

Syllabus for Undergraduate Programme  
**Bachelor of Science in Biotechnology**



Manipur University, Canchipur  
Imphal-795003

## Course Structure of B.Sc. Biotechnology

Semester	Paper Code	Title of Paper	Semester Exam	Internal Assessment	Total Marks
First Semester	BTT101	<i>Fundamentals of Chemistry</i>	80	20	100
	BTT102	<i>Elements of Biochemistry</i>	80	20	100
	BTT103	<i>Elements of Biosciences &amp; Physiology</i>	80	20	100
	BTT104	<i>Basic Cell Biology</i>	80	20	100
	BTP105	<i>Laboratory course- I: Basic Chemistry</i>	80	20	100
	BTP106	<i>Laboratory course- II: Biochemistry-I &amp; Cell Biology</i>	80	20	100
	Total First Semester				
Second Semester	BTT201	<i>Fundamentals of Physics</i>	80	20	100
	BTT202	<i>Biophysics and Bio-Instrumentation</i>	80	20	100
	BTT203	<i>Microbiology</i>	80	20	100
	BTT204	<i>Molecular Genetics</i>	80	20	100
	BTP205	<i>Laboratory course- III: Physics &amp; Bioinstrumentations</i>	80	20	100
	BTP206	<i>Laboratory course- IV: Microbiology &amp; Human genetics</i>	80	20	100
	Total Second Semester				
Third Semester	BTT301	<i>Metabolic pathways</i>	80	20	100
	BTT302	<i>Enzymology</i>	80	20	100
	BTT303	<i>Elements of Molecular Biology</i>	80	20	100
	BTT304	<i>Basic Immunology</i>	80	20	100
	BTP305	<i>Laboratory course- V: Biochemistry-II</i>	80	20	100
	BTP306	<i>Laboratory course- VI: Molecular Biology</i>	80	20	100
	Total Third Semester				
Forth Semester	BTT401	<i>Microbial Biotechnology</i>	80	20	100
	BTT402	<i>Basic Mathematics &amp; Biostatistics</i>	80	20	100
	BTT403	<i>Genetic Engineering</i>	80	20	100
	BTT404	<i>Cell, Tissue &amp; Organ Culture</i>	80	20	100
	BTP405	<i>Laboratory course- VII: Biostatistics &amp; Microbiology</i>	80	20	100
	BTP406	<i>Laboratory course- VIII: Plant &amp; Molecular Biotechnology-I</i>	80	20	100
	Total Forth Semester				
Fifth Semester	BTT501	<i>Biodiversity and Molecular Taxonomy</i>	80	20	100
	BTT502	<i>Plant Biotechnology</i>	80	20	100
	BTT503	<i>Animal Biotechnology</i>	80	20	100
	BTT504	<i>Bioprocess Technology &amp; Nanobiotechnology</i>	80	20	100
	BTP505	<i>Laboratory course- IX: Plant biotechnology-II</i>	80	20	100
	BTP506	<i>Laboratory course- X: Animal biotechnology-II &amp; Immunology</i>	80	20	100
	Total Fifth Semester				
Sixth Semester	BTT601	<i>Computer Application &amp; Bioinformatics</i>	80	20	100
	BTT602	<i>Environmental Biotechnology</i>	80	20	100
	BTT603	<i>Food Biotechnology</i>	80	20	100
	BTT604	<i>Entrepreneurships &amp; Management</i>	80	20	100
	BTP605	<i>Laboratory course- XI: Bioinformatics and food biotechnology</i>	80	20	100
	BTP606	<i>Project Work-I</i>			100
	Total Sixth Semester				

## **FIRST SEMESTER**

### **BTT 101: Fundamentals of Chemistry (Max. marks 80+20=100)**

**Unit 1** Gaseous State and dilute solution: Kinetic theory of gases and derivation of kinetic gas equation, derivation of gas laws - such as Boyle's law, Charles' law, Graham's law of diffusion, Dalton's law of partial pressure and Avogadro's principle. Maxwell's distribution of molecular velocities. Van der Waal's equation, Colligative properties of dilute solution, Osmosis and osmotic pressure.

Electromotive force (EMF): Electrolytic and galvanic cells, principles of oxidation-reduction, EMF and its measurements, free energy, entropy and enthalpy changes for cell reactions.

**20+5 marks**

**Unit 2** Ionic equilibrium and electrochemistry: Concepts of acids and bases, ionization constants of weak acids and bases, ionic product of water, hydrogen ion concentration (pH), buffer solution, common buffer solutions used in biological experiments, salt hydrolysis, solubility and solubility products, Arrhenius theory for dissociation of electrolytes, electrolytic conductance, Faraday's Law of electrolysis, transference and transference numbers, variation of conductance with concentration, effect on infinite dilution and other factors on conductance, inter-ionic attraction theory of conductance.

Chemical Thermodynamics: Types of systems, state and path variables, intensive and extensive variables, Zeroth's law of thermodynamics, first law of thermodynamics and its mathematical derivation, internal energy and enthalpy, thermodynamic derivation of Joule-Thomson effect for ideal and real gases, exothermic and endothermic reactions, calculation of lattice energy by Born-Haber cycle, Lavoisier and Laplace law, Hess's law and their application, entropy and second law of thermodynamics, Gibb's free energy (G) and Helmholtz free energy (A), variation of S, G and A with P, V and T, Gibbs-Helmholtz equation, Maxwell relations, third law of thermodynamics.

**20+5 marks**

**Unit 3** Chemical Kinetics: Rate of a reaction, order and molecularity of a reaction, pseudo-unimolecular reaction, derivation of first order, second order and  $n^{\text{th}}$  order rate equation, temperature dependence of rate of reactions, Arrhenius rate equation, Collision theory of reaction (Lindemann's mechanism), steady state approximation and reaction mechanism, complex reaction – opposing, parallel, consecutive and chain reaction ( $\text{H}_2 + \text{Br}_2$  and  $\text{H}_2 + \text{Cl}_2$  reactions only).

Chemical bonding and Stereochemistry: Concept of chemical bonding – ionic, covalent and metallic bond, their general characteristics, valence bond approach, valence shell electron pair repulsion theory (VSEPR theory), shape of simple molecules like  $\text{BeF}_2$ ,  $\text{BF}_3$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{PCl}_5$ ,  $\text{SF}_6$  etc., molecular orbital theory, hybridization, intermolecular forces and hydrogen bonding, Atomic chemistry-electromagnetism, Basics of stereochemistry, optical Isomerism - optical isomers, isomeric number and tetrahedral carbon atom, enantiomers, diastereomers, racemic modification; geometrical isomerism, condition of geometric isomer, cis-trans and E-Z nomenclature, R-S nomenclature.

**20+5 marks**

**Unit 4** Phase rule and colloids: Gibbs phase rule, application of phase rule to one component/two component systems, determination of solid liquid equilibria, determination of nature of solid phases, Classification of two-component solid-liquid equilibrium, simple eutectic diagram.

Introduction of colloidal solution, size of colloidal particles, types and classification of colloidal systems, preparation of colloidal solution, purification of sols, optical and electrical properties of colloidal solution, Tyndall effect, Brownian movement, determination of Avogadro's number, electrical double layer and zeta potential, electrophoresis, electro-osmosis, isoelectric point, coagulation of colloids, kinetics of coagulation, Schultz hardy law, protection of colloids and gold number, application of colloid in chemistry and biological system.

Basics in organic chemistry: Nomenclature, hydrocarbons – aliphatic and cycloalkanes, alcohols, carboxylic acid, ethers, alkyl halides, amine, nitrile, isocyanide, acid derivatives, nitro and diazonium salt, oxidations, reductions, eliminations, nucleophilic and electrophilic substitution reactions, addition reactions, synthesis of small molecules, Quantitative structure-activity relationships (QSAR)

**20+5 marks**

*Note to the teacher(s): Students have learned most of the topics from this course at 10+2 level, but they need better understanding to apply or realize the relevance of these concepts with living systems, which is necessary while learning biotechnology. Teacher must highlight and emphasize the applications or relevance of chemistry in living system.*

**Suggested Reading Materials:**

1. University General Chemistry by C.N. R. Rao, Macmillan
2. Principles of Physical Chemistry, 4<sup>th</sup> edition by S.H. Marron and C.F. Prutton
3. Physical Chemistry – P.C. Rakshit, Science Book Agency, Calcutta.
4. A Text Book of Physical Chemistry – Samuel Glasstone, Macmillan Student Edition.
5. Physical chemistry - P.W. Atkins, ELBS.
6. Physical Chemistry – G.M. Barron – Mc Grow Hill.
7. Essentials of Physical Chemistry – Bahl and Tuli
8. Organic Chemistry by Marrison and Boyd, Prentice Hall of India Pvt. Ltd, New Delhi
9. Guide book to Mechanism in Organic Chemistry by Peper Sykes, Orient Longman
10. Organic Chemistry by I.L. Finar, Volume-II
11. An introduction to Electrochemistry by Samuel Glasstene
12. Physical chemistry- P.W. Atkins, ELBS.
13. Physical Chemistry for Biological Sciences by Raymond Chang (University science)
14. Physical Chemistry by David Ball
15. Physical Chemistry – P.C. Rakshit, Science Book Agency, Calcutta.

**BTT 102: Elements of Biochemistry (Max. marks 80+20=100)**

**Unit 1** Introduction in Biochemistry, Carbohydrates: Introduction, biological importance. Definition, Classification, glyceraldehydes, Simple Aldose, Simple Ketose, D-glucose, Conformation of D-glucose, Monosaccharides other than glucose, glycosidic bond, disaccharides, polysaccharides, starch, glycogen, peptidoglycan, proteoglycan matrix.

**20+5 marks**

**Unit 2** Lipids: Introduction, Classes, Fatty acids, Physical property Chemical property, Sap value, acid value, iodine number, rancidity. Glycerolipid, Sphingolipid, Lipid derived from isoprene, Behavior of lipid in water, Bile acids, bile salts, plasma lipoproteins, Vesicles, membrane transport.

**20+5 marks**

**Unit 3** Amino acids: Structure and properties of amino acids. Acid-base behavior; amino acids analysis; reactions; Zwitterions; Protein structure: Peptide bond; Determination of primary structure; Sanger's method, Edmann's method, dansylchloride; Forces stabilizing secondary structure, Ramachandran plot; myoglobin, hemoglobin and antibody examples of quaternary structure. **20+5 marks**

**Unit 4** Nucleic acids: Nucleosides, nucleotides, Polynucleotide, Forces stabilizing nucleic acid structure; DNA and its different forms [A, B and Z], RNA and its types. **20+5 marks**

**Suggested Reading Materials:**

1. Outlines of Biochemistry: Conn and Stumpf
2. Principles of Biochemistry: Jeffery Zubey
3. Biochemistry: Stryer
4. Fundamentals of biochemistry: Voet and Voet
5. Principles of Biochemistry: Lehninger

*All the books shall be latest edition.*

**BTT103: Elements of Biosciences & Physiology (Max. marks 80+20=100)**

**Unit 1** Life forms: Classification, Five kingdoms, Eight kingdoms, Key characters of each group. Plant groups- (i) Algae (ii) Fungi (iii) Bryophytes (iv) Pteridophytes (v) Gymnosperms (vi) Angiosperms; Animal phyla- sponges to mammals. Common parasites and pathogens of humans, domestic animals and crops. Economic zoology, Beneficial and harmful organisms, Vermiculture, Aquaculture, Sericulture, Apiculture. **20+5 marks**

**Unit 2** Economically Important Plants: Classification systems, Important families (Fabaceae, Poaceae, Malvaceae, Cucurbitaceae, Cruciferae, Leguminosae), Cereals, Beverages, Fibers, wood, rubber, spices, medicinal plants. Ethnobotany, Vegetation types of India. Threatened plants. Role of biotechnology in reintroducing commercially and economically important plants to wild. Major habitat types of the subcontinent, geographic origins and migrations of species; common Indian mammals, birds. and animals of India. **20+5 marks**

**Unit 3** General and cellular basis of Animal Physiology, Body fluid compartments, transport across cell membrane, Homeostasis, intracellular digestion: digestive enzyme, coordination of digestion, Circulation of body fluid, blood vessels-blood flow, and blood cells. Respiration- Mechanism of breathing, transport of Oxygen and carbon dioxide, Role of kidney in the regulation of water, salt. **20+5 marks**

**Unit 4** Plant hormones: Biosynthesis, storage, breakdown and transport; physiological effects and molecular mechanisms of action. Secondary metabolites and Plant Defense - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Nitrogen Fixation Basic concepts, nif genes and their regulation, potential scope in crop Improvement. Responses of plants to biotic and abiotic stresses. **20+5 marks**

### **Suggested Reading Materials:**

1. Text of Fungi, Bacteria and Viruses Dube H.C.
2. The Plant Kingdom, Bold H.C. Prentice- Hall India
3. Class book of algae, ii. Class book of fungi Chopra G.L.
4. Class book of Botany, Dutta A.C. A Oxford University Press
5. Plant groups Mukherji H. (New central book depot)
6. An introduction to embryophyta Parihar N.S. (Central Book Depot)
7. Botany for degree students-Gymnosperms Vasishtha P.C.
8. Taxonomy of flowering plants Lawrence G.H.
9. Angiosperms (Systematic and life cycle) Chopra G.L
10. Introduction to principles of Taxonomy Shivarajan V.V.
11. Text book of Angiosperms Pandey B.P.
12. Economic Botany in tropics, Kocher S. L.
13. Zoology: Dr. S.M. Saxena.
14. A handbook on Economic Zoology: Jawaid Ahsan
15. Invertebrate Zoology: S. N. Prasad
16. Vertebrate Zoology: Dr. Veer Bala Rastogi
17. Ganong, H, Review of Medical Physiology, 21<sup>st</sup> Edition, McGrawHill.
18. Plant Physiology, Malik C.P. Kalyani Publishers
19. Plant Physiology, Fourth Edition by Lincoln Taiz and Eduardo Zeiger.

*All the books shall be latest edition.*

### **BTT104: Basic Cell Biology (Max. marks 80+20=100)**

**Unit 1:** Cell as a basic unit of living systems; cell theory, pre-cellular evolution: artificial creation of cells. Broad classification of cell types: PPOs, bacteria, eukaryotic microbes, plant and animal cells. A detailed classification of cell types within an organism. Biochemical composition of cells (proteins, lipids, carbohydrates, nucleic acids and the metabolic pool).

**20+5 marks**

**Unit 2:** Ultra structure of the cell membrane; structure and function of cell organelles, cytosol, golgi bodies, endoplasmic reticulum (rough and smooth), ribosomes.

**20+5 marks**

**Unit 3:** Cytoskeletal structures (actin, microtubules etc.), mitochondria, chloroplasts, lysosomes, peroxisomes, nucleus (nuclear membrane, nucleoplasm, nucleolus chromatin).

**20+5 marks**

**Unit 4:** Cell division and cell cycle (including cell synchrony and its applications). Cell-Cell interaction, cell locomotion (amoeboid, flagellar and ciliar). Muscle and nerve cells. Cell senescence and death cell differentiation in plants and animals.

**20+5 marks**

### **Suggested Reading Materials:**

1. Molecular Cell Biology Lodish et al., Scientific American Book
2. Manual of Laboratory Experiments in Cell Biol. Eduard Gasque –W. C. Wilson Pub.
3. Molecular Biology of the Cell, Alberts et al.
4. The Cell – A Molecular Approach, Cooper & Hausman Cell and Molecular Biology, De Roberties EDP and De Roberties EMF, Lea & Febiger Int.
5. Cell Biology- *Jack D. Bruke*, The Williams Twilkin Company.
6. Cell Biology- *Ambrose & Dorothy M. Easty*, ELBS Publications.
7. Cytology- *Wilson & Marrison*, Reinform Publications.

All the books shall be latest edition.

**BTP105: Laboratory course- I: Basic Chemistry (Max. marks 80+20=100)**

Students shall be introduced to pH meter, conductometer, colorimeter, spectrophotometer, microscopes etc.

Students should learn the following:-

1. Preparation of Molar & Normal solution
2. Preparation of buffers of pH range from 4 to 10.5
3. Acid-base titration using pH meter and conductometer
4. Determination of rate constant of an ester hydrolysis reaction
5. Titration of a mixture of acids by a base using pH meter.
6. Detection of elements in organic compound.
7. Identification of functional groups.
8. Preparation of organic solid derivatives.
9. Qualitative analysis for carbohydrates, protein and lipid.
10. Estimation of Inorganic and Organic Phosphates.

*Teachers will supply printed detailed instructions, procedure of the experiments.*

**BTP106: Laboratory course- II: Biochemistry-I & Cell Biology (Max. marks 80+20=100)**

1. Precipitation test of proteins.
2. Quantitative analysis of fat.
3. Determination of pKa value of amino acids.
4. Biochemical analysis of plant sample.
5. Use of micrometer and calibration, measurement of onion epidermal cells and yeast.
6. Cytological preparations: Fixation, dehydration and staining, squash in stain, embedding and sectioning.
7. Cell division: Mitotic and meiotic studies in onion root tips and flower buds.
8. Separation of cell types (from blood), differential staining.
9. Study of permanent slides of protozoan parasites (any seven).

*Teachers will supply printed detailed instructions, procedure of the experiments.*

**SECOND SEMESTER**

**BTT201: Fundamentals of Physics (Max. marks 80+20=100)**

**Unit 1** Interrelationship between Physics and Life sciences. Measurements: Physics quantities, International systems and units, Length: radius of proton, astronomical distances. Mass: atomic mass unit to mass of earth. Time: time for fast elementary particle to pass through nucleus to age of earth. Electric current. Amount of substance. Luminous intensity. Stress and strain in solids, Hook's law, Stress-strain curves, Limit of elasticity. Relevance of elasticity to life sciences.

Refrigeration: Introduction to refrigeration principle: Difference between heat engine and refrigerator, Coefficient of performance. Simple structure and working of gas refrigeration.

**20+5 marks**

**Unit 2** Fluids: Definition, Pressure and Density. Various units of pressure and their inter-conversion. Variation of pressure in a fluid at rest. Pascal's Principle. Measurement of pressure. Fluid Dynamics (Viscosity): Streamline and turbulent flow (definition and explanation). Equation of continuity. Flow of liquids through capillaries. Poiseulle's equation: Derivations and physical significance.

Optics: Properties of light: reflection, refraction, dispersion, diffraction, Interference and Polarization. Concept of polarization. Polarization by reflection – Brewster's law. Polarization by double refraction – Nicol Prism. Lasers: Stimulated emissions, Optical pumping, Concept of population inversion, Laser action, Working of He-Ne laser. Applications of Laser.

**20+5 marks**

**Unit 3** Reynolds number: Derivation and physical significance. Concept of pressure energy. Bernoulli's theorem and its applications; Venturi meter and Pitot's tube. Viscosity estimation by Oswald's viscometer. Relevance to life sciences. Surface tension: Surface tension and surface energy: Definition, concept and derivation. Capillary action. Angle of contact. Wettability. Temperature dependence of surface tension. Relevance to life sciences and applications.

**20+5 marks**

**Unit 4** Heat: A form of energy. Quantity of heat and specific heat. Molar heat capacity of solid. Concept of temperature. Thermal equilibrium– zeroth law of thermodynamics. Measuring temperature. International practical temperature scale.

Magnetism: The magnetic field. The definition of B Poles and dipoles. Gauss' law of magnetism. Magnetism of earth. Paramagnetism. Diamagnetism. Ferromagnetism. Nuclear magnetism. Biomagnetism and its application to medicine.

**20+5 marks**

*Note to the teacher(s): Students have learned most of the topics from this course at 10+2 level, but they need better understanding to apply or realize the relevance of these concepts with living systems, which is necessary while learning biotechnology. Teacher must highlight and emphasize the applications or relevance of Physics in living system.*

### **BTT202: Biophysics & Bio-instrumentation (Max. marks 80+20=100)**

**Unit 1** Energetic of a living body: Sources of heat limits to temperature, heat dissipation and conservation, Lambert-Beer law, spectrophotometer and colorimetry, primary events in photosynthesis, strategies of light reception in microbes, plants and animals, correction of vision faults, electrical properties of biological compartments, electricity as a potential signal, generation and reception of sonic vibrations, hearing aids, intra- and intermolecular interactions in biological systems, spatial and charge compatibility as determinant of such interactions.

**20+5 marks**



**Unit 2** Physical methods applied to find out molecular structure by general spectroscopy: UV-Vis, fluorescence, atomic absorption, IR, Raman spectra, atomic absorption spectrophotometer (AAS) and atomic emissions (AES), ESR/EPR and circular dichroism analysis using light scattering and NMR. Physical methods of imaging intact biological structures; ultrasound, optical filters, X-ray, CAT scan, **ECG**, EEG and MRI. X-rays and lasers-X-ray crystallography, X-ray diffractometer and X-ray fluorescence Spectrometer (XRF).

**20+5 marks**

**Unit 3** Isotopes and radiation-radioactivity, isotopes, measurement of radioactivity, monitoring accumulation of isotopes with Geiger counter, Scintillation counter, autoradiography. Separation techniques; chromatography - TLC, Column chromatography, gas chromatography, HPLC, ion-exchange, mass-spectrometer, electrophoresis, centrifugation, - ultracentrifugation, density gradient, lyophilization. Vacuum drying. Tools using light-colorimeter, types of photometer, fluorimetry.

**20+5 marks**

**Unit 4** Microscopes-light: phase contrast dark field microscope, electron microscope (SEM & TEM), scanning probe microscope (SPM), atomic force microscope (AFM) and scanning tunneling microscope (STM) (For topography, gene mapping, DNA analysis). Interactions of laser beam with tissues, Isotope separation by laser beam with tissues. Flowcytometry and immunofluorescence microscopy, detection of molecules in living cells. Electrophysiological methods: Single neuron recording, patch-clamp recording, Brain activity recording, lesion and stimulation of brain.

**20+5 marks**

**Suggested Reading Materials:**

1. Perspectives of modern physics – Arthur Beiser (Mc Graw Hill)
2. Nuclear physics an introduction – S.B. Patel (New Age International)
3. Introduction to atomic spectra – H.E. White (Mc Graw Hill)
4. Textbook of optics and atomic physics – P.P. Khandelwal (Himlaya Publishing House)
5. Molecular cell biology – Ladish, Berk, Matsudara, Kaiser, Krieger, Zipursky, Darnell (W.H. Freeman and Co.)
6. Biophysics - Cotrell (Eastern Economy Edition)
7. Clinical Biophysics –Principles and Techniques- P. Narayanan (Bhalani Pub., Mumbai)
8. Biophysics – Pattabhi and Gautham (Narosa Publishing House)
9. Instrumentation measurements and analysis – Nakara, Choudhari (Tata Mc Graw Hill)
10. Handbook of analytical instruments – R.S. Khandpur (Tata Mc Graw Hill)
11. Biophysical Chemistry- Upadhyay, Upadhyay and Nath – (Himalaya Pub. House, Delhi)
12. Principles and Techniques of Practical Biochemistry, Keith Wilson (Editor) and John Walker (Editor): Cambridge University Press
13. Principles of Physical Biochemistry, K. E. Van Holde, *et al.*: Prentice Hall
14. Principles of Instrumental Analysis, Douglas A. Skoog, et al: Harcourt College Publishers
15. Quantitative Chemical Analysis, Daniel C. Harris: W. H. Freeman & Co. Bk & cdr edition
16. Spectrophotometry and Spectrofluorimetry: A Practical Approach, Michael G. Gore (Editor): Oxford Univ Press,
17. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, Irwin H. Segel: John Wiley & Sons

*All the books shall be latest editions.*

## **BTT203: Microbiology (Max. marks 80+20=100)**

**Unit 1** History of Microbiology: the microscope, spontaneous generation, biogenesis, fermentation, germ theory of diseases, Microbial Diversity: Prokaryotes and Eukaryotes, Microalgae, Microfungi, Protozoa, Bacteria and Viruses, Bacterial size, shapes and pattern of arrangement, Structures external to cell wall: Flagella, Pili, Capsule, sheath, Prosthecae and stalk. The cell wall structure: Gram positive and gram negative bacteria. Structures internal to cell wall: Cytoplasmic membrane, Cytoplasmic inclusion and nuclear material. Classification of Microbes - Systems of classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of classification of microorganisms Systematics of bacteria, Nutritional types [Definition and examples]. Classification on the basis of oxygen requirement.

**20+5 marks**

**Unit 2** Reproduction and growth of bacteria: Modes of cell division, Growth curve, Lag phase, Exponential phase, stationary phase and death phase, Nutritional requirements. Nutritional types of bacteria, Phototrophs, Chemotrophs, Autotrophs, Heterotrophs, Obligate parasites. Bacteriological media, Selective media, Maintenance media, Differential media.

**20+5 marks**

**Unit 3** Control of microorganisms, Concept of Sterilization - Definition of sterilization, dry and moist heat, pasteurization, tyndalization; radiation, ultrasonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antiseptics sterilants and fumigation. Determination of phenol coefficient of disinfectant.

**20+5 marks**

**Unit 4** Stains and staining techniques – Definition of auxochrome, chromophores, dyes, Classification of stains, Theories of staining, Mechanism of gram staining, acid fast staining, negative staining, capsule staining, flagella staining, endospore staining. **Microbial genetics: lac operon, mutation and plasmid & plasmid vectors.**

**20+5 marks**

### **Suggested Reading Materials:**

1. General Microbiology - Stanier,
2. Introduction to Microbiology - Ingraham,
3. Brock Biology of Microorganisms - Madigan et al,
4. Industrial Microbiology - An introduction, Waites, M.J.
5. Microbiology: Prescott

*All the books shall be latest editions.*

## **BTT204: Molecular Genetics (Max. marks 80+20=100)**

**Unit 1.** DNA Double helix: Physico-chemical considerations. Chromosomes: Chemical composition; structural organization of chromatids, centromere, telomeres, chromatin, nucleosome organization; eu- and heterochromatin; special chromosomes (e.g. polytene and lampbrush chromosomes), banding patterns. Organization of prokaryotic and eukaryotic genomes, supercoiling, repetitive DNA. Karyotypes, pedigree analysis. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

**20+5 marks**

**Unit 2.** Mendelian principles: Dominance, segregation, independent assortment. Allelic Variation & Gene function – Multiple allele, Genetic interaction, Epistatic interactions, Non-Epistatic inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete & incomplete), Expressivity, Pleiotropism, Modifier/Modifying genes, polygenic traits. Non-Mendelian inheritance–cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast), maternal inheritance, uniparental inheritance in algae. Linkage and crossing over, sex determination in plants and animals, sex linkage, sex limited and sex influenced character.

**20+5 marks**

**Unit 3.** Chromosomal variation in Number & Structure – Euploidy, Non-disjunction & Aneuploidy, Aneuploid segregation in plants, Aneuploidy in Human, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy. Chromosomal aberrations, chromosomal rearrangements in Human being, Chromosomal aberrations & evolution. Mutations; spontaneous and induced, chemical and physical mutagens, induced mutations in plants, animals and microbes for economic benefit of man. Inborn errors of metabolism, one gene – one enzyme hypothesis, one gene – one protein, one gene – one polypeptide, colinearity.

**20+5 marks**

**Unit 4.** Population genetics – populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; adaptive radiation and modifications; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution. Principles of Plant Breeding: Objectives, Selfing and crossing techniques, Male sterility, Incompatibility, Hybrid vigour.

**20+5 marks**

**Suggested Reading Materials:**

1. Principles of Genetics, Gardner EJ, Snustad DP,
2. Genetics by Strickberger.
3. Genetics, Goodenough U, Hold International
4. Genetics by Griffith.
5. Genetics by Brookes.
6. Essentials of Genetics (In genomics prospective), Hartwell,
7. Principles of genetics-Robert H.Tamarin, Tata McGraw Hill.
8. Genetics from Genes to Genomes-Leland H.Hartwell, Leroy Hood, Mc Graw Hill.
9. Concepts of Genetics- VII edition-William S.Klug, Michael R. Cummings.  
*All the books shall be latest editions.*

**BTP 205: Laboratory course- III: Physics & Bioinstrumentations (Max. marks 80+20=100)**

1. Determination of “g” by bar pendulum.
2. Determination of viscosity of liquid.
3. Determination of surface tension by capillary rise method.
4. Determination of focal lengths of convex lenses.
5. Determination of horizontal component of Earth’s magnetic field.
6. Determination of radius of curvature of a convex lens by Newton’s ring method.
7. Demonstration of the following instrumentations/methods:
  - UV-Visible spectrophotometer
  - IR –spectrophotometer
  - Atomic Absorption Spectrophotometer (AAS)
  - Chromatography

-XRD

-Centrifugation

-Fluorescence

8. Paper Chromatography of amino acids, sugars, and purine and pyrimidine bases.
9. Colorimetric determination of any one amino acids.
10. Separation of pigments by adsorption chromatography.
11. Thin Layer chromatography separation - sugars & lipids.

*Teachers will supply printed detailed instructions, procedure of the experiments.*

**BTP 206: Laboratory course- IV: Microbiology & Human genetics (Max. marks 80+20=100)**

1. Sterilization techniques
2. Aseptic techniques- Culture transfer from solid to solid, solid to liquid and liquid to liquid: Checking of possible contamination
3. Culture media preparation- Nutrient broth, nutrient agar slant, potato dextrose agar.
4. Culture techniques- Streak plate, pour plate and spread plate
5. Isolation of pure culture by streak plate method.
6. Viable count of bacteria by serial dilution and pour plating.
7. Turbidometry measurement of bacterial growth.
8. Observation of microorganisms
  - a) Wet mount
  - b) Monochrome staining
  - c) Gram staining
  - d) Spore staining
  - e) Fungal staining
9. Isolation of microorganisms from air, water and soil samples.
10. Dilution and pour plating.
11. Antibiotic sensitivity of microbes, use of antibiotic discs.
12. Testing of water quality.
13. Problems on modification in ratio due to interaction of genes– Complementary factors, Supplementary factors, Inhibitory factors, duplicate genes (Explain with the help of plastic beads).
14. Study of chromosomes abnormalities in man: Down's syndrome, Klinefelter Syndrome, Turner Syndrome with the help of Photograph/ Charts/ Karyotype.
15. Human pedigree analysis – various symbols used and problems.

*Teachers will supply printed detailed instructions, procedure of the experiments.*

### **THIRD SEMESTER**

#### **BTT301: Metabolic Pathways (Max. marks 80+20=100)**

**Unit 1** Basic concept of Enzymes. Metabolism: Basic concept and design, **Glycolysis, Fatty acid oxidation, Amino acid metabolism.** **20+5 marks**

**Unit 2** Pentose phosphate pathway: Generation of NADPH<sub>2</sub> and interconnection of glycolysis and pentose-phosphate pathway, control of rate of pentose phosphate pathway by NADPH<sup>+</sup>, regulation of flow of glucose-6-phosphate by the need of NADPH, ribose phosphate and ATP, glucose-6-phosphate dehydrogenase deficiency.

**20+5 marks**

**Unit 3** Gluconeogenesis: Synthesis of carbohydrates by non-carbohydrate precursors, gluconeogenesis is not a reversal of glycolysis, activation of pyruvate carboxylase by acetyl CoA, oxaloacetate shuttle, energy consumption in the synthesis of glucose from pyruvate, reciprocal regulation of gluconeogenesis and glycolysis, conversion of lactate and alanine into glucose in liver.

**20+5 marks**

**Unit 4** Citric acid cycle: Formation of acetyl CoA from 3 pyruvate, condensation of oxaloacetate with acetyl CoA to form citrate, isomerization of citrate into isocitrate, oxidative decarboxylation of succinyl CoA, generation of high energy phosphate from succinyl CoA, regeneration of oxalate, stoichiometry of citric acid cycle, pyruvate dehydrogenase complex, citric acid cycle as a source of biosynthetic precursors, control of pyruvate dehydrogenase complex, control of citric acid cycle, citric acid cycle and its high energy yield. Electron transport and oxidative phosphorylation, energetics of oxidative phosphorylation, photophosphorylation, and energy yield by complete oxidation of glucose.

**20+5 marks**

#### **Suggested Reading Materials:**

1. Principles of Biochemistry by A.L.Lehninger, D.L.Nelson & M.M.Cox. Worth Publishers, New York.
2. Biochemistry by L.Stryer Freeman & Co, New York.
3. Biochemistry by G. Zubay Macmillan Publishing Co, New York.
4. The vital force: A study of Bioenergetics by F.M.Harold Freeman & Co, New York.
5. A Biologist's Physical Chemistry by J.G.Morris Edward Arnold Publishers, London.

*All the books shall be latest editions.*

#### **BTT302: Enzymology (Max. marks 80+20=100)**

**Unit 1** Classification; IUB system, rationale, overview and specific examples. Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory. Enzyme activity, international units, specific activity, turnover number, end point kinetic assay Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of V<sub>max</sub> and K<sub>m</sub>. Bisubstrate reactions. Graphical procedures in enzymology - advantages and disadvantages of alternate plotting. **Line weaver burk plot, Eadie Hofstee plot and Hanes Wolf plot.** Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive, their mode of action and experimental determination.

**20+5 marks**

**Unit 2** Factors affecting catalytic efficiency - proximity and orientation effects, distortion or strain, acid - base and nucleophilic catalysis. Methods for studying fast reactions. Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes. Lysozyme, ribonuclease, trypsin, carboxypeptidase, phosphorylase, aspartate transcarbamylase, glutamine synthetase and phosphofructo kinase. Multi enzyme complexes - pyruvate dehydrogenase and fatty acid synthetase; Na - K ATPase. **20+5 marks**

**Unit 3** Protein ligand binding including measurements, analysis of binding isotherms, cooperativity, Hill and Scatchard plots and kinetics of allosteric enzymes. Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation. **Enzyme reaction mechanism; e.g. ping-pong mechanism & Ternary-complex mechanism.** **20+5 marks**

**Unit 4** Relative practical and economic advantage for industrial use, effect of partition on kinetics and performance with particular emphasis on charge and hydrophobicity (pH, temperature and  $K_m$ ). Various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), microencapsulation and gel entrapment. Immobilized multienzyme systems. Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors. **20+5 marks**

**Suggested Reading Materials:**

1. Cell Biology Vol I to III by V.E. Celis Academic Press.
2. Biological chemistry by H.R. Mahler and E. Cordes
3. Enzymes by Dixon and Webb

*All the books shall be latest editions*

**BTT303: Elements of Molecular Biology (Max. marks 80+20=100)**

**Unit 1** Molecular basis of life – DNA and RNA as genetic material, nucleic acids, structure and functions of DNA and RNA, Watson and Crick model of DNA and other forms for DNA (A and Z) Functions of DNA and RNA including ribozymes. **20+5 marks**

**Unit 2** DNA replication prokaryotic and eukaryotic – Enzymes and proteins involved in replication, theta model and rolling circle model. DNA repair and mechanism-photo reactivation, excision repair, mismatch repair, SOS repair recombination in prokaryotes transformation, conjugation and transduction. **20+5 marks**

**Unit 3** Structure of prokaryotic and eukaryotic gene- genetic code, properties and Wobble hypothesis. Transcription in prokaryotes and eukaryotes mechanism, promoters and RNA polymerase, transcription factors, post transcriptional modifications of eukaryotic mRNA. Translation mechanism of translation in prokaryotes and eukaryotes, post translational modifications of proteins. **20+5 marks**

**Unit 4** Regulation of gene expression, regulation of gene expression in prokaryotes – operon concept (Lac and Tryp), regulation of gene expression in eukaryotes - transcriptional activation, galactose metabolism in yeast. Gene organization and expression in mitochondria and chloroplasts. Insertional elements and transposons. Transposable elements in maize and drosophila. **20+5 marks**

**Suggested Reading Materials:**

1. Genes VIII : Benjamin Lewin
2. Molecular Biology of Gene: Watson et al.
3. Cell & Molecular Biology: Lodish et al.
4. An Introduction to Genetic Engineering By Desmond S. T. Nicholl
5. Principles of Gene Manipulation and Genomics by Sandy Primrose
6. Gene and Genome Technology: Principles and Applications of Recombinant DNA and Genomics by Sandy Primrose
7. Genome, T.A. Brown

*All the books shall be latest editions.*

**BTT304: Basic Immunology (Max. marks 80+20=100)**

**Unit 1** Introduction and overview of immunology, Cells of the immune system, Organs of the immune system, Generation of B cells and T cells response, Antigens. **20+5 marks**

**Unit 2** Antibodies structure and function, Recombinant antibody, Antibody engineering, Antigen-antibody reactions, Antibody genes and generation of diversity. **20+5 marks**

**Unit 3** Major histocompatibility complex (MHC). MHC molecules and organization of their genes, structure and function of MHC gene products, Antigen processing and presentation. Role of MHC molecules and non MHC molecules in antigen presentation. **20+5 marks**

**Unit 4** Humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions. **20+5 marks**

**Suggested Reading Materials:**

1. Immunology & Immunopathology by Stewart.
2. Cellular and Molecular Immunology by Abul K. Abbas et al.
3. Text book of immunology by Barret.
4. Essential immunology by Roitt. Brostoff, Male, Harcourt Brace & Company
5. Immunology by Kubly by Richard A. Goldsby, Thomas J. Kindt. Barbara A. Osborne, Freeman & Company Mosby publishers.
6. Molecular Biotechnology by Bernard R. Glick & Jack J. Pasternak.

*All the books shall be latest editions*

**BTP305: Laboratory course- V: Biochemistry-II (Max. marks 80+20=100)**

1. Determination of absorption spectra of Nucleic acids
2. Absorption spectra of protein
3. Thermal denaturation of DNA
4. Assay of microbial enzymes (any two) - Amylase, Protease, Catalase, Urease, Galactosidase, Alcohol dehydrogenase, Cellulase & Glucose oxidase.
5. Molecular weight determination of enzymes / proteins by Gel filtration, SDS-PAGE.
6. Isolation & Assay of microbial enzymes (any one) - Catalase, Amylase, Pyrophosphatase, Protease, Invertase.
7. Enzyme Kinetics: enzyme concentration curves, pH curve, determination of  $K_m$  and  $V_{max}$

*Teachers will supply printed detailed instructions, procedure of the experiments.*

**BTP306: Laboratory course- VI: Molecular Biology (Max. marks 80+20=100)**

1. DNA isolation
  - from plant cell (leaf of cabbage / mustard),
  - animal cell (goat/rat liver)
  - Human Blood & Microbes
2. Handling of DNA, RNA, cDNA, restriction enzymes
3. Plasmid DNA isolation
4. DNA analysis on gel electrophoresis
5. Gel documentation.
6. Blood Grouping.
7. Differential counting of W.B.C.
8. WIDAL test and VDRL test
9. ELISA Demonstration.
10. Purification of Antigen
11. Purification of Antibodies .

*Teachers will supply printed detailed instructions, procedure of the experiments.*

**FORTH SEMESTER**

**BTT401: Microbial Biotechnology (Max. marks 80+20=100)**

**Unit 1** Microbial Biotechnology–Historical perspectives, Continuous culture, Batch fed culture, quantification of growth, Thermodynamics of Growth, YATP,  $Y_x/s$ ,  $Y_{O_2}$ . Effect of different factors on growth, Study of growth with respect to product formation.

**20+5 marks**

**Unit 2** Fermentation concept and types, Sterilization medium: air, heat, chemical, UV and filtration; characteristics of cultures during growth, heat production, viscosity, oxygen transfer; factors affecting oxygen transfer and scale-up.

**20+5 marks**



**Unit 3** Food & Dairy Microbiology, Microbial flora, Microbial spoilage, Preservation Microbes as single cell proteins, Treatment schemes of Waste water, Assessment of waste water (water portability), Sewage treatment plants, Aerobic & anaerobic treatment processes, Integration of genetic engineering & applied microbiology, Uses of genetically engineered microbes in Agriculture, Industries and Medicine.

**20+5 marks**

**Unit 4** Microbiology application in manufacturing in the pharmaceutical industry process the production methods for pharmaceuticals of microbial origin such as antibiotics and vaccines. Production of proteins and primary and secondary metabolites. Downstream processing & product recovery.

**20+5 marks**

**Suggested Reading Materials:**

1. Microbiology - Pelczar
  2. General Microbiology - Stanier
  3. Food Microbiology -Frazier
  4. Principles of Fermentation Technology - Whitaker, A.
  5. Cellular and Molecular Immunology, Abul K. Abbas, *et al.*: W. B. Saunders Co.
  6. How the Immune System Works, Lauren M. Sompayrac: Blackwell Science Inc.
  7. Basic Immunology Jacqueline Sharon:, Lippincott, Williams & Wilkins 1st edition
  8. Appleton & Lange's Review of Microbiology & Immunology, William W. Yotis, *et al.*: McGraw-Hill Professional Publishing Paperback
  9. Antibody Usage in the Lab Laura Caponi (Editor) and Paola Migliorini (Editor): (Springer Lab Manual), Springer Verlag, Lab manual edition
  10. The Autoimmune Diseases, Noel R. Rose (Editor), Ian R. MacKay (Editor): Academic Press
  11. Allergic Diseases: Diagnosis and management, Roy Patterson (Editor), *et al.*: Lippincott Williams & Wilkins Publishers
  12. Antibody Techniques, Vedpal S. Malik and Erik P. Lillehoj (Editors): Academic Press
- All the books shall be latest editions.*

**BTT402: Basic Mathematics & Biostatistics (Max. marks 80+20=100)**

**Unit 1** Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Sequences and series, Continuity, uniform continuity, differentiability, mean value theorem.

**20+5 marks**

**Unit 2** Linear Algebra: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations, Algebra of matrices, rank and determinant of matrices, linear equations.

**20+5 marks**

**Unit 3** Introduction of biostatistics, uses of statistics in biological sciences; Population and sample; Type of data and methods of data collection; Data arrangement and presentation, formation of tables and charts; Measures of central tendency and dispersal: computation of mean, median and mode from grouped and ungrouped data.

**20+5 marks**

**Unit 4** Measures of dispersion: computation of variance, standard deviation, standard error and their coefficients. Probability distributions: Binomial, Poisson and normal. Hypothesis testing: Student's 't' test, Chi square test, Analysis of variance. Regression and correlation. Experimental designing, planning of an experiment, replication and randomization. Basic introduction to Multivariate statistics.

**20+5 marks**

**BTT403: Genetic Engineering (Max. marks 80+20=100)**

**Unit 1** Genomic DNA, handling of DNA, RNA, cDNA, RT enzymes and other reagents, techniques, laboratory requirements. Safety measures and regulations for recombinant DNA work, choice and selection of the tools and the techniques. Purification of DNA from bacterial, plant and animal cells. Manipulation of purified DNA. Introduction of DNA into living cells.

**20+5 marks**

**Unit 2** Tools and techniques, Vehicles: Plasmids and bacteriophages, available phagemids, cosmids, viruses. Expression vectors, Vectors for cloning and expression in Eukaryotic cells, Super vectors: **YAC and BACs**. Cutting and Joining DNA – Restriction Endonucleases, Ligation, Alkaline Phosphate, **double digest**, Modification of Restriction Fragments ends, Other Ways of joining DNA Molecules. Application of cloning in gene analysis -How to obtain a clone of a specific gene.

**20+5 marks**

**Unit 3** In vitro DNA amplification - PCR: basic features and application. Reverse transcription and cDNA cloning, genome library, Principles and methods of gene mapping (RFLP, RAPD). Principles of Cell-based DNA Cloning, Cloning System for amplifying different sized fragments, Cloning System for producing single-stranded and mutagenized DNA.

**20+5 marks**

**Unit 4** Development of Transgenic plants and animals- transgene delivery method; Northern, Western and Southern blotting for checking transgene. Selected examples of transgenic plants and animals with reference to transgene and utility. Genetically engineered microbes for drug and pharmaceutical Industry: artificial insulin, gene-recombinant vaccine, diagnostic reagents Transposon mutagenesis, site- directed mutagenesis, DNA sequencing. *In situ* localization by techniques such as FISH and GISH.

**20+5 marks**

**Suggested Reading Materials:**

1. Molecular Biology of the Gene: Watson J. D.
2. Molecular Biotechnology: Glick
3. Milestones in Biotechnology : Classic papers in Genetic Engineering: J. A. Davis, W. S. Resnikoff
4. DNA Cloning – A Practical approach: D. M. Glover and B. D. Hames
5. Principles of Gene Manipulation & Genomics – Primrose and Twyman,
6. Molecular cloning – a laboratory manual – Sambrook and Russell (Vol. 1-3)

*All the books shall be latest editions.*

## **BTT404: Cell, Tissue & Organ Culture (Max. marks 80+20=100)**

**Unit 1** Introduction to Techniques - Introductory history, Laboratory organization, Media, Aseptic manipulation. Basic concepts in cell culture - cell culture, Cellular Totipotency, Somatic Embryogenesis. *In vitro* culture: approaches & methodologies - preparation steps for tissue culture, basic procedure for aseptic tissue transfer, incubation of culture.

**20+5 marks**

**Unit 2** Tissue culture methodologies - Plant cells (Callus Culture, Cell Suspension Culture, Organ Micro-culture, plant micro-propagation, Somatic Embryogenesis); Tissue nutrition: Growth Hormones - Plant cells (Composition of culture media, Growth hormones, Vitamins, Unidentified supplements, selection of media); Artificial seeds and their applications in commercial seed industry. Cryopreservation and its applications in germplasm maintenance.

**20+5 marks**

**Unit 3** Tissue nutrition: Animal cells (substrate on which cells grow, Feeder layer on substrate, gas phase for tissue culture, media and supplements). Tissue culture methodologies - Animal cells (Source of tissue, primary culture, differentiation of cells, growth kinetics, animal cell lines and their origin and characterization).

**20+5 marks**

**Unit 4** Cloning & Selection of specific cell types – cloning, somatic cell fusion and HAT selection, Medium suspension fusion, selection of Hybrid clone, production of monoclonal antibodies. Organ Culture - Culture of embryonic organs, whole embryo culture, culture of adult organs.

**20+5 marks**

### **Suggested Reading Materials:**

1. Introduction to Plant Tissue culture: M.K. Razdan
2. Plant Tissue Culture: Theory & Practice: S.S. Bhojwani & M.K. Razdan
3. Micropropagation: Debergh & Zimmermann
4. Plant tissue culture: Kalyankumar Dey
5. Animal Tissue culture: J. Paul
6. Culture of Animal Cells: A Manual of Basic Technique by R. Ian Freshney
7. General Techniques of Cell Culture Handbooks in Practical Animal Cell Biology by Maureen A
8. Culture of Animal Cells: A Manual of Basic Techniques (5<sup>th</sup> Edition): R Ian Freshney. Wiley-Liss,
9. Animal Cell Culture – Practical Approach, Ed. John R W Masters. Oxford Univ Press
10. Cell Growth and Division: A Practical Approach, Ed. R Baserga. Oxford Univ Press.
11. Animal Cell Culture Techniques, Ed Martin Clynes, Springer.
12. DNA Cloning 4, Mammalian systems: A Practical Approach (2<sup>nd</sup> Edition): V Chisholm, DM Glover & BD Hames, Ed., IRL Press.
13. Experiments in Plant Tissue Culture by John H. Dodds & Lorin W. Robert.
14. An Introduction to Plant Biotechnology by H C Chawla Oxford and IBH

*All the books shall be latest editions.*

**BTP405: Laboratory course- VII: Biostatistics & Microbiology (Max. marks 80+20=100)**

1. Techniques of sampling.
2. Application of probability of CRD and RBD experimental design.
3. Analysis of simple correlation and regression.
4. Staining techniques: Simple, negative Staining , Gram Staining, Endospore Staining and Fungal staining
5. Media preparation: nutrient agar, Nutrient broth preparation, Cotton plugging
6. Isolation of Bacteria and fungi from soil, air, water.
7. Estimation of Microorganisms : Total count (haemocytometer)
8. Antibiotic sensitivity test- Paper Disc method.

*Teachers will supply printed detailed instructions, procedure of the experiments.*

**BTP406: Laboratory course- VIII: Plant & Molecular Biotechnology-I**

**(Max. marks 80+20=100)**

1. PTC Laboratory organization of facility and equipment.
2. Aseptic manipulation– washing, capping, packing & sterilization, laminar flow operation & general precautions.
3. Preparation of stock solutions and nutrient media.
4. Processing of various explants for culture initiation.
5. Callus initiation and maintenance.
6. Regeneration of shoots and roots from callus cultures.
7. Micropropagation of economically and commercially important medicinal plants- Initiation of culture, Effect of plant growth regulators on *in vitro* response of an explant, Hardening and transplantation of *in vitro* plants.
8. Agarose gel electrophoresis
9. Estimation of amount of isolated plasmid DNA by OD
10. Estimation of amount of isolated plasmid DNA by agarose gel electrophoresis
11. PCR
12. Restriction enzyme digestion
13. Analysis of amplified product
14. Analysis of DNA by agarose gel electrophoresis
15. Protein extraction from animals cells
16. Chromatographic techniques for protein separation
  - gel filtration
  - ion exchange
  - affinity

*Teachers will supply printed detailed instructions, procedure of the experiments.*

## **FIFTH SEMESTER**

### **BTT501: Biodiversity and Molecular Taxonomy (Max. marks 80+20=100)**

**Unit 1** Biodiversity and its Conservations: Species diversity and ecostabilty (plant, animal and microbial), Basic concept of Biodiversity, Elements of Biodiversity - Ecosystem Diversity, Genetic Diversity, Species Abundance & Diversity, Patterns of Species Diversity. Global patterns of Biodiversity – measuring biodiversity, Cataloging and Discovering Species, Geographical Patterns of Species Richness, Biogeography, Importance of Distribution Patterns (Local Endemics, Sparsely Distributed Species, Migratory Species), GAP Analysis. Conservation– Conservation of Biodiversity (In-situ and Ex-situ Methods, Principle and Applications), Overexploitation threatening living species, International Trade, Animals threatened by International trade, Problems in Controlling International Trade (Enforcement, Reservations, Illegal Trade), Free Trade & the Environment, Common patterns of Overexploitation. **20+5 marks**

**Unit 2** Hotspot biodiversity areas in India, Red Listed plants and RED Data Book, Threatened plants and animals of India. Exotic Species – Plants, Invertebrates, Fishes, Amphibians, Reptiles, Birds, Mammals, Detrimental Effects of Exotic Species. Endangered Species Conservation, Habitat Conservation Plans. Ethics of Conservation – Values of Biodiversity, Biopiracy, Hybridized plants, GM crops (benefits & criticism), Economic Value of Biodiversity, Legal, Ethical and Conservation issues related to uses of biodiversity, Global Conservation Issues. **20+5 marks**

**Unit 3** Basic concept of Taxonomy – Classification, Construction of Phylogenetic tree, Systematics, Cladistics, Cladograms, Phenetics, Nomenclature. Taxonomy in relation to Chromosomal morphology & Evolution – Chromosomal evolution, why location of genes matter, evolutionary oddities about chromosomes, evolutionary effect of rearrangements of chromosomes, karyotypic orthoselection, chromosomal evolution & speciation. **20+5 marks**

**Unit 4** Molecular Taxonomy in relation to DNA characteristics & Protein sequences – modes of molecular evolution, Neutral theory of Molecular evolution, genetic markers for taxonomic purposes, comparing total genome by DNA-DNA hybridization, comparing DNA sequences, Cladistics, biological identification through DNA barcodes, chromosome painting, establishing molecular homology using protein sequences. **20+5 marks**

#### **Suggested Reading Materials:**

1. An advanced Text Book of Biodiversity K.V.Krishnamoorthy, Oxford &IBH, New Delhi.
2. Biodiversity and Conservation. Joshi PC and Namitha Joshi, APH Publishing Company, New Delhi.
3. Biodiversity and Conservation Melchias Oxford and IBH Publishing Company Pvt Ltd., New Delhi
4. Fundamentals of Ecology E P Odom B Saunders &co, Philadelphia, USA.
5. Evolution Savage, Amerind Publishing Company Ltd, New Delhi.
6. The Theory of Evolution John Marynard Smith, Canto.
7. Evolution Mark Ridley, Wiley-Blackwell.
8. Biodiversity and sustainable development Kumar H.D. (Oxford & IBH)
9. Taxonomy of Angiosperms Naik V.N.

*All the books shall be latest editions*

## **BTT502: Plant Biotechnology (Max. marks 80+20=100)**

**Unit 1** Introduction- Definition, Classical vs modern approach. Production of disease free plants-explant, shoot tip culture, shoot tip grafting, viricidtel Compounds. Micropropagation: Basic technique, Automation in the area, scope as a commercial venture. Tissue Culture as source of Genetic Variability- Somaclonal and gametoclinal variation, Selection, Sources and causes of variation, Application in crop improvement. Applications of somatic hybrids in crop improvement.

**20+5 marks**

**Unit 2** Transgenics: Basic concept and essential steps of the process, Some examples of transgenic plants, Use of suitable promoters, Gene silencing and measures to overcome it, Commercial aspects of the technology. Genetic modification in Agriculture – transgenic plants, genetically modified foods, application, future applications, ecological impact of transgenic plants. Genetically modified foods – organic foods, types of organic foods, identifying organic foods, organic food & preservatives. Genetic modification in Food industry – background, history, controversies over risks, application, future applications. Transformation of organelles: Methods and success, advantages of organelle transformation.

**20+5 marks**

**Unit 3** Plant as Biofactories: Concept, Fermentation and production of Pigments, Perfume, Flavors, Insecticides, anticancer agents, industrial enzymes, vitamins, antibiotics and other biomolecules; Cell cultures for secondary metabolite production; Production of pharmaceutically important compounds; Bioenergy generation.

**20+5 marks**

**Unit 4** Molecular breeding: Concept and methodology of different types of molecular markers. Role of molecular markers in crop improvement, conservation of biodiversity; Marker assisted selection; QTL mapping. Molecular farming: Use of plants for production of nutraceuticals, edible vaccines and other desired products. Biofertilizer and bioplastic, Biocontrol and biotechnology.

**20+5 marks**

### **Suggested Reading Materials:**

1. Roberta Smith, Plant Tissue Culture: Techniques and Experiments. Academic Press.
2. Bhojwani, S.S. and Rajdan, Plant Tissue Culture: Theory and Practice.
3. Roberta Smith, Plant Tissue Culture: Techniques and Experiments, Academic Press; 2nd ed,
4. Crispeels, M.J. and Sadava, D.E., Plants, Genes and Crop Biotechnology, Jones and Bartlett Publishers (2nd Edition), 2003.
5. Bhowjwani, S.S., Plant Tissue Culture: Application and Limitations. Amsterdam, Elsevier
6. Bernard R. Glick and John E. Thompson, Methods in Plant Molecular Biology and Biotechnology, CRC Press.
7. Peter M. Gresshoff, Plant Genome Analysis: Current Topics in Plant Molecular Biology. CRC Press.
8. John Hammond, Peter McGarvey, Vidadi Yusibov, Plant Biotechnology: New Products and Applications, Springer Verlag.
9. Plants, genes & crop improvement, Crispeels – ASPB.

*All the books shall be latest editions*

### **BTT503: Animal Biotechnology (Max. marks 80+20=100)**

**Unit 1** Genome Analysis; Human Genome Project, Molecular marker, Chromosome jumping. Chromosome walking, Microsatellite mapping, Chromosome Region Specific Library. DNA fingerprinting and Application of technique.

**20+5 marks**

**Unit 2** Expressing cloned proteins in animal cells, over production and processing of chosen protein. Applications.

**20+5 marks**

**Unit 3** Production of vaccines in animal cells, production of monoclonal antibodies, Bioreactors for large scale culture of cells, Transplanting cultured cells.

**20+5 marks**

**Unit 4** Artificial breeding *in vitro* fertilization and embryo transfer, artificial insemination, germ cell storage, Genetic modifications methods, integration of microinjected sequences into embryos case study on mice, problems after developing transgenic animals.

**20+5 marks**

#### **Suggested Reading Materials:**

1. Animal cell culture – J. Paul
2. Methods in cell biology - Volume 57
3. Culture of animal cells - R. Ian Freshny, Wiley less

### **BTT504: Bioprocess Technology & Nanobiotechnology (Max. marks 80+20=100)**

**Unit 1** Isolation and screening of industrially important microbes. Improvement of the strains for increased yield and other desirable characteristics. Advantage of bioprocess over chemical process. Basic principles in bioprocess. Media **formulation, Thermal death kinetics. Fibrous filters.**

**20+5 marks**

**Unit 2** Bioreactor design, parts and their functions. Types of reactors CSTR, Tower, Jet loop, Airlift, Bubble column, Packed bed. Immobilized cells. Enzyme co-immobilization. Some examples of bioprocess for the production of biomass. Primary and Secondary metabolites, extracellular enzymes, biotechnologically important intracellular products, exopolymers.

**20+5 marks**

**Unit 3** Transport phenomena in bioprocess – Mass transfer. Mass transfer coefficient for gases and liquids. Dimensionless groups. Mass transfer resistance. Rate of oxygen transfer. Determination of oxygen transfer coefficients. Theological properties of intermedium. Biological heat transfer. Heat transfer coefficients. Bioprocess control and monitoring variables such as Temperature, agitation, pressure, pH. On line measurement. On/off control. PID control. Computers in bioprocess control systems, Downstream processing – extraction, separation, concentration, recovery & purification, Industrial production of Ethyl alcohol.

**20+5 marks**

**Unit 4** Fundamentals of Nanobiotechnology: Basic concepts of Nano science and technology, Properties and technological advantages of Nano materials, Nanorevolution of the XX century, Properties at nanoscale (optical, electronic and magnetic). Theory, definitions and scaling.

**20+5 marks**

**Suggested Reading Materials:**

1. Biochemical Engineering, S Aiba, AE Humphrey and NF Millis, Academic Press
2. Biochemical Reactors, B Atkinson, Pion Ltd., London.
3. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm
4. Process Engineering in Biotechnology, A T Jackson, Prentice Hall, Engelwood Cliffs
5. Bioprocess Engineering: Basic Concepts, ML Shuler, and F Kargi, Prentice Hall, Engelwood Cliffs.
6. Principles of Fermentation Technology, PF Stanbury, A Whittaker and SJ Hall, Pergamon Press, Oxford.
7. Biochemical Engineering Fundamentals Bailey and Ollis, McGraw Hill.
8. Bioprocess Engineering, Shule and Kargi, Prentice Hall.

*All the books shall be latest editions*

**BTP505: Laboratory course- IX: Plant biotechnology-II (Max. marks 80+20=100)**

1. Suspension culture technique – Initiation of culture, sub culture and growth measurement.
2. Encapsulation technique for plant propagation.
3. Isolation of protoplast and their culture.
4. Synthetic seed preparation from intact regenerable explants of medicinal plants using sodium alginate.
5. Plant Genomic DNA extraction and purification
6. Plant propagation through tissue culture (seed, shoot tips , and nodal cutting ) orchids ,citrus
7. Culture of anthers and embryos
8. Agrobacterium mediated genetic transformation of plant and their co-culture
9. Detection of DNA and RNA in transgenic plants.
10. Using the method of western and southern for detection of Transgenic plant

**BTP506: Laboratory course- X: Animal biotechnology-II & Immunology**

**(Max. marks 80+20=100)**

1. Raising antibodies.
2. Routes of immunization.
3. Purification and characterization of immunoglobulin.
4. Ouchterlony double diffusion.
5. Immunoelectrophoresis.
6. Conjugation of antibodies.
7. Development of dot blot.
8. Development of Western blot.
9. Animal cell culture

*Teachers will supply printed detailed instructions, procedure of the experiments.*



## **BTT601: Computer application & Bioinformatics (Max. marks 80+20=100)**

**Unit1:** Basic concept: Computer and its components, Characteristics of computers. Generation of computers, types of digital computer. Maintenance, work-station, super computer, hardware basics, software basics and software. Computer programming: various languages, detailed study of C program language, C fundamentals, loops, control, flow, arrays and pointers. Basics of C++ and Java based object oriented programming, Word processing and documentation: Basic word processing in MS Word, PowerPoint and Excel, Preparing and processing text documents.

**20+5 marks**

**Unit2:** Internet technology: internet and world wide web, client- server organization, FTP, HTTP, Telnet, Gopher and other protocols, browsers and mail managers, netscape and internet explorer, internet domain. Searching the web. Search engines, web indexes, internet security, concepts of firewall digital signature, remote login, Java applets and servlets, scripting, Basic ideas of CGI and Perl, Database Management System and Data mimic: Basics of database management system. SQL, Artificial Neural Network technology, Decision Trees.

**20+5 marks**

**Unit3:** Introduction to Bioinformatics; What is Bioinformatics, Human Genome Project, Application of Bioinformatics. Biological Databases; Primary, Secondary and Composite databases, Genome database: NCBI, TIGR, EBI, SANGER, Nucleic Acid Database: GenBank, DDBJ, EMBL, etc, Protein Database: SWISS-PROT, TrEMBL, PIR, etc. Sequence Analysis; Introduction, local and global alignment, substitution scores and gap penalties; Method for the comparison of two sequences viz. Dot matrix plots, Dynamic Programming, Needleman Wunsch & Smith Waterman algorithms, Methods for similarity databases searching like FASTA and BLAST algorithms. Statistical analysis and evaluation of BLAST results. Position-specific scoring matrices. The use of pattern databases like PROSITE and PRINTS.

**20+5 marks**

**Unit4:** Phylogenetic Analysis: Definition and Terminology; Cladogram, Dendrogram, Phylogram and Phenogram; Species tree and Gene tree: homology, paralogy, orthology, analogy, homoplasy, xenology; Tree Construction Methods: Maximum Parsimony, Maximum Likelihood, Distance based methods; Application of Phylogeny: Evolutionary study, Pedigree analysis, Drug Target Identification, Computational Methods: Gene Prediction, sequence alignment and sequence searching, multiple sequence alignment, protein structure prediction.

**20+5 marks**

### **Suggested Reading Materials:**

1. Computer application in Biology: A basic introduction- Keen, RE and Spain, JD (1992): John Wiley and Sons.
2. *Yashwant Kanitkar*, Programming in C, BPB Publications
3. E. Balaguruswamy, Programming in C, Tata McGraw Hill
4. *David W. Mount*, Bioinformatics, sequence & Genome Analysis, cold Spring Harbor Lab Press
5. *S.C. Rastogi*, Bioinformatics, Concept, Skills & Applications, CBS Publications.

## **BTT602: Environmental Biotechnology (Max. marks 80+20=100)**

**Unit1.** Environmental impact of conventional and modern fuel : Renewable and nonrenewable resources of energy ,conventional fuel and their environmental impact -Firewood ,Plant ,Animals, Wastes, Coal ,Gas, Animal oil .Modern fuel and their environmental impact- Methanogenic bacteria ,Biogas ,Microbial Hydrogen production ,conversion of sugars to ethanol , The Gasohol experiment ,plant based petroleum industries ,cellulose degradation for combustible fuel . **20+5 marks**

**Unit2:** Bioremediation: Bioremediation of soil and water contaminated with oil spills ,heavy metals and detergent s. Degradation of pectin and cellulose using microbes . phytoremediation. degradation of pesticides and other toxic chemical by microorganism -degradation of aromatic and chlorinated hydrocarbon and petroleum product .Treatment of municipal waste and industrial effluents. **20+5 marks**

**Unit3:** Biofertilizers \Biopesticides: Roles of symbiotics and asymbiotics Nitrogen fixing bacteria in the benrichment of soil .Algae and fungal biofertilizers (VAM) ,Vermicomposting, Biopesticides–*Bacillus thuringiensis* and tradition biocontrol method . Bioleaching enrichment of ores by microorganisms ,plants and animals.(gold, copper and uranium). Environmental significance of genetically modified microorganism, plants and animals. **20+5 marks**

**Unit4:** Applied ecology: Environmental pollution; global environmental change; biodiversity- status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. **20+5 marks**

### **Suggested Reading Materials:**

1. Plants and environment \_ *Dauenmire ,R:John Wiley*
2. Concept of Ecology \_ *Kormondy ,EJ;Prentice Hall of India , New Delhu*
3. Environmentals ecology- *B. Freeman Academic Press,UK*
4. Biofertilizers in Agriculture \_*NS subba Rao (Ed\_n ; OXFORD & IBH*
5. Biological control \_*CD Huffakerr ; Plenum Press, New York.*
6. *Fundamentals of ecology- odum ,Ep, WB Sander, Philadelphia,usa*

## **BTT603: Food Biotechnology (Max. marks 80+20=100)**

**Unit1.** Principles of food biotechnology :Basic principles and application of biotechnology in food industries with regard to production ,processing regulatory aspect of modern biotechnology application in food industry in the context of environment protection of human and animals. **20+5 marks**

**Unit2.** Fermentation technology: natural and synthetic media. Fermenters types and cell bioreactors, Process development: shake flask fermentation, upstream processing, Disintegration of cells, separation, extraction, concentration and purification of products. **20+5 marks**

**Unit3:** Lactic acid bacteria-put a dash distribution, classification and physiology; antimutagenic ,antimicrobial and health promoting effects ; malo-lactic. Protective factors of lactic bacteria

in food preservations. Yeasts and moulds associated fermented food .Technology for the production Sauerkranut ,Kimchi, Bamboo shoot ,rice beer ,idli, dosa ,yogurt ,dahi, kefir ,cheese miso , tempch and salami ,traditional fermented food of India ,nutritional changes.

**20+5 marks**

**Unit4.** Microbes in food technology: microbial starters for industrial production; sources, propagation ,preservation, and use of starters. Improvement of starters by classical and molecular biological techniques. Microbial protein as food and feed: SCP and economics of SCP and microbially derived additive ,flavors and odors, Pathogenic microbes – infections; bacterial toxins and mycotoxins sources, physiological effects; methods of prevention and control in foods and feeds.

**20+5 marks**

**Suggested Reading Materials:**

1. Food biotechnology *Ed .dietch knorr, Marcell dekker inc.*
2. Hand book of food analysis (vol I & vol II)\_ *leo m.l nollet ,marcel dekker*
3. Food microbiology \_ *W.C Frazier ;Mc Graw Hill book Co.*
4. Modern food microbiology \_*J.M.Jay ,D. Van ; Nostrand co.*
5. Fermented food (7)-*Ed.by A.H rose ;academics press*
6. Microbial food poisoning \_*Ed.A.R.Elev.chapmam&Hall*
7. Principles of enzymology for food science – *whittaker ,J.R Marcle Dekker*
8. Introduction to fermentation technology –*Whittaker*
9. Biochemical Reactors \_*JM Lee; Prentice Hall Inc ,USA*
10. Bioprocess technology :Fundamentals and application ,*KTH ,Stocholm.*

**BTT604: Entrepreneurship & Management (Max. marks 80+20=100)**

**Unit1.** Introduction: Meaning, need and importance of entrepreneurship, promotion of entrepreneurship, factors influencing entrepreneurship, feature of a successful entrepreneurship. Establishing an enterprise: from s business organization, project identification, selection of the product, project formulation, assessment of project feasibility. Financing the enterprise: importance of finance\loan and payment. Characteristics of business frame, Fixed capital management. Source of fixed capital, working capitals, its sources and how to move for loan .inventory direct and indirect raw materials and its management.

**20+5 marks**

**Unit2:** Marketing management: meaning and important, marketing – mix, product management – product line ,product mix ,stages of product life cycles .Marketing research and importance of workers . Physical distribution and man management .Entrepreneurship and international business: meaning of international business, selection of product, selection of a market for international business ,expert financing, Institutional support for exports.

**20+5 marks**

**Unit3:** Communication: Meaning and Definitions, Principles of Communication, Types of Communication, Personal Space, Nonverbal communication, Language affecting behaviour, Listening Skills, Requisites of an effective letter. Business Letters: Form and style; the opening, salutation, the body, the subject line, the message, the complementary closing signature, reference, initials, enclosure, notation, post script, spacing, continuation-page punctuation style.

**20+5 marks**

Unit 4 Kinds of Business Letters, planning the letter characteristics. routine request, requesting appointments, letter of acknowledgment, persuasive request letters, refusal letters, collection letters, complaints, claim and adjustment letters. Sales letters, responses to letters with sales potentials, Public relations, Press release, memos and other form of messages, informal and analytical reports, agenda and minutes of meetings, Preparing classified advertisement, dinette mail advertising.

**20+5 marks**

**Suggested Reading Materials:**

1. Rao, Nageshwar: Business Communication
2. Dr. S.C. Shrama: : Business Communication
3. Dr. V.S. Vyas : : Business Communication
4. Pal Rajendra and Korlahali J.S. : Essentials of Business Communication
5. Desai Vasant- Dynamics of Entrepreneurial Development, Himalayan Publishing House, Bombay
6. Dr. C.B. Gupta & Dr. S.S. Khanka, Entrepreneurship & Small Business Management, Sultan Chand & Sons, Delhi

**BTP605: Laboratory course- XI: Bioinformatics and food biotechnology**

**(Max. marks 80+20=100)**

1. Statistical analysis of experimental data using computer software
2. Data presentation using computer software
3. Scientific literature survey using internet
4. Using NCBI, GenBank, DDBJ, EMBL, SWISS-PROT etc.
5. Estimation of BOD (2 samples)
6. VAM Staining.
7. Microbial load and their relative density in foods (bacteria, fungi, yeast)
8. Detection and isolation of toxigenic *A. flavus* from stored foods, qualitative and quantitative estimation of aflatoxins from cultured stains.
9. Estimation of Lactic acid and Lactose
10. Immobilization of Yeast cells
11. Studies in Indigenous fermented foods and beverages of N.E. Regions- Isolation and Identification of Microorganisms involved in fermentation under controlled condition.

*Teachers will supply printed detailed instructions, procedure of the experiments.*

**BTP606: Project Work (Max. marks 100)**

Project work may be carried out on any topic out of the syllabus. However preference should be given on Food Biotechnology and Bioremediation of water as the course was opened under Innovative Programme of the UGC on the topic “Application of Biotechnology in Food and Water Security”. Students should be encouraged to work independently, however each student should be assigned to a faculty member of the Department. At the end of the project work, each student should submit report in the form of dissertation to the Head of the Department within a dateline fixed by the Head of the Department. The dissertation should be examined and evaluated by a committee of faculty members.