GAUHATI UNIVERSITY
DEPARTMENT OF BIOTECHNOLOGY
FYUGP in Biotechnology

Programme Structure

Course name	Credit distribution (Theory+Practical)
SEMESTER I (Total credits: 22)	
1. Introduction to the living world	4 (3+1)
2. Chemistry I to be co-opted from the syllabus of BSc in Chemistry	4 (3+1)
3. To be co-opted from the syllabus of BSc in Botany (Course name: Plant and Microbial Diversity) OR BSc in Zoology (Course name: Diversity of Non-chordates)	4 (3+1)
4. Multidisciplinary course 1 (As per GU guidelines)	3 (3+0)
5. Value-added course 1 (As per GU guidelines)	3 (3+0)
6. Ability Enhancement Course 1 (As per GU guidelines)	4 (4+0)
SEMESTER II (Total credits: 22)	
1. Biomolecules	4 (3+1)
2. Chemistry II to be co-opted from the syllabus of BSc in Chemistry	4 (3+1)
3. To be co-opted from the syllabus of BSc in Botany (Course name: Cell Biology and Biomolecules) OR BSc in Zoology (Course name: Diversity of Chordates)	4 (3+1)
4. Multidisciplinary course 2 (As per GU guidelines)	3 (3+0)
5. Value-added course 2 (As per GU guidelines)	3 (3+0)
6. Ability Enhancement Course 1 (As per GU guidelines)	4 (4+0)
SEMESTER III (Total credits: 22)	
1. Cell Biology	4 (3+1)
2. Chemistry III to be co-opted from the syllabus of BSc in Chemistry	4 (3+1)
3. To be co-opted from the syllabus of BSc in Botany (Course name: Laboratory and Field Techniques in Plant Science) OR BSc in Zoology (Course name: Principle of Genetics)	4 (3+1)
4. Multidisciplinary course 3 (As per GU guidelines)	3 (3+0)
5. Internship	4 (0+4)
6. Skill Enhancement Course 1 (SEC 1)#	3 (2+1)
SEMESTER IV (Total credits: 22)	
1. Biochemistry and Metabolism	4 (3+1)
2. Introductory Microbiology and Immunology	4 (3+1)
3. Anatomy and Physiology	4 (3+1)
4. Biotechniques and Data Analysis	4 (3+1)
5. Free/Minor course 1 (Online, MOOC, or other stream/discipline)	4*
6. Skill Enhancement Course 2 (SEC 2)#	2 (1+1)
SEMESTER V (Total credits: 22)	

1. Molecular Biology and Genetic Engineering	4 (3+1)
2. Genetics and Systematics	4 (3+1)
3. Developmental Biology	4 (3+1)
4. Ecology and Environment	4 (3+1)
5. Free/Minor course 2 (Online, MOOC, or other stream/discipline)	4*
6. Skill Enhancement Course 3 (SEC 3)#	2 (1+1)
SEMESTER VI (Total credits: 22)	
1. Industrial Biotechnology	4 (3+1)
2. Bioinformatics and Biostatistics	4 (3+1)
3. Introduction to Omics	4 (3+1)
4. Dissertation	4 (0+4)
5. Free/Minor course 3 (Online, MOOC, or other stream/discipline)	4*
6. Skill Enhancement Course 4 (SEC 4)#	2 (2+0)

* The credit distribution of this course will depend upon the chosen course.

#To be updated shortly.

Notes:

I. For a student pursuing FYUGP in Biotechnology, all the courses are compulsory.

II. Yellow highlighted courses are to be pursued from the concerned department. These courses are not required to be taught at the Department of Biotechnology of the college.

III. Minor courses offered for other stream/discipline students are given below.

1. Introduction to the living world
2. Biomolecules
3. Cell Biology
4. Biotechniques and Data Analysis
5. Molecular Biology and Genetic Engineering
6. Industrial Biotechnology

IV. Multidisciplinary courses, Value-added courses, and Ability enhancement courses are to be taught by non-Biotechnology faculty members for the whole college.

FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **First**

Course level: **100-199**

Course name: INTRODUCTION TO THE LIVING WORLD

Course objective: To impart basic understanding of life, the cell as unit of life, how it works, what are different forms of life, how do you collect and identify. Moreover it will also let to know the benefits of various life forms towards Human and how they are important for our existence.

Course eligibility: The student should have passed Class XII physics, chemistry, biology and mathematics.

UNIT I- Introduction (9 contact hours)

The Plant, Animal and the Microbial world: Diversity, nomenclature, Taxonomy, Survey and conservation strategies; Cell dimensions, Solvent and solutions, diffusion, osmosis, permeability, Fluids, Colloids, colloidal properties.

UNIT II- Life Processes (10 contact hours)

Life Processes: Nutrition, Digestion, Absorption, assimilation, respiration, Growth and Reproduction, Excretion; Cell as fundamental unit of life: Imaging, structural organization, organelles; Diffusion; Osmosis; Genetic principles and Molecular Basis of Inheritance: Basic principles of inheritance, Polyploidy, Aneuploidy, Test cross, Back cros, Mapping population, NILs, RILs, Double Haploids, Hybrids,

UNIT III- Ecosystem and evolution (8 contact hours)

Introduction to Ecosystem, Environment and Evolution: Biomes and Biomass, Niche, habitat, stratification, Biotic and Abiotic factors, Energy flow, Productivity, Nutrient Cycle, Adaptations, Population, Population interactions, Ecological successions.

UNIT IV- Biology for human welfare (10 contact hours)

Plants, Animals and Microbes in Human welfare: Domestication of plants and animals, preparation of fermented foods (cheese and curd, brewing alcohol), agriculture practices, food processing, diagnostics, antibiotics, high yielding crops and breeds, Plant and animal breeding (Introductory), Psiciculture (Introductory), Apiculture (Introductory), Sericulture (Introductory), Plant Tissue Culture, Single cell proteins, Sewage treatment and Swasha Bharat campaign, Microbes and biofertilizers.

UNIT V- Natural resources, sustainability and biotechnological solutions (8 contact hours)
Natural resources and sustainable management: Renewable and non-renewable resources (air, water, soil, sunlight, plants, animals, microbes, fossil fuel, sustainable exploitation of resources, Three Rs- Reduce, Recycle and reuse. Harnessing non-conventional energy resources – wind, solar and hydro power. Biotechnological solutions to challenges faced by humankind- bioremediation, genetically modified organisms.

PRACTICAL
(30 contact hours)

1. Estimating population- Plants/animals/Microbes by Random/Non-random sampling methods.
2. To study plant population density by Quadrant method/Trans-sect sampling method.
3. Microbial sample collection from field and enumeration of microbial load.
4. Measuring biodiversity of an area.
5. Identification of food plants of sericigenous insects and their rearing/ apiculture techniques.
6. Investigating osmosis in chicken eggs.
7. Culturing and indentifying nitrogen fixing bacteria from leguminous plants.

Graduate attribute

Course outcome: The students will be able to conduct survey, collect biological samples and identify they systematically which will help them in future course to undertake jobs in laboratories and in conducting further research such as Ph.D. they will also gather insights into the various applications of life forms which will help them in innovate.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr Pranjan Barman, Assistant Professor, Department of Biotechnology, Gauhati University

Dr Debasish Borbora, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Second**

Course level: **100-199**

Course name: BIOMOLECULES

Course objective: To impart chemical structural and functional understanding of different biomolecules that make up a living system.

Course eligibility: The student should have passed Class XII physics, chemistry, biology and mathematics.

UNIT I- Water (5 contact hours)

Structure and ionization of water, chemical and physical properties of different forms of water, weak acids and bases, pH, Hendersen-Hasselbalch equation, pKa.

UNIT II- Carbohydrates (8 contact hours)

Sources (plants, animals, microbes, marine), nomenclature and structural types (different carbon number, monomers, dimers, oligomers, polymers), functional types (aldoses, ketoses), reducing and non-reducing, structural conventions (Haworth projection, Fischer model, boat and chair configuration, cyclisation, isomerisation), optical properties (α and β, D and L, enantiomers, epimers), nutritional importance.

UNIT III- Lipids (10 contact hours)

Fatty acids sources (plants, animals, microbes, marine), structure, configuration (saturated, unsaturated and *trans* fatty acids), structural types (short, medium and long chain). Triglyceride, phosphoglyceride and sphingolipid sources (plants, animals, microbes, marine), nomenclature and structural types. Derived lipids- phospholipids and glycolipids. Waxes and long chain fatty alcohols. Structural composition, types and biological significance of conjugated lipids (chylomicrons and lipoproteins). Sterol sources, types and their biological significance, steroids and steroid derived vitamins, prostanoids and eicosanoids and their biological significance. Lipid soluble antioxidants.

UNIT IV- Amino acids and proteins (10 contact hours)

Structure, classification (based on structure, polarity, nutritional importance, metabolic fate and others), optical properties (D and L, chirality), chemical properties, pI. Peptide bond, dipeptide characteristics, Ramachandran plot, structural levels of proteins (primary, secondary, tertiary, quaternary), helicity, pI, hydropathy and hydrophilicity indices, structural and functional domains, motifs. Types of proteins (fibrous and globular), protein folding, chaperones and chaperonins, protein separation and purification.

UNIT V- Nucleic acids (10 contact hours)

Structures of purines and pyrimidines, nucleotides, nucleosides, forces stabilizing DNA and RNA structures, different types of bonds, base pairing, stacking, helicity, forms, supercoiling, twists and bends, isomorphic, anisomorphic and cruciform structures in DNA, spectral characteristics (melting curves, $C_o t$ values, chromacity), RNA types (hnRNA, rRNA, mRNA, tRNA, miRNA and riboswitches), tRNA structure, ribozymes. DNA-DNA and DNA-protein interactions, organization of DNA into chromosomes.

PRACTICALS

(30 Contact hours)

1. Preparation of biological buffers.
2. Preparation of standard curve of glucose by anthrone method / phenol-sulphuric acid method and determination of unknown sugar concentrations.
3. Preparation of BSA standard curve using Folin-Lowry reagent / Bradford method and determination of unknown protein concentrations.
4. Preparation of standard curve of DNA by diphenylamine reaction and estimation of unknown DNA by spectrophotometric determination.
5. Preparation of standard curve of RNA by orcinol reaction and estimation of unknown RNA by spectrophotometric determination.
6. Separation of a mixture of amino acids through thin layer chromatography/ paper chromatography

7. Extraction of DNA/RNA from plant/animal tissues and their estimation through agarose gel electrophoresis
8. Lipid extraction by Folch method/ solvent extraction and their separation by silica-based adsorption chromatography.

Graduate attribute

Course outcome: Students will be able to attribute different chemical, physical, physiological and nutritional properties to biological building blocks and their polymers and contextualize the structural interactions that help life processes work. In addition, students will gain the skill to practically assess the contents of biomolecules in different sources.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr H. K. Sarma, Associate Professor, Department of Biotechnology, Gauhati University

Dr Mohammad Imtiyaj Khan, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Third**

Course level: **200-299**

Course name: CELL BIOLOGY

Course objective: To develop understanding of the cell as unit of life, its architecture, how it works and what are the subcellular components and their functions.

Course eligibility: The student should have passed Class XII physics, chemistry and biology with mathematics (desirable). The student should have studied Introduction to the living world and Biomolecules offered in semesters 1 and 2.

UNIT I- Cellular architecture (10 contact hours)

Cell: Introduction and classification of organisms by cell structure, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane, its organization (Fluid Mosaic Model) and permeability, membrane as a dynamic entity, and transport across the membrane. An insight into the organization of the trans-membrane proteins.

UNIT II- Membrane and membranous bodies (10 contact hours)

Membrane Vacuolar system, cytoskeleton, cytoplasmic streaming 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.

Lysosomes: Vacuoles and microbodies: Structure and functions.

Ribosomes: Structure and functions.

Mitochondria: Structure and function, genome, biogenesis.

Chloroplasts: Structure and function, genome, biogenesis

UNIT III- Nucleus (11 contact hours)

Nucleus: Structure and function, chromosomes and their structure, nucleolus.

UNIT IV- Extracellular matrix (14 contact hours)

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors, receptor ligand interactions and their function. Signal transduction- basic concept. Basics of apoptosis.

PRACTICALS

(30 Contact hours)

1. Demonstration of dialysis/plasmolysis/de-plasmolysis and the effect of temperature and organic solvents on semi permeable membrane.

2. Demonstration of different stages of mitosis and meiosis using onion root tip.

3. Study of structure of any phytoplanktons, zooplanktons, diatoms, blue green algae, algae and fungi (including yeast).

4. Microtomy: Fixation, block making, sectioning, staining and microscopy of animal tissue/plant tissue.

5. Preparation of nuclear, Mitochondrial & cytoplasmic fractions by density gradient centrifugation/isopycnic centrifugation/ultra centrifugation.

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.

5. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

6. T. Devasena 2012. Cell Biology. Oxford University Press.

Graduate attribute

Course outcome: Students will be skilled to isolate, appreciate the architecture and identify different subcellular components.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr Sujoy Bose, Associate Professor, Department of Biotechnology, Gauhati University

Dr S. S. Swargiary, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Fourth**

Course level: **200-299**

Course name: **Biochemistry and Metabolism**

Course objective: To impart understanding of different metabolic pathways in a living system. This course will introduce students to the world of metabolic pathways which are interconnected and metabolites produced in the body are products of series of chemical transformations/reactions catalysed by enzymes in the presence of coenzymes/cofactors under favourable conditions.

Course eligibility: The student should have passed semesters I and II of FYUGP in Biotechnology.

THEORY (3 credits)

UNIT I: Protein metabolism (8 Contact hours)

A historical perspective.
Amino acids & Proteins**:** Functions of amino acids and proteins. Amino acid separation and protein purification (Native and SDS-PAGE, ion-exchange chromatography, gel filtration chromatography, affinity chromatography). Denaturation and renaturation of proteins. Amino acid biosynthesis and protein synthesis.

UNIT II: Protein functions- Enzymes (18 Contact hours)

Enzymes: Nomenclature and classification of enzymes, holoenzyme, apoenzyme, cofactors, coenzymes, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, determination of enzyme activity (Km & Vmax), specific activity, effects of pH and temperature, enzyme inhibition, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyper-thermophilic archaea and bacteria. Role of: NAD^+, $NADP^+$, FMN/FAD, coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, lipoic-acid, biotin, cyanocobalamine, tetrahydrofolate and metallic ions.

UNIT III: Carbohydrate metabolism (18 Contact hours)

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

Carbohydrate Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, glyoxylate pathway, gluconeogenesis, glycogenolysis and glycogen synthesis. TCA cycle, electron transport chain, oxidative phosphorylation.

UNIT IV: Lipid metabolism (8 Contact hours)

Lipids: Functions and properties of fatty acids, essential fatty acids, phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, prostaglandins, cholesterol. Lipid metabolism- fatty acid biosynthesis, α, ß and ω-oxidation of fatty acids.

UNIT V: Nucleic acid metabolism (8 Contact hours)

Nucleic acids: Physical & chemical properties of nucleic acids, nucleosides & nucleotides. Denaturation and renaturation of DNA, biologically important nucleotides, biosynthesis and degradation of purines & pyrimidines, nitrogen metabolism, urea cycle.

PRACTICALS (1 credit)

1. Preparation of biological buffers.
2. Estimation of blood glucose by glucose oxidase method.
3. Separation and identification of Amino acids by TLC.
4. Separation and identification of lipids by TLC.
5. Separation and identification of sugars by TLC.
6. Agarose gel electrophoresis for nucleic acid separation.

SUGGESTED READINGS

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.

5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co.

6. Biochemical methods by Sadasivam and Manickam, Third edition, New Age International Publishers, New Delhi.

7. An introduction to practical biochemistry by David T. Plummer. McGraw Hill Education, 3rd Edition.

Graduate attribute

Course outcome: Students will be able to understand the metabolic flow of carbon in the body. In addition, students will gain the skill to practically assess enzyme activity.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr Mohammad Imtiyaj Khan, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP

Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Fourth**
Course level: **200-299**

Course name: **Introductory Microbiology and immunology**

Course objective: To impart basic understanding of the microbial world, its diversity including bacteria, fungi, algae, protozoa and viruses; and also acquaint the students with linked immune responses against microbial entities.

Course eligibility: The student should have passed semesters I, II and III of FYUGP in Biotechnology, Chemistry, Botany, Zoology, Microbiology or other allied subjects.

THEORY (3 credits)

Unit I: Introduction, History and Scope of Microbiology (6 Contact hours)

General concept of microbes, their distribution. Historical milestones in microbiology. Contribution of Scientists to the field of Microbiology: Anton von Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch and Ivanowsky. Importance and applications of microbiology.

Unit II: Microbial Systematics and Diversity (8 Contact hours)

Classification of microorganisms: Carl Woese classification, Whittaker's five kingdom concept. General characteristics and classification of Bacteria, Archaea, Mycoplasmas, Cyanobacteria, Fungi, Algae, Protozoa and viruses. Bergey's Manual of Systematic Bacteriology.

Unit III: Microbial growth requirements and culture techniques (10 Contact hours)

Nutritional requirements of microorganisms - Macronutrients, micronutrients and growth factors. Nutritional types of microorganisms: Autotrophs and heterotrophs, phototrophs and chemotrophs. Principles of growth, Kinetics of growth, Methods of measuring growth: direct and indirect methods. Concepts of culture media and its types. Microbial cultures - Concepts of pure culture, methods of pure culture isolation, enrichment culturing techniques, preservation of microbial cultures.

Unit IV: Sterilization and aseptic techniques (6 Contact hours)

Definition of terms -sterilization, disinfectant, antiseptic, sanitizer, germicide, microbicidal agents, microbiostatic agents and antimicrobial agent. Physical methods of sterilization – Dry heat, moist heat, radiation methods, filtration methods. Chemical methods of sterilization - Alcohol, aldehydes, phenols, halogen, metallic salts, quaternary ammonium compounds and sterilizing gases.

Unit V: Staining techniques **(8 Contact hours)**

Nature of dyes. Physical and chemical theories of staining- Staining techniques; principle, procedure and applications: Simple staining, differential staining, and structural staining.

Unit VI: General account on microbial diseases and concepts of immunity

(10 Contact hours)

Causal organism, pathogenesis, epidemiology, diagnosis, prevention and control. Introduction to immunity. Introduction to the components of immunity: Innate and acquired; active and passive; humoral and cell-mediated immunity. Basic outline of primary and secondary organs of immune system - Thymus, bone marrow, spleen and lymph nodes. Types of cells of immune system – granulocytes, lymphocytes and monocytes.

Unit VII: Antigens and antibodies **(12 Contact hours)**

Introduction to antigens and haptens. Antibodies - basic structure, types, properties and functions of immunoglobulins. Complement system. Concepts on antigen – antibody interactions and its practical utility; ELISA. Concept of Hypersensitivity and Autoimmunity. Blood grouping, polyclonal and monoclonal antibodies - production and applications, hybridoma technology. Vaccines.

PRACTICALS (1 credit)

1. Microbiology Good Laboratory Practices and Biosafety.
2. Preparation of culture media for cultivation of bacteria
3. Preparation of culture media for cultivation of fungi
4. Sterilization of medium using Autoclave, handling bacteriological and BOD incubators.
5. Light compound microscope and its handling
6. Microscopic observation of bacteria, Cyanobacteria, Algae and Fungi.
7. Simple staining and Gram’s staining
8. Hanging-drop method.
9. Isolation of pure cultures of bacteria by streaking method.
10. Identification of human blood groups.

11. Separate serum from the blood sample (demonstration).
12. Total and/or differential Leukocyte Count of the given blood sample.
13. Demonstration of ELISA using dot-ELISA method.

Reference books:

- Microbiology: An Introduction by Tortora, Funke and Cases.
- Biology of Microorganisms by Brock, Madigan and Martinko.
- Textbook of Microbiology by Ananthanarayan and Paniker
- General microbiology by Roger Y Stainer, John L Ingraham, Mark L Wheelis, page R Painter
- Microbiology- by Prescott, Harley, klein
- Microbiology Diversity, disease, and the environment by Abigail A salyers, Dixie D Whitt
- Microbial Biotechnology by PC Trivedi
- Methods for general and molecular microbiology- by C.A Reddy (Editor), Beverdge, Breznak, Marzluf, Schnider and Sryder
- Kuby Immunology**.** by Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen.
- The elements of immunology by Fahim Halim Khan

Graduate attribute

Course outcome: Students will be skilled to operate basic microbiology instruments, handling of sterilization processes and cultures required at both academic and industrial setups. The course will also enable them to perform primary staining methodologies for identification of organisms and to analyze immunological responses utilizing antigen-antibody interaction study tools.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr Sujoy Bose, Associate Professor, Department of Biotechnology, Gauhati University

Dr Debasish Borbora, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Fourth**

Course name: **Anatomy and Physiology**

Course level: **500-599**

Course objective: The aim of this course is to introduce the principles of anatomy and physiology of plant and animals. This course, in particular imparts the concepts and mechanisms of integration in the different functional systems of the plants and animals. This course examines life processes of animals and plants, metabolism, nutrition and digestion, excretion, endocrine function, circulation, respiration and temperature regulation and their interrelatedness.

Course eligibility: The student should have passed semester III of FYUGP in Biotechnology or in other allied subjects.

Plant anatomy and Physiology

Unit-I: Plant Cell Structure **(4 Contact hours)**

Nature of plant cell wall, Plant tissue- meristematic tissue, permant tissue, secretory and secondary meristem., Apical cell theory, Histogen theory, Tunica-Corpus
theory, histogen theory and Korper-Kappe theory).Quiescent centre, Root cap.

Unit-II: Differentiation **(4 Contact hours)**

Differentiation of root, stem and leaf, Types of vascular bundles and Vascular cambium, Origin, development, Structure of Dicot and monocot root, Structure of Dicot and monocot stem, Structure of Dicot and monocot leaf, Structure and function of Stomata, Stomatal types.

Unit-III: Morphogenesis **(4 Contact hours)**

Differentiation and cell polarity in Unicellular and multicellular system, root hair and stomata formatio), Shoot Apical meristem (SAM): Origin, structure and function and ultrastructure of meristems. Organogenesis: Differentiation of root, stem, leaf and axillary buds. Mechanism of leaf primordium: initiation & development, Structure and function of root apical meristem

(RAM): Root cap, quiescent centre and origin of lateral roots. Transition from vegetative apex into reproductive apex.

Unit-IV: Reproductive Biology in plants **(4 Contact hours)**

Microsporangium, Microsporogenesis, Microgametogenesis, Megasporangium, Megagametogenesis, Pollination and fertilization, Endosperm, Embryogenesis.

ANIMAL PHYSIOLOGY AND ANATOMY

UNIT V: Body organization and Integumentary system (4 Contact hours)

General Anatomy of the body, Introduction to various kinds of body planes, cavities- their membranes, Tissues- level of organization (Types, origin, function and repair). Anatomy and histology of human skin. Function of skin temperature regulation by skin.

UNIT VI: Digestion and Respiration (5 Contact hours)

Digestion: Mechanism of digestion and 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 VII: Circulation (5 Contact hours)

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

UNIT VIII: Muscle physiology and osmoregulation (5 Contact hours)

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

UNIT IX: Nervous and endocrine coordination (5 Contact hours)

Mechanism of generation and 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 and hyper-secretions.

PRACTICALS:

1. Study of meristem (Permanent slides/ Photographs).
2. Study of Simple Tissues (Parenchyma, Collenchyma and Sclerenchyma), Complex tissues (xylem and phloem).
3. Study of Normal secondary growth structure in dicot stem and root (Sunflower)
4. Determination of bleeding time and clotting time of blood.
5. Preparation of blood smears and identifying various WBC
6. Determination of blood groups,
7. Determination of total erythrocyte count.
8. Determination of TLC and DLC
9. Estimation of hemoglobin
10. Determination of specific gravity of blood.
11. Determination of osmotic fragility of RBC.
12. Measurement of blood pressure.

SUGGESTED READINGS:

1. Plant Anatomy – Part I Cells and Tissues by Coutler E. G. , 1969. – Edward Arnold, London.
2. Integrative Plant Anatomy, Dickenson, W.C. (2000). Harcourt Academic Press, USA
3. Guyton and Hall Textbook of Medical Physiology, 11th edition (2006), J. E. Hall; W B
4. Saunders and Company, ISBN-13: 978-1416045748.
5. Ganong's Review of Medical physiology, 24th edition (2012), K. E. Barett, S. M. Barman, S.
6. Boitano and H. Brooks; Tata McGraw Hill, ISBN-13: 978-0071780032.
7. Principles of Anatomy and Physiology, 13th edition (2011), Gerard J. Tortora and Bryan H.
8. Derrickson; Wiley and Sons, ISBN-13: 978-0470565100.
9. Human Physiology, 9th edition (2006), Stuart I. Fox; Tata McGraw Hill, ISBN-13: 978-
10. 0077350062.
11. Lab Manual on Blood Analysis and Medical Diagnostics, 1st edition (2012), Dr. Gayatri
12. Prakash; S. Chand, ISBN: 81-219-3967.
13. Manual of Practical Physiology, 4th edition (2012), A. K. Jain; Arya Publication, ISBN:
14. 8178553155.

15. Textbook of Practical Physiology, 7th edition (2007), CL Ghai; Jaypee Publication, ISBN-13:
16. 978-8184481419.

Graduate attribute

Course outcome: The students will learn how anatomy and physiological systems are integrated and identify physiological trade-offs. Understand the synthesis of several areas within physiology (respiration, circulation, digestion, energy metabolism, etc.) as they apply to plant and animal's ability to maintain existence. Identify, analyze, evaluate, and construct reasoning through critical thinking processes as applied to topics in animal physiology.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr H. K. Sarma, Associate Professor, Department of Biotechnology, Gauhati University

Dr Pranjan Barman, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Fourth**
Course level: **200-299**

Course name: **Biotechniques and Data analysis**

Course objective: To impart understanding of different analytical methods used in biotechnology to acquire data. This course will introduce students to various physical and chemical phenomena associated with biological compounds that are exploited in analytical methods.

Course eligibility: The student should have passed semesters I, II and III of FYUGP in Biotechnology, Chemistry, Botany, Zoology, Microbiology or other allied subjects.

THEORY (3 credits)

UNIT I: Microscopy **(15 Contact hours)**

Principles, techniques and applications of- light microscopy (bright field, dark field, stereozoom), phase contrast microscopy, interference and florescence microscopy, electron microscopy (TEM and SEM), polarization microscopy, atomic force microscopy, confocal microscopy. Principles of fixation and staining (stains and dyes), types of fixatives and stains, embedding for electron microscopy, Field emission TEM and SEM, ultramicrotomy.

UNIT II: Spectroscopy and centrifugation **(12 Contact hours)**

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared, atomic absorption, circular dichroism, Raman). Mass spectrometry (ionization, mass analyzers, detectors), fluorescence spectroscopy, luminometry. Principles of centrifugation (microcentrifugation, ultracentrifugation), preparative and centrifugal types, cell fractionation techniques (density gradient), isolation of sub-cellular organelles and particles.

UNIT III: Chromatography **(12 Contact hours)**

Principle of chromatography (void volume, bed volume, partition coefficient). Thin layer chromatography (paper, silica), column chromatography (gel filtration, size exclusion, affinity, ion exchange, hydrophobic interaction), gas chromatography (GC), High Performance Liquid Chromatography (HPLC), High Performance Thin Layer Chromatography (HPTLC), Fast Protein Liquid Chromatography (FPLC).

UNIT IV: Electrophoresis and immunochemical techniques **(10 Contact hours)**

Principles and techniques of starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, cellulose-acetate and capillary electrophoresis, isoelectric focusing, western blotting. Immunoassay formats, immunoblotting, immunoaffinity chromatography, Fluorescence Activated Sell Sorting (FACS), antibody-based biosensors, nanotechnology and its applications.

Unit-V: Data analysis and interpretation (11 Contact hours)

Microscopy-image input & processing (noise removal, image filtering, segmentation, feature identification), image file formats, cell measurement and count, texture analysis, FRET convolution, fractal surface measurement. Spectroscopy-peaks in IR spectrum, functional groups assigned to wave number, concentration (ppm) against absorbance in AAS, mass to charge (m/z) ratio against relative intensity measurement in mass spectrometry, retention time, retention front and peak identification in HPTLC, GC-MS and HPLC, peak area determination, Raman shift against peak intensity, wavelength (nm) determination in Circular Dichroism.

PRACTICALS (1 credit)

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.

SUGGESTED READINGS

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Biochemical methods by Sadasivam and Manickam, Third edition, New Age International Publishers, New Delhi.
6. An introduction to practical biochemistry by David T. Plummer. McGraw Hill Education, 3rd Edition.
7. Spectroscopy: Fundamentals and Data interpretation by Neeraj Kumar Fuloria, Shivkanya Fuloria.
8. Computer Assisted Microscopy: The Measurement and Analysis of Images by John C Russ, 2011. Springer Verlag.

9. Data Analysis and Signal Processing in Chromatography, Volume 21 by A Felinger, 1998. Elsevier Press.

Graduate attribute

Course outcome: Students will be skilled to operate analytical instruments, acquire data using using them, analyse the acquired data and interpret them to draw biologically relevant inferences.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr Pranjan Barman, Assistant Professor, Department of Biotechnology, Gauhati University

Dr Mohammad Imtiyaj Khan, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Fifth**
Course level: **300-399**

Course name: **Molecular Biology and Genetic Engineering**

Course objective: To impart basic understanding of Nucleic acid and How they function and introduce the students to basic techniques of manipulating Nucleic Acid.

Course eligibility: The student should have passed **I**Vth sem in Biotechnology/Zoology/Botany/Microbiology or allied subjects.

THEORY (3 credits)

Unit-I: Structure of Nicleic Acid: Establishment of DNA as the genetic material, Nucleasome structure and packaging, Histones, and Non-histones nucleosome characteristics.
(10 contact hours)

Unit-II:The central Dogma- replication, transcription, translation, post-transcriptional and post translational modifications,rolling circular model of replication, relaxed and supercoiled DNA, melting temperature, denaturation and renaturation kinetics. **(10 contact hours)**

Unit-III: The Genetic code, Organization of genes in Prokaryotic and Eukaryotic organisms, Gene expression and Regulation. **(15 contact hours)**

Unit-IV: Recombinant DNA technology: DNA modifying enzymes, Restriction digestion, Cloning vectors, Genomic DNA and cDNA library preparationReverse transcription.
(15 contact hours)

Unit-V: Introduction to DNA sequencing, PCR and Blotting techniques. **(10 contact hours)**

PRACTICALS (1 credit)

1. Extraction, quantification of DNA, RNA and Proteins
2. Gel electrophoresis for qualitative estimation of extracted DNA
3. Isolation and restriction digestion of plasmid DNA.
4. PCR Primer designing.

Suggested Readings:

1. Molecular Biology of the Gene, Watson, CSH publishing
2. Introduction to Genetic Engineering by Desmond S.T. Nicholl, Cambridge
3. Genes by Benzamin & Lewine
4. Principles of Gene Manipulation and Genomics By S.B. Primerose and R.M. Twyman, Blackwell publishing.

Graduate attribute

Course outcome: Students will be able understand the chemical nature of Nucleic Acid, their structures and how they function and they would be able to learn basic techniques for handling and manipulating nucleic acid which will have applications in higher academics and also in Biotech industries.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr Pranjan Barman, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Fifth**
Course level: **300-399**

Course name: **Genetics and Systematics**

COURSE OBJECTIVES: The course should enable the students to:

- Comprehend detailed understanding of the chemical basis of heredity
- Understand genetic methodology and quantification of heritable traits in families and populations that will provides insight into cellular and molecular mechanisms.
- Understand as to how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability etc.
- Understand the role of genetic mechanisms in evolution.
- Account for the central concepts of the field and principles of phylogenetic analysis, especially based on the parsimony criterion
- Discuss and apply methods to generate relevant molecular data, mainly sequence data
- Choose and apply existing software in the included course parts, from generating relevant molecular data to phylogenetic analysis
- Critically analyse, evaluate, compile, and present the results of molecular systematics.

Course eligibility: The student should have passed semesters I to IV semesters of FYUGP in Biotechnology/Botany/Zoology/Microbiology or other allied subjects.

THEORY (3 credits)

Unit-I: Mendelian, Non-Mendelian & Sex-linked inheritance (20 contact hours)

Mendelian principles- laws of dominance, independent assortment, segregation. Non-Mendelian inheritance- co-dominance, incomplete dominance, gene interactions,pleiotropy, epistasis, multiple alleles, polygenic traits.Sex differentiation, dosage compensation, sex linked traits, sex linked inheritance, linkage maps and linkage testing (lod score), crossing over, homologous and non-homologous recombination, transposition, tetrad analysis, QTLs, karyotypes, pedigree analysis, genetic disorders.

Unit-II: Chromosomal and Extrachromosomal inheritance (14 contact hours)

Experiments of Hershey-Chase, Griffith, Avery-Macleod-McCarty, Meselson-Stahl. Continuous and discontinuous DNA replication, rolling circle mechanism, genome complexity, euchromatin,

heterochromatin, fine structure of gene, *cis-trans* complementation assay. Mitochondrial and chloroplast genes, cytoplasmic inheritance, maternal effects, recombination in bacteria (transformation, transduction, sex-duction, conjugation), fine structure analysis of microbial genes, plasmids and episomes.

Unit-III: Mutation (6 contact hours)

Types, causes, and effects, spontaneous and induced(radiations, chemicals), structural and numerical alterations of chromosomes,tautomeric forms, somatic and germinal mutations,insertional mutagenesis, DNA repair mechanisms.

Unit-IV: Quantitative and population genetics (5 contact hours)

Allele frequencies, random mating, Hardy-Weinberg equilibrium, inbreeding, outbreeding, genetic equilibrium and disequilibrium, random genetic drift, adaptive and molecular evolution, multigene families.

Unit-V: Systematics and Biological nomenclature (10 contact hours)

Classification (artificial, phenetic, evolutionary, cladistic), identification and keys. Concept of taxon, taxa, variation (sympatric, allopatric, parapatric), reproductive isolation mechanisms, molecular evolution.Classical and quantitative methods of plant, animal and microbial taxonomy, evolutionary relationships among taxa, phylogeny estimation, dendograms, cladograms, chemotaxonomy.

Unit-VI: Evolution and behaviour (5 contact hours)

Altruism in man and animals, evolution of human, human tree of life, group and kin selection, domestication, hybrids, molecular divergence, molecular clock. Geological timescale-eras, periods, epochs, major events in geological time scale, fossilization, radio-carbon dating.

PRACTICALS (1 credit)

1. Field visits for systematic collection and identification of bryophytes, pteridophytes, algae, fungi (mushrooms), lichens, insects (aquatic and terrestrial) and preparation of herbariums/ voucher specimens.

2. Stereozoom microscopic identification of planktons (zoo and phyto), ecto and endoparasites, diatoms, leaf parts, cross section of fruits, leaves, buds and roots.

3. Study of mitosis in onion root tip and meiosis in cells from onion flower through staining and observation at 40X and 100X magnification in a brightfield microscope.

4. Capture *Drosophila melanogaster* flies in the laboratory, culture them in flasks/milk bottles/ flat bottom culture vials and observe them under stereozoom microscope for mutants and wild types (red and black eye, wings, mouth parts, thorax, legs and abdomen).

5. Collect *Chironomas* sp. larvae (midge fly larvae) from the environment, bring back to the laboratory and observe polytene chromosomes under a brightfield microscope after staining.

6. Introduction to numerical phenetics, distance methods using Phylogeny Inference Package (PHYLIP) or any other free online tools.

7. Import or construct a data matrix for PHYLIP analysis and generate random trees through bootstrapping using online algorithms like PAUP.

Suggested Readings:

1. Gardner, E. J., Simmons, M. J., Snustad, D. P. 2006. Principles of Genetics, 8th Edition, John Wiley & Sons Inc.
2. Banerjee, P. K. 2011. Problems on Genetics, Molecular Genetics and Evolutionary Genetics. 2ndEdn., S Chand & Company.
3. Clug, W. S., Cummings, M. R., Spencer, C. A., Pallodino, M. A., Killian, D. 2019. Concept of Genetics, 11thEdn., Pearson publications, India
4. Singh, B. D. 2023. Fundamentals of Genetics, 6thEdn., Scientific International Pvt Ltd., India.
5. Singh, G. 2020. Plant Systematics. CRC Press, Boca Raton, USA
6. Mayr, E., Ashlock, P. D. 2014. Principles of Systematic Zoology, Tata McGraw Hill India Ltd.
7. Fox, C. W., Wolf. J. B. 2006. Evolutionary Genetics: Concepts and Case Studies. Oxford University Press.
8. Johnson, N. A. 2021. Darwin's Reach: 21st Century Applications of Evolutionary Biology, 1stEdn., CRC Press, Boca Raton.
9. Bedis, M. R. 1999. Practical Approaches on Principles of Genetics. Universal Prakashan, Pune, India.
10. Subramaniam, U. 2022. Practical Manual on Environmental Biology and Evolution. Lambert Academic Publishing, UK.

Graduate attribute

Course outcome:

- The knowledge required to design, execute, and analyze the results of genetic experimentation in animal, microbial and plant model systems.
- The ability to evaluate conclusions that are based on genetic data.
- Understanding the role of genetic technologies in industries related to biotechnology, pharmaceuticals, energy, and other fields.
- Discuss and applied principles of delimitation and identification of species and other taxa
- Teamwork and leadership skills including group analysis of data, working together in the research laboratory, joint compositions of written reports, substantive participation in practical approaches and developing skills to perform genetic studies.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr H. K. Sarma, Associate Professor, Department of Biotechnology, Gauhati University

Dr Sushmita Das, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Fifth**
Course level: **300-399**

Course name: **Developmental Biology**

Course objective: This course aims to explore the fundamental concepts and mechanisms that regulate the animal development from fertilization of the egg to early development, formation of germ layers (ectoderm, mesoderm, endoderm) and their derivatives organogenesis.

Course eligibility/Prerequisites: The student should have passed semester IV of FYUGP in Biotechnology or in other allied subjects.

THEORY (3 credits)

UNIT I: Gametogenesis and Fertilization (10 Contact hours)

Definition, scope and historical perspective of development Biology, Gametogenesis– Spermatogenesis, Oogenesis, Fertilization- Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk. Plants-cell structures, tissues -meristematic (ground, dermal, vascular), apical, intercalary, lateral, shoot and root apex, primary anatomy of monocots and dicots. Fertilization events, double fertilization, post fertilization changes.

UNIT II: Early embryonic development (20 Contact hours)

Cleavage: Definition, types, patterns and mechanism, Blastulation: Process, types and mechanism, Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation and differentiation of primary germ layers, Fate Maps in early embryos. Plants-Development and structure of anther, stigma, androecium, gynoecium, pollen, stigma and style. Post pollination events. Endosperm types, monocot and dicot seeds. Microsporangium, microsporogenesis, megasporangium, megasporogenesis.

UNIT III: Embryonic Differentiation (20 Contact hours)

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 and tertiary embryonic induction, Neural induction and induction of vertebrate lens. Plants-concept of totipotency and de-differentiation, cell polarity in acellular unicellular and multicellular plants. Shoot Apical meristem (SAM), ultrastructure of meristems.

UNIT IV: Organogenesis (10 Contact hours)

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers, Development of behaviour: constancy and plasticity, Extra embryonic membranes, placenta in Mammals**.** Plants-differentiation of root, stem, leaf and axillary buds; bud dormancy. Mechanism of leaf primordium initiation, development and phyllotaxis. Flower development, genetic control of flower development, senescence in plants.

PRACTICALS (1 credit)

1. Study of the structure of gametes in some representative cases, i.e. frog, fish, fowl and a mammal.
2. Study of fertilization, early development of frog/fish through induced spawning under laboratory conditions.
3. Identification of developmental stages of chick and frog embryo using permanent mounts.
4. Preparation of a temporary stained mount of chick embryo.
5. Study of developmental stages of *Anopheles*.
6. Study of the developmental stages of *Drosophila* from stock culture/ photographs..
7. Study of the Histological structure of different types of mammalian placenta.
8. Dissection and observation of anthers and stigma of flowers under steromicroscope
9. Collection, dissection and microscopic study of angisoperms (leaves and stems, fruits) and gymnosperm seeds/ cones.

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.

SUGGESTED READINGS:

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.

2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.

3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

4. Leyser, O., Day, S. (2002). Mechanism of Plant Development. Blackwell Science, UK

5. Gibbs, M. A. (2003). A Practical Guide to Developmental Biology. Oxford university Press.

Graduate attribute

Course outcome: The students will learn the sequence of events and mechanisms directing various stages of animal development including gametogenesis, fertilization, cleavage, gastrulation and organogenesis. Understand the role of differential gene expression in embryonic development, cell-cell communication and tissue induction processes that direct the differentiation of cells, tissues and organs during embryogenesis.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr S. S. Swargiary, Assistant Professor, Department of Biotechnology, Gauhati University

FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Fifth**
Course name: **Ecology and Environment**

Course level: **300-399**

COURSE OBJECTIVES: The course should enable the students to:

- Analyze the interrelationship between living organisms and the environment.
- Understand the importance of environment by assessing its impact on the human world.
- Enrich their knowledge on themes of biodiversity, natural resources, pollution control and waste management.
- Understand the constitutional protection given for environment.

Course eligibility: The student should have passed semesters I to IV semesters of FYUGP in Biotechnology/Botany/Zoology/Microbiology/Environment/Wild life science or other allied subjects.

THEORY (3 credits)

Unit-I: Ecosystem Structure and Biodiversity (15 contact hours)

Structures - biotic and abiotic components, energy flow in ecosystems, energy flow models, ecological pyramids, food chains, food webs. Biogeochemical cycles, ecological succession, species diversity, concept of ecotone, habitat and niche. Ecosystem stability, ecosystem services.Biodiversity types- deserts, forests, rangeland, grassland, wetlands, lakes, estuarine, oceans. Hotspots, biogeographic zones, conservation (in-situ and ex-situ), conventions on biological diversity, biological diversity act, wildlife protection act, biosphere reserves, national parks, wildlife sanctuaries.

Unit-II: Population and Community Ecology (15 contact hours)

Population characteristics, carrying capacity, population growth and density, metapopulation, concept of ‘r’ and ‘k’ species, keystone species, flagship species. Community types and interaction (predation, herbivory, parasitism and allelopathy). Biological invasions, sustainability.Human population distribution, mortality, life expectancy, urbanization, population pressure on natural resources. Population and public health issues, epidemiology, hygiene, sanitation, vectors and water borne diseases.

Unit-III: Microbial and Molecular Ecology (10 contact hours)

Communities, colonization, diversity, succession, physical and chemical interactions (stress, osmoregulation, starvation, quorum sensing, syntrophy, antibiotics, lantibiotics), interactions with higher taxa. Habitat characterization-culture based, biomarkers, stains, PCR, RT-PCR, FISH, pyrosequencing, metagenome analysis and DGGE. Geomicrobiology (concept).

Unit-IV: Air and Water Pollution (8 contact hours)

Types of air pollutants, natural and anthropogenic sources, primary and secondary pollutants, urban air quality, noise pollution. Sampling and monitoring of air pollutants (gaseous and particulates), acid rain. Types and sources of water pollutants, impact on living organisms, measurement of quality parameters, microbiological analysis of water.Greenhouse gases, global climate change.

Unit-V: Soil pollution (5 contact hours)

Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components), analysis of soil quality, soil pollution control. Industrial effluents and their interactions with soil components, soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers.

Unit-VI: Waste and Wastewater (7 contact hours)

Hazardous substances-types, chemicals, polymers and plastics (polyaromatic hydrocarbons, polychlorinated biphenyls), solid wastes. Biomethanation of solid waste, sanitary land filling, incineration. Environmental Impact Assessment (EIA), Environmental Management Plan (EMP). Recycling of wastewater from food; beverage; dairy; leather tanning; textile; paper and pulp industries.

PRACTICALS (1 credit)

1. Design a $1m^2 \times 1m^2$ quadrate frame, visit a grassland/ open field with less human activity and estimate the number of flowers/ herbs/ shrubs/ grass types/ insects by quadrate random sampling method.

2. Design a $10\ m^2 \times 1m^2$ transect frame, visit a grassland/ dry wetland/ biosphere reserve/ sacred grove/ plantation area and determine the abundance and distribution of a particular species of plant/ herb/ grass/ flower/ insect by systematic transect sampling method.

3. Measure the BOD, phosphate, sulphate and nitrate content in water collected from any of these sources (well/ lake/ wetland/ wastewater/ deep tubewell/ municipal supply)

4. Measure the pH, conductivity, turbidity, total dissolved solids (TDS), dissolved oxygen (DO) and temperature of water samples from any of these two sources (well/ lake/ wetland/ marshland/ municipal supply/ wastewater/ agricultural field/ stagnant water source) using a water analysis kit.

5. Collect soil samples from any of the sources (agricultural/ urban/ peat/ landfill/ stream/ creek/ backyard), sieve them and calculate carbon and sulphur content by Winogradsky column method.

6. Isolation and microscopic identification of bacteria and fungi in water samples collected from wastewater source and polluted soils.

7. Isolation and microscopic identification of air microflora (bacteria, fungi, yeast) by exposing petriplates of Nutrient Agar/ Potato Dextrose Agar/ Sabouraud Dextrose Agar to open air in the surrounding laboratory premises.

Suggested Readings:

1. Smith, T. M., Smith, R. L. 2006. Element of Ecology, 6thEdn. Pearson Education Inc. India.
2. Odum, E. P., Barrett, G. W. 2005. Fundamentals of Ecology, 5th Edition, Thompson Asia Books Pvt Ltd., Singapore.
3. De, A. K., De, A. 2022. Environmental Chemistry, 10thEdn., New Age International Publishers, India.
4. Atlas, R. M., Bartha, R. 1998. Microbial Ecology, 4thEdn., Pearson Education Inc. India.
5. Wright, R. T., Boorse, D. F. 2015. Environmental Science: Towards a Sustainable Future, 12thEdn., Pearson Education Inc. India.
6. Asthana, D. K., Asthana, M. 2022. A Textbook of Environmental Studies, revised edn., S Chand & Company, New Delhi, India.
7. Wheater, C., Cook, P. A., Bell, J. R. 2004. Practical Field Ecology, 2ndEdn., John Wiley and Sons Ltd.
8. Mumjadar, R., Kashyap, R. 2010. Practical Manual of Ecology and Environmental Science, Prestige Books, India.

Graduate attribute

Course Outcomes:

- Discover knowledge in ecological perspective and value of environment.
- Understand the significance of various natural resources and its management.

- Demonstrate a comprehensive understanding of the world's biodiversity and the importance of its conservation with reference to our region.
- Categorize different types of pollutions and their control measures.
- Discover effective methods of waste Management.
- Analyze global environmental problems and come out with best possible solutions.
- Summarize about environment and understand the importance of ecosystems.
- Acquire knowledge about biodiversity and as to how animals compete with their food requirements at various trophic levels in the food chain.
- Describe the flow of energy through the various components of ecosystem.
- Summarize about the toxicity of heavy metals on the biotic and a biotic components.
- Describe the ecological values and consumptive use of ecosystem.
- Analyze the important pollutants in air water and soil.
- Describe the various methods commonly employed for the disposal of solid waste.
- Understand concept of climate change and impacts.
- Evolve strategies to environmental issues and understand the role of government and legal aspects in environmental protection.
- Discuss the silent features of the hazardous waste management and EIA
- Enumerate the effects of population explosion on overall ecosystem

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr H. K. Sarma, Associate Professor, Department of Biotechnology, Gauhati University

Dr Sushmita Das, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Sixth**
Course name: **Industrial Biotechnology**

Course level: **300-399**

Course objective: This course will allow students to gain understanding in the application of biotechnology for industrial purposes which includes manufacturing processes using cost effective resources to generate products of industrial importance.

Course eligibility: The student should have passed semesters I, II, III, IV and V of FYUGP in Biotechnology, Chemistry, Botany, Zoology, Microbiology, or other allied subjects.

THEORY (3 credits)

UNIT I: Introduction to Industrial Biotechnology (6 contact hours)

History of biotechnology, scope, and importance. Commercial potential of biotechnology in India. Overview of traditional and modern industrial biotechnology. Fermented foods and beverages in India and the world.

UNIT II: Industrial fermentation (12 contact hours)

Fermentation equipments, types of fermenters, single batch, continuous, surface, batch and fed-batch, submerged and solid-state fermentation. Fermentation process and mode of operation. Control and optimization of fermentation parameters. Fermentation kinetics. Media formulation and industrial sterilization.

UNIT III: Microbes in industrial process (12 contact hours)

Screening of industrially relevant microorganisms, strain development strategies- mutation, recombination (parasexual recombination in fungi, bacterial recombination, and protoplast fusion) and recombinant DNA technology. Immobilization methods of whole cells.

UNIT IV: Industrial production of primary and secondary metabolites (15 contact hours)

Production of primary metabolites: organic acids (citric acid, lactic acid, acetic acid), amino acids (lysine, glutamic acid and tryptophan), vitamins and alcohol (ethanol and butanol). Production of secondary metabolites: antibiotics (penicillin, streptomycin), and pigments (carotenoids).

UNIT V: Industrial products of food and pharmaceutical industries (15 contact hours)

Use of microbes in the production of dairy products (cheese, yoghurt, fermented milk), processing of perishable foods (sauerkraut, fermented fish, and bamboo shoot) and processing of cereals (soybean). Production process of fermented beverages (beer and wine). Biomass production: single cell proteins (SCPS), yeasts and LAB. Production of recombinant proteins with therapeutic applications: insulin, human growth hormone, recombinant vaccines, and monoclonal antibodies.

PRACTICALS (1 credit)

1. Screening of antibiotic producing strains by crowded plate technique.
2. To calculate minimum inhibitory concentration (MIC) of an antibiotic screened from the above method.
3. Screening of lactic acid bacteria (LAB) from curd/yoghurt/cheese.
4. Screening of microbes producing organic acids using indicator dye method.
5. To study the effect of temperature, pH on the growth of any industrially relevant microbe.

SUGGESTED READINGS

1. Cruegers Biotechnology: A textbook of Industrial microbiology- Wulf Crueger, Anneliese Crueger, edited by K.R. Aneja, Medtech Publications.
2. Fermentation Microbiology and Biotechnology-E.M.T El. Mansi, C.F.A. Bryce, Arnold L Demain And A.R. Allman, CRC Press, Boca Raton, USA.
3. Waites, M.J., Morgan, N.L., Rockey,J.S., Higton, G., "Industrial Microbiology: An Introduction" Blackwell, 2001.
4. Lee, S.Y., Nielsen, J. and Stephanopoulos, G., "Industrial Biotechnology: Products and Processes," John Wiley & Sons, 2016.
5. Mathur, N., "Industrial Microbiology- A Laboratory manual," Aavishkar Publisher Distributors, 2007.

Graduate attribute

Course outcome: Students will gain knowledge about industrially relevant microbial strains and production process of various industrially important products. This will also enhance their knowledge on the basics of industrial fermentation process to develop novel microbial products.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr H. K. Sarma, Associate Professor, Department of Biotechnology, Gauhati University

Dr M. I. Khan, Assistant Professor, Department of Biotechnology, Gauhati University

Dr Sushmita Das, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Sixth**

Course name: **Bioinformatics and Biostatistics**
Course level: **300-399**

Course objective: The objective is to give students an introduction to the basic practical techniques of bioinformatics and the application of bioinformatics and biological databases in real research problems.

Course eligibility: The student should have passed semesters I to V of FYUGP in Biotechnology, Botany, Zoology, Microbiology, or other allied subjects.

THEORY (3 credits)

Unit I: Introduction to computer fundamentals and bioinformatics (5 Contact hours)

Computer fundamentals-different types of operating systems. Requirements of software and hardware configuration for Bioinformatics computing. Historical background, Scope and Applications of Bioinformatics.

Unit II: Biological databases and data retrieval (10 Contact hours)

Introduction to biological databases- primary, secondary and composite databases, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), file formats. Searching Databases: SRS, Entrez, Sequence Similarity Searches- FASTA, BLAST.

Unit III: Sequence alignment (10 Contact hours)

Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms- BLAST and CLUSTALW, amino acid substitution matrices- PAM and BLOSUM.

Unit IV: Phylogenetic analysis (5 Contact hours)

Types of phylogenetic trees, Different approaches of phylogenetic tree construction-maximum parsimony, maximum likelihood and distance methods.

Unit V: Descriptive and Relational Statistics (10 contact hours)

Data collection and tabulation, graphical representation of data, measures of central tendency (Mean, Median and Mode) with examples, measures of dispersion (range, quartile deviation, mean deviation,

standard deviation, standard error and coefficient of variation) with examples, concept of skewness and kurtosis.

Unit VI: Probability and Inferential Statistics (5 contact hours)

Basic concepts and basic terms of probability, mathematical, statistical and axiomatic definitions of probability, conditional probability and independence of events, addition and multiplication theorems (statements only) with simple examples. Statements and applications of binomial, poisson and normal distributions.

Unit VII: Testing of hypothesis (12 contact hours)

Test statistic, null and alternative hypotheses, Type-I and Type-II errors, level of significance, one tailed and two tailed tests. Hypothesis testing for mean, proportion, variance. Tests of significance based on goodness of fit, means, variances using Chi-square test, t-test (one and two tailed), F-test and analysis of variance (ANOVA).

Unit VIII: Sampling and statistical inference (8 contact hours)

Concept of dependent and independent variables, types of parametric and non-parametric tests, types of correlation, computation of Karl-Pearson correlation coefficient, Spearman's rank correlation coefficient and Simple linear regression analysis. Factor and discriminant analysis.

PRACTICALS (1 credit)

1. Understanding of different types of operating systems and requirements for Bioinformatics computing.

2. Understanding and use of various sequence information resources: Genbank, EMBL, Protein information resource (PIR)

3. Understanding and using: Swissprot, TREMB, PDB.

4. Sequence retrieval (protein and gene) from NCBI.

5. Sequence alignment using BLAST and interpretation of results.

6. Multiple sequence alignment using Clustal W.

7. Generating phylogenetic tree using Standalone Softwares and Online Tools.

8. Calculate mean, mode, median, standard error, standard deviation and variance from a given set of data using biostatistics.

9. Calculate the Chi square value of a set of data to test goodness of fit.

10. Find the coefficient of correlation of a set of data between seed yield per plant (in grams) and plant height (in cm).

11. Calculate the probability of two dice theorem simultaneously thrown at the same time.

SUGGESTED READINGS:

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House.

2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications.

3. LeskM.A.(2008) Introduction to Bioinformatics, 3rd International Student Edition, Oxford Publication,

4. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

5. Mount, D.W. (2001) Bioinformatics: Sequence and Genome Analysis, 1st ed., Cold Spring Harbor Laboratory Press (New York).

6. Baxevanis, A.D. and Ouellette, B.F. (2005) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd ed., John Wiley & Sons, Inc. (New Jersey).

7. Zerold H Zar. 2014. Biostatistical analysis. 5thEdn., Pearson India Limited

8. Ronald N Forthofer, Eun Sul Lee, Mike Hernandez. 2007. Biostatistics: A guide to design, analysis and discovery. First Indian Reprint. Academic Press, Elsevier.

9. C R Kothari, Gaurav Garg. 2022. Research Methodology: Methods and Techniques. New Age International Publishers Pvt Ltd., New Delhi.

Graduate attribute

Course outcome: The students will become familiar with the important bioinformatics databases, learn to perform text and sequence based searches, analyze arid discuss the results in light of molecular biology knowledge.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr S. S. Swargiary, Assistant Professor, Department of Biotechnology, Gauhati University

Dr H. K. Sarma, Associate Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Sixth**
Course name: **Introduction to Omics.**
Course level: **300-399**

Course objective: To impart basic understanding to Genomics, Transcriptomics, Proteomics and Metabolomics and introduce students to basic tools.

Course eligibility: The student should have passed Vth sem in Biotechnology/Zoology/Botany/Microbiology or allied subjects.

THEORY (3 credits)

Unit-I: Introduction to Genome, Transcriptome, proteome and metabolome. **(10 contact hours)**

Unit-II: Genetic Mapping, Mapping population, Molecular and physical markers- SSR, STMS, VNTR, AFLP, RFLP. Concept of Dominant and Co-dominant markers. **(10 contact hours)**

Unit-III: Genomic DNA library, cDNA library, Differential Gene Expression Analysis (DGEA), Sequencing, Assembly and Physical Mapping. **(15 contact hours)**

Unit-IV: Proteomics: 2D Gel Electrophoresis, Iso-electric focusing, MALDI-TOF MS, Sub-cellular localization of expressed proteins (Introductory), Biomarker screening (Introductory). **(15 contact hours)**

Unit-V: Metabolomics: HPLC, GC-MS, LC-MS, Lipidomics. **(10 contact hours)**

PRACTICALS (1 credit)

1. Demonstration of PCR Genotyping
2. Demonstration of HPLC
3. Demonstration of GC MS and LC MS

Suggested Readings:

1. Genomes by T.A. Brown
2. Principles of Gene Manipulation and Genomics By S.B. Primerose and R.M. Twyman, Blackwell pUblishing
3. Protein Biochemistry and Proteomics by Hubert Rehn, Elsevier Academic Press.

Graduate attribute

Course outcome: Students will be able to attribute different tools and techniques used in omics studies. In addition, students will gain the skill to practically analyze high throughput data which will help them in solving problems in Biology both in academia and in the industry.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr Sujoy Bose, Associate Professor, Department of Biotechnology, Gauhati University

Dr Pranjan Barman, Assistant Professor, Department of Biotechnology, Gauhati University

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FYUGP
Department of Biotechnology
Gauhati University
Syllabus for NEP 2020 Implementation
Semester: **Sixth**

Course name: **Dissertation**

Course level: **400-499**

Guidelines for Dissertation under FYUGP in Biotechnology

1. The dissertation work should be done in-house.
2. The topic should be relevant to Biotechnology or Bioinformatics, in general.
3. The report should be prepared as per the guidelines of Gauhati University.
4. The evaluation should be carried out both internally and externally. External examiner will conduct viva-voce and award marks. Both the internal examiner and external examiner will award marks for the dissertation report (or Thesis).

Theory Credit: 01
Practical Credit: 03
No. of Required Classes: 75 (Theory: 0; Practical: 75)
No. of Contact Classes: 75 (Theory: 0; Practical: 75)
No. of Non-Contact Classes: Nil
Particulars of Course Designer (Name, Institution, email id):

Dr Sujoy Bose, Head of the department and Associate Professor, Department of Biotechnology, Gauhati University

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