TLC	2 units
6. Estimation of Amino acids	2 units
7. Estimation of inorganic phosphate by Subbarow method	1 unit

SEMESTER IV

BTP 401- MOLECULAR BIOLOGY

Unit 1. Molecular basis of life- an introduction. Experimental proof of DNA and RNA as genetic material 3 hours

Unit 2. Nucleic Acids

Structure and function of DNA and RNA
 Watson and Crick model of DNA and other forms of DNA(A and Z)
 Function of DNA and RNA including ribozymes 7 hours

Unit 3. DNA Replication

Prokaryotic and Eukaryotic- Enzymes and proteins involved in replication, Theta model and Rolling circle model.

Unit 4. DNA Repair

Causes and mechanisms – photoreactivation , excision repair, mismatch repair, SOS repair 4 hours

Unit 5. Recombination in prokaryotes

Transformation, Conjugation and Transduction 5 hours

Unit 6.Structure of Prokaryotic and Eukaryotic gene- genetic code, Properties and Wobble hypothesis 5 hours

Unit 7. Transcription in Prokaryotes and Eukaryotes

Mechanism, Promoters and RNA polymerase, transcription factors, Post transcriptional modification of eukaryotic mRNA 7 hours

Unit 8. Translation

Mechanism of translation in Prokaryotes and Eukaryotes, Post transcriptional modification of proteins. 8 hours

Unit 9. Regulation of gene expression

Regulation of gene expression in Prokaryotic – Operon concept (Lac and Tryp)
 Regulation of gene expression in Eukaryotic- transcriptional activation, galactose metabolism in yeast

Unit 10. Gene organization and expression in Mitochondria and chloroplast. 8 hours

Unit 11. Insertional elements and transposons.

Transposable elements in Maize and Drosophila. 4 hours.

BTP 402 –Molecular Biology

1. Preparation of DNA model	1 unit
2. Estimation of DNA by DPA method	1 unit
3. Estimation of RNA by Orcinol method	1 unit
4. Detergent lysis of RBC	1 unit
5. Osmotic lysis of RBC	1 unit
6. Extraction and estimation of protein from animal goat liver/ muscle source by Salt precipitation & organic solvent method.	3 units
8. Protein separation by Polyacrylamide Gel Electrophoresis (PAGE)	3 units
9. Charts on –Conjugation, Transformation and Transduction.	1 unit

SEMESTER V

BTP 501 Genetic Engineering and Environmental Biotechnology

PART A: Genetic Engineering

Unit 1. Introduction to Genetic Engineering	1 hour
Unit 2. Tools for Genetic Engineering.	
1. DNA manipulative enzymes- Restriction enzymes and DNA ligases.	1 hour
2. Gene cloning vectors- Plasmids, Bacteriophage and Cosmids.	3 hours
Unit 3. In vitro construction of recombinant DNA molecules – (pBR 332, PUC 19) Isolation of passanger and vector DNA, creation of r-DNA.	
	3 hours
Unit 4. Transformation of r DNA- Transformation of r-DNA molecules into target host organisms-Calcium chloride mediated, Electroporation and microinjection.	
	2 hours
Unit 5. Screening and selection of recombinant host cells- Immunological screening and Colony hybridization.	
	2 hours
Unit 6. Gene Libraries- Genomic DNA and c DNA cloning technique	
	2 hours
Unit 7. Expression of cloned DNA in E coli.	
	1 hour
Unit 8. Molecular Biology Techniques.	
a) Electrophoretic technique – Proteins and nucleic acids	6 hours
b) Polymerase chain reaction (PCR)	
c) Site directed mutagenesis (SDM)	
d) Nucleic acid sequencing Sanger's method	
e) Blotting techniques- Southern, Western and Northern blot.	
Unit 9. Application of r-DNA techniques in human health.	
a) Production of Insulin	4 units
b) Production of recombined vaccines – Hepatitis –B	
c) Production of human growth hormones.	

PART B: ENVIRONMENTAL BIOTECHNOLOGY

Unit 1. Renewable and Non Renewable resources of energy 1 hour

Unit2. Conventional fuel and their environmental impact – Firewood, Plant , Animal, Coal and Gas. 2 hours

Unit 3. Modern fuels and their environmental impact - Methanogenic bacteria, Biogas, Microbial hydrogen Production, conversion of sugar to alcohol & Gasohol. 3 hours

Unit 4. Bioremediation

Bioremediation of soil and water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes, Phytoremediation. Degradation of pesticides and other toxic chemical by other Micro- organism- Degradation of aromatic and chlorinated hydrocarbons and petroleum products.

Unit 5. Treatments of Municipal waste and Industrial effluents. 2 hours

Unit 6. Biofertilizers.

Role of symbiotic and asymbiotic nitrogen fixing bacteria in enrichment of soil. Algal and Fungal bio fertilizers (VAM) 3 hours.

Unit 7. Bioleaching

Enrichment of ores by microorganisms (Gold, Copper and Uranium) 2 hours

Unit 8. Environmental significance of Genetically modified microbes, plants and animals.

1 hour

BTP 502 - Genetic Engineering and Environmental biotechnology.

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| 1. Isolation of genomic DNA from bacteria, plant and animal tissue. | 3 units |
| 2. Isolation of plasmid DNA (E coli) | 1 unit |
| 3. Restriction digestion of DNA | 2 units |
| 4. Separation of DNA by Gel Electrophoresis. | 2 units |
| 5. SDS PAGE | 2 units |
| 6. Bacterial examination of water by MPN Method. | 2 units |
| 7. Estimation of BOD (2 samples) | 2 units |
| 8. VAM staning | 1 unit |

BTP 503- Immunology and Animal Biotechnology

PART A: Immunology

Unit 1. History and scope of Immunology	1 hour
Unit 2. Types of Immunity	2 hours
Unit 3. Cell and organs of immune responses and their functions.	2 hours
Unit 4. Antigens Types, haptens, epitopes and Factors influencing antigenicity.	2 hours
Unit 5. Antibodies Structure, types, properties and functions of immunoglobulins. Production of antibodies	3 hours
Unit 6. Compliment System Structure, components, Properties and Functions	2 hours
Unit 7. Antigen-Antibody reaction Invitro test – precipitation, Immuno-electrophoresis, Haem agglutination, Labelled antibody (RIA, ELISA and Immuno-Fluorescent techniques) In-vivo Serological reaction – Phagocytosis	6 hours
Unit 8. Hypersensitivity and Allergic reaction	2 hours
Unit 9. Blood cell components, ABO blood grouping, Rh typing	2 hours
Unit 10. Vaccines and Immunization Passive and Active immunization. Types of Vaccines- Inactivated, Attenuated and Recombinant Vaccines- Peptide and DNA Vaccines.	3 hours

PART B: ANIMAL BIOTECHNOLOGY

Unit 1. Scope of Animal Tissue Culture.	1 hour
Unit 2. Culture Media Simulating natural conditions for growth of animal cell:	

1. Natural Media –Plasma Clot, biological fluids tissue extract, embryo extract, importance of Serum in media.
2. Chemical defined media 3 hours

Unit 3

- a) Primary culture- Cell lines, and cloning, disaggregation of tissue, isolation of tissue, enzyme disaggregation and mechanical disaggregation.
- b) Secondary culture: Transformed animal cells and continuous cell lines. 3 hours

Unit 4: Transfection of animal cell lines, HAT selection, Selectable markers and Transplantation of Cultural Cells. 3 hours

Unit 5. Expression of Cloned proteins in animal cell: Expression vector, over production and down stream processing of the expressed proteins 2 hours

Unit 6. Production of vaccines in animal cells. 1 hour

Unit 7. Production and application of monoclonal antibodies. 3 hours

Unit 8. Growth factors- promoting proliferation of animal cells EGF, FGF, PDGF, IL-1, IL-2, NGF and Erythropoietin. 3 hours

Unit 9. Transgenic Animals
Techniques and Application and Transgenic mice and sheep. 3 hours

BTP 504 – Immunology and Animal Biotechnology

1. Blood grouping 1 unit
2. Differential count of WBC 2 units
3. Widal test and VDRL test 2 units
4. Dot Elisa 1 units
5. ELISA-Demonstration 2 unit
6. Ochterlouny Double diffusion (ODD) 1 units
7. Isolation of liver parenchyma cells. 3 units
8. Rocket Electrophoresis. 2 units
9. Separation of Serum from blood & precipitation of Immunoglobulins. 2 units

SEMESTER VI

BTP 601-Plant Biotechnology

Unit 1. In- vitro methods in plant tissue culture, Aseptic Techniques, Nutrient media , and use of growth regulators (Auxins, Cytokinins and Gibberelins)	6 hours
Unit 2. In-vitro fertilization – Ovary and Ovule culture.	2 hours
Unit 3. Clonal propagation of elite species (Micro propagation)	4 hours
Unit 4. Organ Culture Anther, Embryo, Endosperm culture and their applications. Organogenesis and Somatic Embryogenesis- Technique and application.	10 hours
Unit 5. Protoplast Culture Isolation, regeneration and viability test, somatic hybridization, method of protoplast Fusion-Chemical and electro fusion, practical application of somatic hybridization and cybridization	10 hours
Unit 6. Somaclonal variation and their significance.	3 hours
Unit 7. In-vitro production of secondary metabolites- Techniques and significance.	5 hours
Unit 8. Role of tissue culture in agriculture, horticulture and forestry.	4 hours

BTP 602- Plant Biotechnology

Total Units Alloted: 15

1. Preparation of plant culture media- MS (1962) and White's medium	4 Units
2. Production of callus and suspension culture	2 Units
3. Plant Protoplast Isolation	2 Units
4. Plant Propagation through Tissue Culture (Shoot tip and nodal Culture)	4 Units
5. Preparation of Synthetic seeds	1 Unit
6. Anther Culture	2 Units

BTP 603-Industrial Biotechnology

Total hours allotted: 45 hours

Unit 1. Introduction to industrial Biotechnology, basic principals of fermentation technology. 1 hours

Unit 2. Screening and Isolation of Microorganism, maintenance of strains, strain improvement (Mutant selection, Recombinant DNA methods) 2 hours

Unit 3. Fermentation Media.
Natural and Synthetic media.
Sterilization techniques- Heat , Radiation and Filtration methods. 2 hours.

Unit 4. Fermenters.
Process of Aeration , Agitation, Temperature regulation and Foam control.
Types of fermenters- Typical, Airlift, Tower and Bubble- up Fermenter. 5 hours

Unit 5. Types of fermentation
Solid state, submerged fermentation and continuous fermentation.
Immobilized enzyme and cell bioreactors. 3 hours

Unit 6. Process Development
Shake flask fermentation, Down stream processing (DSP), Disintegration of cells, Separation, Extraction, Concentration and Purification of products 4 hours

Unit 7. Production of microbial products.
Brief account of the following products obtained by industrial microbiological fermentation.
Alcohol
Alcoholic Beverage- Beer.
Organic acid- Citric acid
Antibiotic- Penicillin
Amino acids- Glutamic acid
Vitamin – B12
Brief account of Steroids Biotransformation. 11 hours

Unit 8. Enzyme Biotechnology
Characteristics of enzymes
Industrial products enzymes- analysis.
Industrial use of enzymes- Detergent, Leather, Beverage, Food and Pharmaceuticals
Bioreactors for enzyme production- Stirred tank, membrane reactors and continues flow reactors. 6 hours

Unit 9. Fermented food.

Fermented food- Yogurt, buttermilk, Idli, Dosa, Cheese, Tempeh.

Microbial Foods- Single cell proteins(SCP), Single cell oils(SCO) 5 hours

Unit 10. Plant cell suspension culture for the production of food additives- Saffron

Capsaicin. 2 hours

Unit 11. Technique of mass culture of Algae- Spirulina.

1 hour

Unit 12. Microbial Polysaccharides and polyesters; production of xanthum gum and polyhydroxyalkonoides (PHA)

3 hours

BTP 604-Industrial Biotechnology

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| 1. Algal and fungal culture- Spirulina, Agaricus, Yeast and Aspergillus. | 4 units |
| 2. Estimation of citric acid from Aspergillus culture. | 2 units |
| 3. Estimation of lactic acid and lactose. | 3 units |
| 4. Immobilization of yeast cells. | 1 unit |
| 5. Preparation of wine | 2 units |
| 6. Estimation of Alcohol by specific gravity method. | 1 unit |
| 7. Immobilization of enzyme- (Envertase can be obtained from yeast cells and observed for glucose production). | 2 units |
| 8. Visit to research Centers/Institutions/Industries. | |