



CURRICULUM OF B.Sc. BIOTECHNOLOGY (HONS.)

UTKAL UNIVERSITY
BHUBANESWAR, ODISHA
UNDER
SEMESTER & CHOICE BASED CREDIT SYSTEM

Outline of B. Sc. syllabus in Biotechnology (Semester System)

Course Structure: (For Hons.)

Total Marks: 2400

Total credits: 140

Detailed course structure

Core courses= 14 papers each of 6 credit each (100 marks each)

Ability Enhancement Compulsory Course (AECC) = 2 papers of 2 credit each(50 marks each)

Skilled Enhancement Courses (SEC) = 2 Papers 2 credit each (50 marks each)

Discipline Specific Elective (DSE) = 3 Papers 6 credit each (100 marks each) and project reports 6 credit (100 marks)

General Electives (GE) = 4 Papers 6 credit each (100 marks each)

For Papers with Practical Component: Theory- 75 marks (Mid Sem 15 + End Sem 60)

Practical-25 marks (End Sem)

For Papers with no practical: 100 marks paper= 20 (Mid Sem) + 80 (End sem)

50 marks paper= 10 (Mid sem) + 40 (End Sem)

Semester-I

(Total Marks=350)

Core courses (100 marks each)

C-1: Biochemistry & metabolism (Theory-75 + Practical-25)

C-2: Cell biology (Theory-75 + Practical-25)

AECC-1 (50 Marks)

Options: MIL communication

GE-1 (100 marks)

Options: Development Biology (Theory-75 + Practical-25)

Semester-II

(Total Marks=350)

Core Courses (100 marks each)

C-3: Mammalian Physiology (Theory-75 + Practical-25)

C-4: Microbial and plant Physiology (Theory-75 + Practical-25)

AECC-2 (50 marks) (any one of the followings)

Options: EVS

GE-2 (100 marks)

Options: Biotechnology and human welfare-1 (Theory-75 + Practical-25)

Semester-III

(Total Marks=450)

Core Courses (100 marks each)

C-5: Genetics (Theory-75 + Practical-25)

C-6: General Microbiology (Theory-75 + Practical-25)

C-7: Chemistry-1

SEC-1 (50 marks)

Options: Molecular Diagnostic

GE-3 (100 marks)

Options: Biotechnology, biosafety and human welfare-I or II (Bioethics and Biosafety) (Theory-75 + Practical-25)

Semester-IV

(Total Marks=450)

Core Courses (100 marks each)

C-8: Molecular Biology(Theory-75 + Practical-25)

C-9: Immunology (Theory-75 + Practical-25)

C-10: Chemistry-2 (Theory-75 + Practical-25)

SEC-2 (50 marks)

Options: English

GE-4 (100 Marks)

Options: Entrepreneurship development (Theory-75 + Practical-25)

Semester-V

(Total Marks=400)

Core Courses (100 marks each)

C-11: Industrial Fermentations (Theory-75 + Practical-25)

C-12: Recombinant DNA technology (Theory-75 + Practical-25)

DSE-1: Animal diversity I (100 marks) (Theory-75 + Practical-25)

DSE-2: Plant Diversity-I (100 marks) (Theory-75 + Practical-25)

Semester-VI

(Total Marks=400)

Core courses (100 marks each)

C-13: Bio Analytical Tools (Theory-75 + Practical-25)

C-14: Genomics and proteomics (Theory-75 + Practical-25)

DSE-3 Animal Diversity-II (100 marks) (Theory-75 + Practical-25)

DSE-4: Plant Diversity-II (100 marks) (Theory-75 + Practical-25) / Project Report (100 marks)
(Project- 75 + Viva- 25)

Syllabus in details

SEMESTER-I

C-I BIOCHEMISTRY AND METABOLISM (Theory)

(75 Marks)

UNIT-I

Amino acid & Proteins: Structure and properties of Amino acids, Types of Proteins and their Classification, Forces stabilizing protein structure and shape. Different levels of structural organization of proteins, Fibrous and globular proteins.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

UNIT-II

Lipids: Structure and functions – Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, Sphingolipids, Glycolipids, Cerebrosides, Gangliosides, Prostaglandins, Cholesterol.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, Purines & Pyrimidines. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA.

UNIT-III

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, Enzyme activity, Specific activity, Common feature of active sites, Enzyme specificity.

UNIT-IV

Carbohydrates Metabolism: Reactions, energetic and regulation. Glycolysis: Fate of pyruvate under aerobic and anerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron transport chain, Oxidative phosphorylation, β -oxidation of fatty acids.

PRACTICAL

(25 Marks)

1. To study activities 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 by glucose oxidase method.

5. Principles of Colorimetry: (i) Verification of Beer's Lambert'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.
9. Quatitative estimation of proteins.

C-2: CELL BIOLOGY (Theory)

(75 Marks)

UNIT-I

Cell: Introduction and structural organization of prokaryotic and Eukaryotic cells, compartmentalization of eukaryotic cells, cell fractionation.

Cell membrane and Permeability: Chemical components of biological membranes and its organization, Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT-II

Cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure & function including role in protein segregation; Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT-III

Lysosomes: Vacuoles and micro bodies: Structure and functions.

Ribosomes: Structure and function including role in protein synthesis

Mitochondria: Structure and function, Genomes, Biogenesis.

Chloroplasts: Structure and function, Genomes, Biogenesis.

Nucleus: Structure and function, Chromosomes and their structure.

UNIT-IV

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membranes receptors for extra cellular matrix, macromolecules, regulation of receptors expression and function. Signal transduction.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

PRACTICALS

(25 Marks)

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 Eukaryotic cell.
6. Microtomy: Fixation, Block making, Section cutting, Double staining of animal tissues like liver, Oesphagus, Stomach, pancreas, Intestine, Kidney, Ovary, testes.
7. Cell division in onion root tip/insect gonads.
8. Preparation of Nuclear, mitochondria & cytoplasmic fractions.

AECC-1: MIL COMMUNICATION

(50 Marks)

GE-1: DEVELOPMENTAL BIOLOGY (Theory)

(75 Marks)

UNIT-I

Gametogenesis and Fertilization

Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization.

Different types of eggs on the basis of yolk.

UNIT-II

Early embryonic development

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism

Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers.

UNIT-III

Embryonic Differentiation

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV

Organogenesis

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

PRACTICALS**(25 Marks)**

1. Identification of developmental stages of chick and frog embryo using permanent mounts
2. Preparation of a temporary stained mount of chick embryo
3. Study of developmental stages of *Anopheles*.
4. Study of the developmental stages of *Drosophila* from stock culture/ photographs..
5. Study of different types of placenta.

SEMESTER-II

C-3: MAMMALIAN PHYSIOLOGY (Theory)

(75 Marks)

UNIT-I

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

Composition of blood, Plasma proteins & their role, blood cells, Haematopoiesis, 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, salutatory 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

(25 Marks)

1. Finding the coagulation time of blood
2. Determination of blood group
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin (% Hb in blood)

C-4: MICROBIAL AND PLANT PHYSIOLOGY(Theory)

(75 Marks)

UNIT-I

Nutritional classification of microorganism 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 elctro 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-classifacation based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure. Chemolithotropic metabolism, Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and methanogens.

UNIT-III

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: Development, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)

Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization.

PRACTICALS

(25 Marks)

1. Separation of photosynthetic pigment 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 Ecoli using turbidometric method and to calculate specific growth rate and generation time.
5. To study and plot the growth curve of Aspergillus niger by radical growth measurments
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 termal death time and ecimal reduction time of E.Coli.

AECC-2: EVS

(50 Marks)

GE1: BIOTECHNOLOGY AND HUMAN WELFARE-1 (Theory)

(75 Marks)

UNIT-I

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

UNIT-II

Agriculture: N₂ 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: DNA fingerprinting; Solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

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

PRACTICALS

(25 Marks)

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Study of a plant part infected with a microbe
2. To perform quantitative estimation of residual chlorine in water samples
3. Isolation and analysis of DNA from minimal available biological samples
4. Case studies on Bioethics (any two)

SEMESTER-III

C-5: GENETICS (Theory)

(75 Marks)

UNIT-I

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.

Mendelian genetics : Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes.

UNIT-II

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Chromosome and genomic organization: Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT-III

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abnormalities— Aneuploidy and Euploidy.

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, sex linked inheritance.

UNIT-IV

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over.

Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.

Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

PRACTICALS

(25 Marks)

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Karyotyping with the help of photographs
4. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
5. Study of polyploidy in onion root tip by colchicine treatment.

C-6: GENERAL MICROBIOLOGY (Theory)

(75 Marks)

UNIT-I

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.

Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT-II

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT-III

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways

Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT-IV

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria.

PRACTICALS

(25 Marks)

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.

C-7: CHEMISTRY-1

SEC-1: MOLECULAR DIAGNOSTICS (Theory)

(Total 50 marks)

UNIT-I

Enzyme Immunoassays:

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

UNIT-II

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT-III

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Anti-idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno fluorescence. Radioimmunoassay.

UNIT-IV

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Kirby-Bauer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
2. A kit-based detection of a microbial infection (Widal test)
3. Study of Electron micrographs (any four).
4. Perform any one immuno diagnostic test (Typhoid, Malaria, Dengue)

GE-3: BIOTECHNOLOGY, BIOSAFETY AND HUMAN WELFARE-I or II (Bioethics and Biosafety) (Theory) (75 Marks)

UNIT-I

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinated hydrocarbons and petroleum products

UNIT-IV

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

UNIT-II

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

UNIT-II

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

PRACTICALS

(25 Marks)

1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
2. Isolation of lymphocytes for culturing
3. Case study on handling and disposal of radioactive waste
4. Calculation of BOD of water sample.

SEMESTER-IV

C-8: MOLECULAR BIOLOGY (Theory)

(75 Marks)

UNIT-I

DNA structure and replication

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

UNIT-II

DNA damage, repair and homologous recombination

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Homologous recombination: models and mechanism.

UNIT-III

Transcription and RNA processing

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

UNIT-IV

Regulation of gene expression and translation

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

PRACTICALS

(25 Marks)

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 DN

C-9: IMMUNOLOGY (Theory)

(75 Marks)

UNIT-I

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, Tlymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT-II

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory.

UNIT-III

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing and presentation, Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency diseases, AIDS.

UNIT-IV

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

PRACTICALS

(25 Marks)

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

C-10: CHEMISTRY-2

SEC2: ENGLISH (50 Marks)

GE4: ENTREPRENEURSHIP DEVELOPMENT (Theory)

(75 Marks)

UNIT-I

INTRODUCTION: Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT-II

ESTABLISHING AN ENTERPRISE: Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

UNIT-III

FINANCING THE ENTERPRISE :Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

UNIT-IV

MARKETING MANAGEMENT: Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product life cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

UNIT-V

ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS: Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.

**** Project Report on a selected product should be prepared and submitted (25 Marks)***

SEMESTER-V

C-11: INDUSTRIAL FERMENTATION (Theory)

(75 Marks)

UNI- I

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

UNIT-II

Production of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT-III

Purification & characterization of proteins, Upstream and downstream processing. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT-IV

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (K_a) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

PRACTICALS

(25 Marks)

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.)

C-12: RECOMBINANT DNA TECHNOLOGY (Theory)

(75 Marks)

UNIT-I

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

UNIT-II

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, Applications of Genetic Engineering in animals: Production and applications of transgenic mice, Therapeutic products produced by genetic engineering- blood proteins, human hormones, immune modulators and vaccines (one example each).

UNIT-III

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Protein engineering concepts and examples (any two).

UNIT-IV

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants.

PRACTICALS

(25 Marks)

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. Demonstration of PCR

DSE-1: ANIMAL DIVERSITY-I (Theory)

(75 Marks)

UNIT-I

- a) Outline of classification of Non- Chordates upto subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes.
- b) Protozoa: Locomotion, Reproduction, evolution of Sex, General features of *Paramoecium* and *Plasmodium*. Pathogenic protozoans
- c) Porifera: General characters, outline of Classification; skeleton, Canal System

UNIT-II

- a) Coelenterata: General Characters, Outline of classifications Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation.
- b) Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations.
- c) Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.

UNIT-III

- a) Annelida: - General features, Outline of classification, Coelom: Metameric segmentation, General features of Earthworm, Vermicomposting.
- b) Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture, Sericulture.

UNIT-IV

- a) Mollusca : general features, Outline of classification, Shell Diversity; Torsion in gastropoda,
- b) Echinodermata: General features, Outline of Classification Larval forms
- c) Hemichordata: Phylogeny: Affinities of *Balanoglossus*

PRACTICALS

(25 Marks)

1. Identification and Classification of Any these of the following –

Porifera: *Scypha*, , *Leucosolenia*, *Euspongia*, *Hylonema*, *Euplectella* Cnidaria: *Medrepora*, *Millepora*, *Physalia*, *Porpita*, *Varella*, *Aurelia*, *Metridium*

Platyhelminthes: *Taenia*, *Fasciola*, Aschelminthes: *Ascaris*, *Ancylostoma*, *Enterobius* Annelida: *Pheretima*, *Hirudinaria*, *Chaetopterus*, *Nereis*, *Aphrodite*

Arthropoda: *Julus*, *Scolopendra*, *Peripatus*, *Carcinus*, *Limulus*, *Lepisma*, *Dragonfly*, *Musca*, *Acheta*

Mollusca: *Pila*, *Unio*, *Mytilus*, *Loligo*, *Sepia*, *Octopus*, *Solen*

Echinodermata: *Asterias*, *Ophiothrix*, *Echinus*, *Holothuria*, *Astrophyton*

Hemichordata: *Balanoglossus*

2. Identification of slides with two points of identification.

Amoeba, *Paramoecium*, *Ceratium*, *Plasmodium*, *Opalina*, L.S. Sponge, Spicules of sponges, L.S. *Hydra*, *Obelia*, *Bougainvillia*, Larvae of *Fasciola*, Seta of Earthworm, Radula

3. Ecological Note – On any of the specimens in Exercise No 1 Models of dissection of Earthworm, Cockroach

Earthworm: Digestive, Nervous System,

Cockroach: Digestive Reproductive, Nervous System

DSE-2: PLANT DIVERSITY-I (Theory)

(75 Marks)

UNIT-I

Algae:

General character, classification and economic importance. Life histories of algae belonging to various classes:

Chlorophyceae – *Volvox*, *Oedogonium*

Xantho phyceae – *Vaucheria*

Phaeophyceae – *Ectocarpus*

Rhodophyceae-*Polysiphonia*

UNIT-II

Fungi:

General characters, classification & economic importance.

Life histories of Fungi:

Mastigomycontina- *Phytophthora*

Zygomycotina-*Mucor*

Ascomycotina- *Saccharomyces*

Basidomycotina-*Agaricus*

Deutromycotina-*Colletotrichum*

UNIT-III

Lichens :

Classification, general structure, reproduction and economic importance. Plant diseases: 4 of 36 Casual organism, symptoms and control of following plant diseases.

Rust & Smut of Wheat.

White rust of Crucifers.

Late blight of Potato.

Red rot of Sugarcane.

Citrus Canker.

UNIT-IV

Bryophytes:

General characters, classification & economic importance.

Life histories of following:

Marchantia.

Funaria.

PRACTICALS

(25 Marks)

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory.
2. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
3. Study and section cutting and lectophenol mount of plant disease materials studied in theory.
4. Study of various types of lichens.
5. Study of external features & anatomy of vegetative and reproductive parts of *Marchantia* and *Funaria*
6. Collection of algae, fungi, plant diseases materials and bryophytes available locally.

SEMESTER-VI

C13: BIO-ANALYTICAL TOOLS (Theory)

(75 Marks)

UNIT-I

Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT-II

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT-III

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT-IV

Introduction to electrophoresis, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

PRACTICAL

(25 Marks)

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.

C-14: GENOMICS & PROTEOMICS (Theory)

(75 Marks)

UNIT-I

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT-II

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT-III

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

UNIT-IV

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution.

Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data.

PRACTICALS

(25 Marks)

1. Use of SNP databases at NCBI and other sites
2. Detection of Open Reading Frames using ORF Finder
3. Proteomics 2D PAGE database
4. Softwares for Protein localization.
5. Native PAGE
6. SDS-PAGE

DSE-3: ANIMAL DIVERSITY-II (Theory)

(75 Marks)

UNIT-I

Proto-chordates, Pisces and Ambhibia

Proto-chordates: Outline of classification, General features and important characters of *Herdmania*, *Branchiostoma*

Origin of Chordates

Pisces: Migration in Pisces, Outline of classification

Amphibia: Classification, Origin, Parental care, Paedogenesis

UNIT-II

Reptilia, Aves and Mammalia (15 Periods)

Reptelia: Classification, Origin

Aves: Classification, Origin, flight- adaptations, migration

Mammalia: Classification, Origin, dentition

UNIT-III

Comparative anatomy of vertebrates I (15 Periods)

Comparative anatomy of various systems of vertebrates: Integumentary, digestive respiratory systems.

UNIT-IV

Comparative anatomy of vertebrates II (15 Periods)

Comparative Anatomy of vertebrates – Heart, Aortic arches, Kidney & urinogenital system, Brain, Eye, Ear.

Autonomic Nervous system in Mammals

PRACTICALS

(25 Marks)

1. Identification & Classification upto order of the following: Proto-chordata: *Salpa*, *Doliolum*, *Herdmania*, *Branchiostoma*

Cyclostomata: *Myxine*, *Petromyzon*

Chondrichthyes: *Scoliodon*, *Zygnea*, *Pristis*, *Trygon*, *Raja*, *Chimaera*

Ostiechthyes: *Labeo*, *Mystus*, *Catla*, *Hippocampus*, *Anabas*, *Echeneis*, *Lophius*, *Polypeterus*

Amphibia: *Rana*, *Hyla*, *Amblystoma*, *Necturus*, *Proteus*.

Reptiles: *Hemidactylus*, *Calotes*, *Draco*, *Phrynosoma*, *Naja Vipera*, *Bungarus*

Aves: *Columba*, *Alcedo*, *Passer*

Mammalia: *Ornithorhynchus*, *Macropus*, *Didelphes*, *Dasypus*

2. An Ecological Note on any one of the specimens in Experiment 1

3. Identification of the following slides

Mammalian Histology: Liver, Lung, Intestine, Kidney, Ovary, Testes

Slides of *Salpa*, *Doliolum*, Spicules of *Herdmania*, Tadpole of Frog

4. Preparation of a permanent mount of *Salpa*, Placoid scales, spicules of *Herdmania*, Pharynx of *Amphioxus*, Tadpole Larva of frog

5. Identification of endoskeletons of frog and rabbit.

DSE-4: PLANT DIVERSITY-II or PROJECT REPORT(Theory)

(100 Marks)

UNIT-I

Pteridophytes

General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – *Rhynia*.

UNIT-II

Pteridophytes: Type studies

Life histories of *Selaginella*- (Heterospory and seed habit), *Equisetum*, *Pteris*, *Lycopodium*.

UNIT-III

Gymnosperms

General characters, classification, geological time scale, theories of fossil formation, types of fossils, fossil gymnosperms- *Williamsonia* & *Glossopteris*, telome and stele concept.

UNIT-IV

Gymnosperms: Type studies

Life histories of *Cycas* & *Pinus*, economic importance of gymnosperms.

PRACTICALS

1. Examination of morphology and anatomy of vegetative and reproductive parts of *Selaginella*, *Equisetum* & *Pteris*.
2. Examination of morphology and anatomy of vegetative & reproductive parts of – *Cycas* & *Pinus*
3. Plant collection (pteridophytes & gymnosperms)