

B. Sc. Biotechnology Curriculum

FIRST SEMESTER

COURSE CODE	TITLE OF THE COURSE	CREDITS	DISTRUBUTION OF MARKS					TOTAL PASS MARKS
			INTERNAL EXAM	P.M	EXTERNAL EXAM	P.M.	TOTAL MARKS	
C-1.T.	BIOCHEMISTRY & METABOLISM	04	15	06	60	24	75	30
C-2.T.	CELL BIOLOGY	04	15	06	60	24	75	30
C-1&C2.P.	PRACTICAL	04	10	04	40	16	50	20
AECC1	*	02	10	04	40	16	50	20
GE-1.T	**	04	15	06	60	24	75	30
GE-1.P	**	02	05	02	20	08	25	10

SECOND SEMESTER

COURSE CODE	TITLE OF THE COURSE	CREDITS	DISTRUBUTION OF MARKS					TOTAL PASS MARKS
			INTERNAL EXAM	P.M	EXTERNAL EXAM	P.M.	TOTAL MARKS	
C-3.T.	MAMMILIAN PHYSIOLOGY	04	15	06	60	24	75	30
C-4.T.	MICROBIAL & PLANT PHYSIOLOGY	04	15	06	60	24	75	30
C-3&C4.P.	PRACTICAL	04	10	04	40	16	50	20
AECC2	*	02	10	04	40	16	50	20
GE-2.T	**	04	15	06	60	24	75	30
GE-2.P	**	02	05	02	20	08	25	10

* AECC: - Eng/ EVS/ MIL (Hindi, Urdu, Bangla etc.)

** GE: - Botany, Chemistry, Zoology, Geology, Anthropology

THIRD SEMESTER

COURSE CODE	TITLE OF THE COURSE	CREDITS	DISTRUBUTION OF MARKS					TOTAL PASS MARKS
			INTERNAL EXAM	P.M	EXTERNAL EXAM	P.M.	TOTAL MARKS	
C-5.T.	GENETICS	04	15	06	60	24	75	30
C-6.T.	GENERAL MICROBIOLOGY	04	15	06	60	24	75	30
C-7.T.	CHEMISTRY-1	04	15	06	60	24	75	30
C-5, C6&C7.P.	PRACTICAL	06	15	06	60	24	75	30
SEC-1	*	02	10	04	40	16	50	20
GE-3.T	**	04	15	06	60	24	75	30
GE-3.P	**	02	05	02	20	08	25	10

*:- Environment & Public Health, Computer Application & Information Technology

**:- Botany, Chemistry, Zoology, Geology, and Anthropology

FOURTH SEMESTER

COURSE CODE	TITLE OF THE COURSE	CREDITS	DISTRUBUTION OF MARKS					TOTAL PASS MARKS
			INTERNAL EXAM	P.M	EXTERNAL EXAM	P.M.	TOTAL MARKS	
C-8.T.	MOLECULAR BIOLOGY	04	15	06	60	24	75	30
C-9.T.	IMMUNOLOGY	04	15	06	60	24	75	30
C-10.T.	CHEMISTRY-2	04	15	06	60	24	75	30
C-8, C9&C10.P.	PRACTICAL	06	15	06	60	24	75	30
SEC-2	*	02	10	04	40	16	50	20
GE-4.T	**	04	15	06	60	24	75	30
GE-4.P	**	02	05	02	20	08	25	10

*:- Entrepreneurship, Science & Life

**:- Botany, Chemistry, Zoology, Geology, and Anthropology

FIFTH SEMESTER

COURSE CODE	TITLE OF THE COURSE	CREDITS	DISTRUBUTION OF MARKS					TOTAL PASS MARKS
			INTERNAL EXAM	P.M	EXTERNAL EXAM	P.M.	TOTAL MARKS	
C-11.T.	INDUSTRIAL FERMENTATION	04	15	06	60	24	75	30
C-12.T.	RECOMBINANT DNA TECHNOLOGY	04	15	06	60	24	75	30
C-11&C12.P.	PRACTICAL	04	10	04	40	16	50	20
DSE-T.1.	PLANT BIOTECHNOLOGY	04	15	06	60	24	75	30
DSE-T.2.	ENVIRONMENTAL BIOTECHNOLOGY	04	15	06	60	24	75	30
DSE-1&2.P.	PRACTICAL	04	10	04	40	16	50	20

SIXTH SEMESTER

COURSE CODE	TITLE OF THE COURSE	CREDITS	DISTRUBUTION OF MARKS					TOTAL PASS MARKS	
			INTERNAL EXAM	P.M	EXTERNAL EXAM	P.M.	TOTAL MARKS		
C13	BIO ANALYTICAL TOOLS	04	15	06	60	24	75	30	
C-13 P	PRACTICAL	02	05	02	20	08	25	10	
DSE-3.T.	ANIMAL BIOTECHNOLOGY	04	15	06	60	24	75	30	
DSE-4.T.	BASICS OF MATHEMATICS & BIOSTATISTICS	04	15	06	60	24	75	30	
DSE-3&4.P.	PRACTICAL	04	10	04	40	16	50	20	
DISSERTATION	DISSERTATION	06						100	50
----	*Extracurricular activities(1st to 4 th semester)	01						50*	

Total number of credits in six semesters = 140 (T= Theory, P= Practical)

1 CREDIT (*50 marks) for extension co-curricular/extracurricular activities during 1st, 2nd, 3rd and fourth semester.

DETAILS OF CURRICULUM

FIRST SEMESTER

BIOCHEMISTRY & METABOLISM (C-1)

UNIT I

Carbohydrates Definition, Classification of Carbohydrates; Chemical structure and properties & examples of Monosaccharide, Disaccharides, Oligosaccharides and Polysaccharides. Structure and properties of Purines & Pyrimidines.

UNIT II

Proteins: Definition, structure and classification of Amino acids. Basics of essential and non-essential amino acid, Acid-base properties and solubility's, Amino acid sequencing of proteins; Structure, properties and functions of primary, secondary and tertiary proteins.

UNIT III

Lipids: Definition, classification and properties of lipids; Saturated and Unsaturated Fatty Acids and their role and functions in microorganisms. Structure and properties of waxes, steroids, lipo-proteins and lipo-polysaccharides.

UNIT IV

Enzymology Definition, structure and properties of enzymes, Classification of enzymes; Co-enzymes and Cofactors; Introduction to Active site and Enzyme specificity; Factors affecting the enzyme action: temperature, pH, activators, inhibitors, substrates; Enzyme-substrate interaction: Fisher lock-key hypothesis and Koshland induced fit hypothesis.

UNIT V

Cell signaling Hormones & their receptors, Cell Surface receptors, signaling through G-Protein coupled receptors, Signal transduction pathways, second messengers, Regulation of signaling pathways, Bacterial Chemotaxis.

PRACTICALS

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins.

CELL BIOLOGY (C-2)

UNIT I

Origin of life on Earth - The theory of Extraterrestrial contact. Theory of Chemical Evolution, Primitive Earth Conditions – anoxic reductive atmosphere, relatively high temperature, Volcanic eruption, radioactivity, high frequency UV radiation. Abiotic formation of sugars, amino acids, organic acids, purines, pyrimidines, glycerol and formation of nucleotides and their polymerization to RNA on reactive Surfaces, polymerization of amino acids to Polypeptides and Proteins. Ribozymes and RNA World. Formation of DNA.

UNIT II

Basics of Cell Biology (structure & function) – Discovery of cell and Cell Theory; Comparison between plant and animal cells; Cell wall; Plasma membrane; Modification of plasma membrane and intercellular junctions.

UNIT III

Structural Organization and function of cellular organelles: - Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes, Plastids, Vacuoles, Chloroplast, Cytoskeleton and its role in motility.

UNIT IV

Membrane structure & transport – Models of membrane structure, Membrane lipids, proteins and carbohydrates; Solute transport by Simple diffusion, Facilitated diffusion and Active & Passive transport

UNIT V

Cell cycle - An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra-cellular control of cell division, Programmed cell death (Apoptosis), intrinsic & extrinsic pathways of cell death, Cancer.

PRACTICALS

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

ENGLISH/EVS/MIL COMMUNICATION (AECC-1)

BIOTECHNOLOGY AND HUMAN WELFARE (GE-1)

UNIT I

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT II

Agriculture: Nitrogen fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB..

UNIT IV

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

SECOND SEMESTER

MAMMALIAN PHYSIOLOGY (C-3)

UNIT I: Digestion and Respiration

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice Respiration: Exchange of gases, Transport of O₂ and CO₂, Oxygen dissociation curve, Chloride shift.

UNIT II: Circulation

Composition of blood, Plasma proteins & their role, blood cells, Haemopoiesis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT III: Muscle physiology and osmoregulation

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT IV: Nervous and endocrine coordination

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters. Mechanism of action of hormones (insulin and steroids) Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

PRACTICALS

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin

MICROBIAL AND PLANT PHYSIOLOGY (C-4)

UNIT I:

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

UNIT II:

Effect of the environment on microbial growth Temperature- temperature ranges for microbial growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure. Chemolithotrophic metabolism, Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and methanogens.

UNIT III:

Photosynthesis- Photosynthesis pigments, anoxygenic and oxygenic photosynthesis, concept of two photo systems, photosynthetic pigments photophosphorylation, , physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation, calvin cycle, CAM plants, photorespiration, compensation point.

UNIT IV:

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants. Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberellins, cytokinins, abscisic acid, ethylene) Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization

PRACTICALS

1. Separation of photosynthetic pigments by paper chromatography.
2. Demonstration of aerobic respiration.
3. Preparation of root nodules from a leguminous plant.
4. To study and plot the growth curve of *E. coli* using turbidometric method and to calculate specific growth rate and generation time.
5. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
6. To study the effect of pH on the growth of *E. coli*
7. To study the effect of temperature of *Aspergillus niger* by dry weight method.
8. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

ENGLISH/EVS/MIL COMMUNICATION (AECC-2)

BIOETHICS AND BIOSAFETY (GE-2)

Unit I - Introduction to Ethics & Bioethics Ethical issues in genetic engineering, patenting human genes, cloning; Biotechnology & social responsibility.

Unit II - Intellectual property Rights TRIPS; GATT; International Conventions; Patent-basic principle & requirements.

Unit III - Biosafety regulatory frame work for GMOs in India; Biosafety regulatory frame work for GMOs at International level.

Unit IV - Hazard assessment Use of genetically modified organisms & their release in environment; Biosafety in laboratory- Laboratory associated infections and other hazards.

Unit V- International dimensions in Biosafety- Bioterrorism & conventions on biological weapons.

THIRD SEMESTER

GENETICS (C-5)

UNIT I

Science of Genetics – an overview of history of Genetics Present, about three general areas of Genetics (Classical, Molecular & Evolutionary). Mendelism & Chromosome Theory – Mendel's principles, applications of Mendel's principles, Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance, Inheritance patterns in Human. Linkage & Crossing over.

UNIT II

Allelic Variation & Gene function Multiple allele, Genetic interaction, Penetrance (complete & incomplete), Expressivity, Pleiotropism. Non-Mendelian inheritance Evidences for Cytoplasmic factors, cytoplasmic inheritance & extranuclear inheritance (mitochondrial, chloroplast)

UNIT III

Nucleic acids: Structure, function and properties of DNA and RNA. Watson and Crick model of DNA. DNA forms (A, B and Z), their characteristic. Different types of RNA, their structure and function. Organization of Genomes – bacterial, viral, human, organelles.

UNIT IV

Chromosomal variation in Number & Structure Euploidy, Non-disjunction & Aneuploidy, Aneuploidy in Human, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Special chromosome, Deletion, Duplication, Inversion, Translocation, Centromeric & Non-centromeric breaks in chromosomes, chromosomal rearrangements in Human being, Chromosomal aberrations & evolution. Human karyotype, Banding techniques

UNIT V

Mutation Types, causes and detection, insertional mutagenesis. Bacterial genetics (conjugation, transformation, transduction)

PRACTICALS

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of - Barr body -*Rhoeo* translocation.
5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicine treatment.

GENERAL MICROBIOLOGY (C-6)

UNIT I

History of Microbiology: Leeuwenhoek and his microscope, Germ theory of disease – Koch's postulates, development in disease prevention, antiseptics, immunization, chemotherapy, classes of microorganisms, bacteria, virus, fungi. Morphological characters of bacteria, fungi, PPLOs. Difference between eukaryotic & prokaryotic cells. Nature of microbial cell surfaces; Gram positive and Gram negative bacteria, kinds of flagella, Ultra structure of flagella.

UNIT II

Nutritional classification of microorganisms: Industrial media (Requirements for carbon, nitrogen) Concept of sterilization, Methods of sterilization of media and equipments /glassware. Isolation of pure cultures.

Microscopes Concepts - Resolving power. Construction and working: Dissecting, Compound Light and Darkfield. Inverted. Phase contrast. Fluorescence. Electron microscopes. (4 Periods)

UNIT III

Growth and reproduction in bacteria, fungi, virus & bacteriophages – lytic cycle, lysogenic. Factors affecting growth – pH, temperature, O₂ requirement.

UNIT IV

Principles of food preservation: Spoilage of food by microbes; Methods of food preservation, Removal of microorganisms, Asepsis, Preservation by using high temperature and low temperatures. Preservation by drying: Methods of drying. Factors in the control of drying. Preservation by food additives.

UNIT V

Microbes in extreme environments –Thermophiles, psychrophiles and alkalophiles. Pathogenesis and pathogenic microorganisms, defense mechanism against microorganisms. (Typhoid, AIDS, Dermatormycoses) .

PRACTICALS

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

CHEMISTRY-1(C-7)

Group –A (INORGANIC)

Unit -1 (Atomic Structure): -

Electromagnetic waves, Matter waves and their difference, Problems based on de-Broglie's relationship. Heisenberg's uncertainty Principle. Time independent Schrodinger's equation for hydrogen like atom (derivation not required).

Unit-2 (Periodic Properties): -

Periodicity in the following properties: Atomic and ionic radii, Ionization energy, electron affinity and electronegativity.

Unit -3 (Covalent Bonding): -

Polar and Non-polar covalent bonds, Properties of covalent compounds, Bond theory, Hybridization, Shapes of inorganic molecules and ions

(a) Without lone pair on central atom

(b) With lone pairs (s) on central atoms.

Group –B (ORGANIC)

Unit-1

Classification of carbon atoms in organic compounds alkyl, alkenyl and alkynyl groups, Functional groups, relative seniority of functional groups, IUPAC system of nomenclature. Polarisation of covalent bonds, Hybridization of carbon σ and π bonds, Polarisation of covalent bonds, Inductive effect, electromeric effect, Resonance, condition of Resonance, Hyperconjugation, Hydrogen bond its effect on physical properties of organic compounds. Effect of inductive effect resonance effect on physical properties molecules.

Unit- 2

An idea of reaction mechanism and reaction intermediates – carbocation, carbonion and carbon free radicals.

Unit-3

Alkanes: - Sources methods of formation, Physical properties and chemical properties of alkanes.

Group- C (PHYSICAL)

Unit-1 (Gaseous state): -

Ideal and real gases, Causes of deviation of an real gas from ideal behavior. Equation of state of ideal gases, correction of pressure and volume terms for real gases in equation of state. Units and significance of van der Waals constant. Applications of van der Waals equation.

Unit- 2 (Dilute Solutions): -

Ideal and non- ideal solute, ions, methods of expressing concentrations of solutions, colligative properties- Relative lowering of vapour pressure, osmosis and osmotic pressure.

Unit-3 (Chemical Kinetics and catalysis): -

Chemical kinetics and its scope, rate of reaction, factors influencing the rate of reaction- concentration, temperature, pressure, light and catalyst. Order and molecularity, Derivation of expression for the 1st order reaction. Units of specific rate constants for various order of reactions, half life and mean life. Effect of temperature on the rate of reaction: - Arrhenius Equation experimental determination of order of reaction. Radioactive decays as the 1st order phenomenon.

Practical

ORGANIC PRACTICAL

1. Hydrolysis of ester: Ethyl benzoate to benzoic acid.
2. Nitration: Nitrobenzene to m- dinitrobenzene
3. Oxidation: Oxidation of Benzaldehyde to benzoic acid.
4. Detection of elements (Nitrogen, sulphur and Halogen) and functional groups (Phenolic, carboxylic acid, aromatic nitro, aromatic amino, aldehydes and ketone)

INORGANIC PRACTICAL

1. Acidimetry- alkalimetry: preparation of 250cc (N/10) oxalic acid solution.
Determination of acetic acid in vinegar using standard NaOH solution.
2. Permanganometry: Determination of Fe^{++} iron in Mohr's salt by standard permanganate.
3. Complexometric: Estimation of calcium ion in water using EDTA.

FUNDAMENTALS OF COMPUTERS & BIOINFORMATICS (SEC-1)

UNIT I

Computers: General introduction (Characteristic, capabilities, generations).

Hardware: Organization of hardware (Input devices, memory, control unit, arithmetic and logic unit, output devices).

Software: (system software, application software)

UNIT II

Languages: (Low level, High level), interpreter, compiler, data processing, batch, on-line, real time (examples form bio-industries, e.g. application of computers in coordination of solute concentration, pH, temperature, etc., of a fermenter in operation)

UNIT III

Introduction to Office operations: Microsoft word, Microsoft excel Microsoft power point.

UNIT IV

Internet application: Introduction to operating systems.

UNIT V

Bioinformatics: Application of computer in Biotechnology, genome analysis, sequence analysis, primer designer, phylogenetic analysis.

PRACTICALS (BIOINFORMATICS)

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

PRACTICALS (COMPUTERS)

1. MS-DOS (Internal commands: - MD, CD, RD, CLS, EXIT, COPY CON, TYPE, DATE, TIME, ECHO, PROMPT, DIR, Batch file command)
2. MS-Word (insertion of text, paragraph, images, mail merge, hyperlink, auto text, auto correct, page setup, header & footer, toolbars, text direction, change case, border and shading, bullets and numbering, font, word count, protect document, macro, spelling and grammer, insertion of table and its all elements)
3. MS-Excel (functions:- arithmetic, logical and text oriented functions, Goal seek, scenarios, formula auditing, sorting, filtering, validation etc)
4. MS-Power Point (All tools to create attractive presentation)
5. Internet Browsers

BASICS OF FORENSIC SCIENCE (GE-3)

Unit I

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

Unit II

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

Unit III

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

Unit IV

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

FOURTH SEMESTER

MOLECULAR BIOLOGY (C-8)

UNIT I

DNA as the genetic material – experiments proving DNA and RNA as genetic material.

Eukaryotic genomes: Chromosomal organization and structure. Euchromatin, heterochromatin, centromere, telomere. Chromatin structure (nucleosome), histone and non-histone proteins.

UNIT II

DNA Replication: Semi-conservative mode of DNA replication, experimental proof. Unidirectional and bidirectional mode of DNA replication, theta model and rolling circle model. DNA replication in prokaryotes and eukaryotes, different stages, proteins and enzymes involved. DNA damage and repair: causes of DNA damage, mutations. Repair mechanisms- photoreactivation, excision repair, mismatch repair, SOS repair.

UNIT III

Transcription in prokaryotes and eukaryotes, different stages, mechanism, promoters, transcription factors, RNA polymerases. Post transcriptional modifications- 5' cap formation, 3'-end processing/polyadenylation and gene splicing and generation of mature mRNA. Inhibitors of transcription.

UNIT IV

Translation/Protein synthesis: Mechanism of initiation, elongation and termination of protein synthesis in prokaryotes and eukaryotes. Inhibitors of translation. Post-translational modifications.

UNIT V

Regulation of Gene Expression in prokaryotes and eukaryotes, induction and repression, positive and negative regulation. Operon model- lac, trp, catabolite repression, transcription attenuation.

Molecular mechanisms of DNA recombination– Site Specific and Homologous recombination. **Genetic Code:** concept, elucidation or cracking of genetic code, features of genetic code, Wobble hypothesis.

PRACTICALS

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test or reverse mutation for carcinogenicity

IMMUNOLOGY (C-9)

UNIT I

Immunology: Introduction, History and Scope. Terminology of immune system. Immunity: Definition, types of Immunity- Innate, Adaptive/acquired (active, passive, natural/artificial, Humoral and Cell mediated immunity). Features of Immune Response – memory, cell specificity/diversity, recognition of self and non-self.

UNIT II

Cells of the Immune System – B and T cells (types and receptors), Null cells, Monocytes, Polymorphs.

Organs of the Immune System: Primary and Secondary Lymphoid organs- Thymus, Spleen, Lymph nodes.

UNIT III

Antigens: Concept, Types of Antigens, Antigenic determinants/epitopes, Hapten. Antigen and Immunogen. Antigenicity and Immunogenicity. Factors affecting antigenicity. Antibodies: Structure, Types/Classes, properties and functions of immunoglobulins. Production of antibodies. Antibody diversity (a brief account only).

Antigen – Antibody Interactions: Binding sites, Binding forces, Affinity, Avidity, Cross reactions. Precipitation and Agglutination reactions, RIA, ELISA etc. techniques. Complement system: Structure, components, properties and functions.

UNIT IV

Immune Response: Introduction, Humoral Immunity – Primary and Secondary immune response – B cells in antibody formation (differentiation, maturation and activation of B cells). Role of MHC molecules. Immune Response of Plants.

PRACTICALS

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

CHEMISTRY -2 (C-10)

Group – A (INORGANIC)

Unit-1

Chemistry of elements of first transition series: - Characteristics properties of d-block elements. Properties of the elements of the first transition series their binary compounds and complexes illustration relative stability of their oxidation states, coordination number and geometry.

Unit-2

Coordination compounds: - Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, Isomerism in coordination compounds, Valence bond theory of transition metal complexes.

Group- B (ORGANIC)

Unit -1 (Alkenes): -

Nomenclature of alkenes, Methods of formation, Mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides; the Saytzeff rule, Hoffmann elimination; physical properties and relative stabilities of alkenes, Chemical reaction of alkenes; Mechanism involving in electrophilic and free radical additions, Markovnikov's rule Kharasch effect, Hydroboration-oxidation, oxymercuration- reduction, Epoxidation, Ozonolysis, Hydroxylation and oxidation with KMnO_4 , Polymerization of alkenes, Substitution at allylic and vinylic position of alkenes.

Unit-2 (Nomenclature, structure and Bonding in alkynes): -

Methods of formation, chemical reactions of alkynes, acidity of alkynes, Mechanism of electrophilic and nucleophilic addition reaction, Hydroboration- oxidation, metal ammonia reduction, oxidation and polymerization.

Unit- 3 (Alkyl and aryl halides): -

Preparation of alkyl halides Nucleophilic substitution- $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ and elimination reaction – E_1 , E_2 and $\text{E}_{1\text{CB}}$, Reactions with metals. Methods of formation of aryl halides, Nuclear and side chain reactions, comparison of reactivity and dipole moment with alkyl halides, vinyl halides and allyl halides.

Unit-4 (Alcohols): -

Classification and nomenclature, Methods of formation, physical and chemical properties of monohydric alcohols, comparison of alcohols and phenols.

Group-C (PHYSICAL)

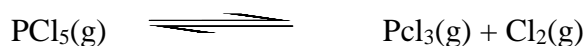
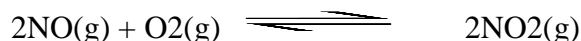
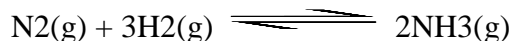
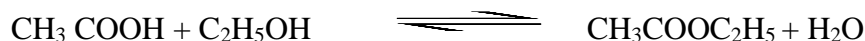
Unit-1

Definition: - System, surrounding, intensive and extensive properties, reversible and irreversible process isothermal, adiabatic and isochoric process, Heat works, internal energy,

Heat capacity, 1st law of thermodynamic, Expression for work done in various processes; Enthalpy; Second law of thermodynamic; concept of entropy, Gibbs free energy and Heilmhitz work function; criteria of equilibrium and spontaneity – Gibbs –Helmholtz equation, Maxwells's four relation- derivation on the basis of the properties of exact differential.

Unit-2 (Chemical Equilibrium): -

Law of mass action, Derivation of expressing for equilibrium constant (K_p and K_c) for the following reactions.



Application of Le-Chatellers Principle to the above equilibria.

Relationship between temperature and pressure on equilibrium between two phases.

- (a) Ice \rightleftharpoons Water
- (b) Water \rightleftharpoons Steam
- (c) C(Diamond) \rightleftharpoons C (Graphite)
- (d) Clausius \rightleftharpoons Clapeyron equation.

Practical

1. Qualitative inorganic analysis of salt mixture containing four radicals including one interfering radical.
2. Preparation of sodium trioxalato ferrate(III)
3. Preparation of copper tetraammine complex.
4. Gravimetric analysis of sulphate of barium.

ENTERPRENEURSHIP DEVELOPMENT (SEC-2)

Unit -I

Need, Scope & Characteristics of Entrepreneurship.

Identification of opportunities.

Exposure to Demand based, Resource based, Service based, Import Substitute and Export Promotion Industries.

Market Survey Techniques.

Unit II

Need, Scope and Approach for Project Formulation.

Structure of Project Report.

Books of Accounts

Resource Management – Men, Machine and Materials.

(a) Creativity and Innovation (b) Problem Solving Approach.

(c) Strength Weakness Opportunity and Threat (SWOT) Techniques.

Techno-Economic Feasibility of the project.

Quality Control / Quality Assurance and Testing of Product.

Unit III

Business Plan

Elements of Marketing and Sales Management.

(a) Nature of Product and Market Strategy.

(b) Packaging and Advertising After sales Service

Management of self and understanding human behavior.

Sickness in Small Scale Industries and their Remedial measures.

Recommended Books:

1. Couger, Creativity & Innovation
2. Dollinger M.J.-Entrepreneurship Development(Prentice Hall 1994)
3. Holt Entrepreneurship; New Venture Creation (Prentice Hall 1999)

RESEARCH METHADODOLOGY (GE-4)

Unit I

Research- Purpose, Types & Research plan and its components. Survey, Observation, Case Study.

Unit II

Research problem: Identification and formation of research problem. Elements in research methodology. Research Design, components of research.

Unit III

Role of IPR and patenting in Research and Development. Ethical, legal, social and scientific issues in research.

Unit IV

Data Collection, Sources of Data, Primary Data, Secondary Data. Procedure Questionnaire. Sampling, merits & demerits. Experiments; kinds and procedure. Control Observation- Merits & Demerits. Kinds. Procedurre, Brief idea of Sampling errors.

FIFTH SEMESTER

INDUSTRIAL FERMENTATION (C-11)

UNIT I

Commercial Production of Microorganisms – Industrial Fermenters, Single-cell Protein.
Principles of Microbial growth – introduction, the ways of growing microorganisms, ways to increase yield of microbes, Batch, fed-batch and continuous cultures.

Products from Microorganisms – Metabolites, Enzymes, Antibiotics.

UNIT II

Bioreactor / Fermenter – types & operation of Bioreactors, physico-chemical standards used in bioreactors, limitations of bioreactors, stages of fermentation processes, Media design for fermentation processes, Solid substrate fermentation, Fermenters (Stirred tank, bubble columns, airlift. Bioreactors, Static, Submerged and agitated fermentation), advantages & disadvantages of solid substrate & liquid fermentations.

UNIT III

Technology of Microbial cell maintenance – steps to maintain microbial culture in an aseptic & sterile environment (how to inoculate, preserve & maintain), Strain preservation, maintenance and strain improvement by mutation of gene transfer processes

UNIT IV

Downstream processing – extraction, separation, concentration, recovery & purification, operations, Industrial production of Ethyl alcohol, Acetic Acid (Vinegar), α -amylase, protease penicillin, vitamin B12, with reference to easily available raw materials.

UNIT V

Enzyme technology – nature of enzymes, application of enzymes, limitations of microbial cells used as catalysts in fermentation, genetic engineering & cloning strategy for enzymes, technology of enzyme production, use of immobilized cells and enzymes, industrial applications of immobilized enzymes.

PRACTICALS

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)

RECOMBINANT DNA TECHNOLOGY (C-12)

UNIT I

Introduction to gene cloning, enzymes and basic tools involved in gene cloning.

UNIT II

DNA sequencing methods, hybridization techniques (Northern, southern, western blotting), In Situ hybridization, PCR.

UNIT III

Isolation and purification of total cell DNA

UNIT IV

Cloning vectors in prokaryotes and eukaryotes (pBR 322, pUC18, M13, cosmids, Phagemids, phasmids, yeast vectors, Animal viral vectors - SV40, Plant viral vectors - CaMV, Agrobacterium – Ti plasmid.

UNIT V

Introduction of recombinant DNA into living cells an overview. Selection and screening of recombinant clones. Genetic engineering in animals: Production of transgenic mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines, transgenic animals. Genetic engineering in plants: Use of Agrobacterium tumefaciens and Arhizogenes, Ti plasmids.

PRACTICALS

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

PLANT BIOTECHNOLOGY (DSE-1)

UNIT I

Introductory History – Concepts of Cell theory & Cellular totipotency, Milestones in plant tissue culture. Infrastructure & Organization of plant tissue culture laboratory – General & aseptic laboratory, different work areas, equipments & instruments required, other requirements. Aseptic techniques – Washing & preparation of glassware, packing & sterilization, media sterilization, surface sterilization, aseptic work station, precautions to maintain aseptic conditions.

UNIT II

Culture Medium – Nutritional requirements of the explants, PGR's & their in vitro roles, media preparation.

Explant' for plant tissue culture – histological and/or cellular characteristics Response of explants *in vitro* – Dedifferentiation and Redifferentiation

- a) Callus formation
- b) Organogenesis (direct and indirect)
- c) Embryogenesis (direct and indirect)

UNIT III

Callus culture technique – Introduction, principle, protocol, factors affecting, Morphology & internal structure, genetic v Suspension culture technique

Organ culture technique – Introduction, principle, protocol factors affecting w.r.t. root tip culture, leaf culture, shoot tip & meristem culture.

Anther & pollen culture technique – Introduction, principle, protocol, factors affecting, ovary, ovule, embryo and endosperm culture. Protoplast – protoplast isolation, protoplast culture.

UNIT IV

Somatic hybridization – Protoplast fusion techniques, selection of hybrids, production of symmetric & asymmetric hybrids & cybrid production.

Somaclonal variation – Introduction, terminology, origin, selection at plant level, selection at cell level, mechanism, assessment, Introduction to secondary metabolite production

UNIT V

Genetic transformations – DNA uptake by seeds, pollens, transformation of protoplasts, agrobacterium mediated transformations, direct DNA transfer methods –electroporation, microprojectile bombardment, microinjection, use of marker genes, integration & expression of foreign DNA

PRACTICALS

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

ENVIRONMENTAL BIOTECHNOLOGY (DSE-2)

UNIT I

Renewable and non-renewable resources of Energy.

Conventional fuels and their environmental impacts:

- Firewood
- Plant and animal wastes
- Coal
- Gas
- Petroleum

UNIT II

Modern fuels and their environmental impacts:

- Methanogenic bacteria and biogas
- Microbial hydrogen production
- Conversion of sugars to ethanol. The gasohol experiment
- Plant based petroleum industry
- Biomass production and Cellulose degradation for combustible fuel.

UNIT III

Microbiological quality of food and water, Environmental monitoring (Physical and Chemical) Biological analysis, Biosensors.

UNIT IV

Treatment of municipal waste and industrial effluents (Solid & Liquid).

Degradation of pesticides and toxic chemicals by microorganisms.

Thuringiensis toxin as a natural pesticide.

UNIT V

Biological control of insects and pathogens. Vermi Culture.

Enrichment of ores by microorganisms. Biofertilizers : Classification, production and applications.

PRACTICALS

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.

SIXTH SEMESTER

BIOANALYTICAL TOOLS (C-13)

UNIT I

Thermodynamics as applied to biological systems: Enthalpy. Entropy. Free energy. Gibb's free energy (G). Helmholtz free energy (A). Thermoregulation: Thermometric properties and types of thermometers (clinical, thermocouple, bimetallic, platinum resistance, thermistor - thermometers).

UNIT II

Separation & Identification of Materials - Concept of Chromatography (Partition Chromatography, Paper Chromatography, Adsorption Chromatography, TLC, GLC, Ion Exchange Chromatography, Gel Chromatography, HPLC, Affinity Chromatography); Electrophoresis .

UNIT III

Centrifugation – Basic Principle of Centrifugation, Instrumentation of Ultracentrifuge (Preparative, Analytical), Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient, Centrifugation of associating systems, Rate-Zonal centrifugation, sedimentation equilibrium Centrifugation.

UNIT IV

X-Ray Crystallography – X-ray diffraction, Bragg equation, Reciprocal lattice, Miller indices & Unit cell, Concept of different crystal structure, determination of crystal structure [concept of rotating crystal method, powder method].

UNIT V

General spectroscopy: UV, Visible and Infra-Red Fluorescence, Atomic absorption, IR, Raman spectra.

PRACTICAL

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

ANIMAL BIOTECHNOLOGY (DSE-3)

UNIT I

Introduction: Principles & practice. History and Development of animal cell culture. Scope and Applications.

Culture Media: Media components, Serum containing and serum free media. Natural media, Growth factors required for proliferation of animal cells. Chemically defined media, balanced salt solutions. Physical requirements for growing animal cells in culture

UNIT II

Primary Cell Culture techniques: Isolation of tissue explants, disaggregation- enzyme disaggregation and mechanical disaggregation of the tissue. development of primary culture and cell lines. Subculture. Contamination. Suspension culture.

Secondary cell culture – transformed cell and continuous cell lines. Finite and infinite cell lines. Cell lines: Commonly used cell lines- their organization and characteristics. Karyotyping, biochemical and genetic characterization of cell lines.

UNIT III

Organ Culture: technique, advantages, applications and limitations. Artificial skin. Transfection of animal cells: transfection methods. Methods for cell fusion, Selectable markers, HAT selection and Antibiotic resistance.

UNIT IV

Cloning and expression of foreign genes in animal cells: Expression vectors. Over production and preparation of the final product i.e. expressed proteins. Production of vaccines in animal cells. Hybridoma Technology: Production of monoclonal antibodies and their applications.

UNIT V

Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology

PRACTICALS

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel

BASICS OF MATHEMATICS AND BIOSTATISTICS (DSE-4)

UNIT I

The Set theory-Set, types of sets, subsets and its properties. Linear and geometric functions.

UNIT II

Limits of functions (basic idea without analytic definition). Derivatives of functions.

UNIT III

The binomial theorem for positive index, formula for negative integral index and fractional index. Logarithm (Definition, laws of logarithm and use of log table).

UNIT IV

Differentiation of function of functions, Trigonometric, logarithmic exponential and inverse circular functions. Intergration (general introduction, significance and application for simple algebraic and trigonometric functions).

UNIT V

Biostatistics – Probability calculations

Methods of sampling, confidence level

Measurement of central tendencies-Mean, Media, Mode

Measurements of deviations and dispersion-Mean Deviation, Standard deviation

PRACTICALS

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

DISSERTATION / PROJECT /ON THE JOB TRAINING

Dissertation of the project work to be carried out by the candidates either in the departmental laboratory or other suitable industries/ institutions/ laboratories to have real on the spot knowledge by technological applications of biotechnological skills.

The dissertation / project /on the job training should be submitted in bound form for evaluation

Presentation and defense of project works: Students will be judged on the basis of

- i) Quality of work
- ii) Preparation of dissertation
- iii) Delivery and quality of talk
- iv) Defense in response to audience queries