

B.Sc. Biotechnology (Professional) Syllabus- CBCS

Effective from August, 2019

Department of Biotechnology,

GAUHATI UNIVERSITY

Gopinath Bordoloi Nagar, Guwahati 781014, Assam, India.

CHOICE BASED CREDIT SYSTEM (CBCS)
B.Sc. (Honours/Professional) Biotechnology

COURSE STRUCTURE

	Type	CORE	AEC	SEC	DSE	GEN
	Credit	6 (60T+ 40P)	4 (100T)	4 (60T + 40P)	6(4T+2P) 60T + 40P	6 (5T + 1P) 80T + 20P
Semester I		C1(BIT-HC-1016)	AECC1 (ENG-AE-1014)			GE-1 (BIT-HG-1036)
		C2(BIT-HC-1026)				
Semester		C3(BIT-HC-2016)	AECC1 (ENG-AE-1014)			GE2 (BIT-HG-2046)
		C4(BIT-HC-2026)				
Semester III		C5 (BIT-HC-3016)		SEC-1 (BIT-SE-3014)		GE-3 (BIT-HG-3016)
		C6 (BIT-HC-3026)				
		C7 (BIT-HC-3036)				
Semester		C8 (BIT-HC-4016)		SEC-2 (BIT-SE-4014)		GE-4 (BIT-HG-4016)
		C9 (BIT-HC-4026)				
		C10 (BIT-HC-4036)				
Semester V		C11 (BIT-HC-5016)			DSE-I (BIT-HE-5016)	
		C12 (BIT-HC-5026)			DSE-2 (BIT-HE-5026)	
Semester VI		C-13 (BIT-HC-6016)			DSE-3 (BIT-HE-6016)	
		C-14 (BIT-HC-6026)			DSE-4 (BIT-HE-6026)	

LIST OF PAPERS:

Semester I	C1	BIT-HC-1016	Biochemistry & Metabolism	6 credits (60T + 40P marks)
	C2	BIT-HC-1026	Cell Biology	6 credits (60T + 40P marks)
	AECC1	ENG-AE-1014	English/ EVS/ MIL communication	4 credits
	GE1	BIT-HG-1036	Biotechnology & Human Welfare	(5 + 1P) credits (80T + 20P marks)
Semester II	C3	BIT-HC-2016	Mammalian Physiology	6 credits (60T + 40P marks)
	C4	BIT-HC-2026	Plant Physiology	6 credits (60T + 40P marks)
	AECC1	ENG-AE-1014	English/ EVS/ MIL communication	4 credits
	GE2	BIT-HG-2046	Developmental Biology	(5 + 1P) credits (80T + 20P marks)
Semester III	C5	BIT-HC-3016	Genetics	6 credits (60T + 40P marks)
	C6	BIT-HC-3026	General Microbiology	6 credits (60T + 40P marks)
	C7	BIT-HC-3036	Chemistry-I	6 credits (60T + 40P marks)
	SEC1	BIT-SE-3014	Enzymology	4 credits (60T + 40P marks)
	GE3	BIT-HG-3016	Bioethics and Biosafety	(5 + 1P) credits (80T + 20P marks)
Semester IV	C8	BIT-HC-4016	Molecular Biology	6 credits (60T + 40P marks)
	C9	BIT-HC-4026	Immunology	6 credits (60T + 40P marks)
	C10	BIT-HC-4036	Chemistry-II	6 credits (60T + 40P marks)
	SEC2	BIT-SE-4014	Industrial Fermentations	4 credits (60T + 40P marks)
	GE4	BIT-HG-4016	Entrepreneurship Development	(5 + 1P) credits (80T + 20P marks)
Semester V	C11	BIT-HC-5016	Bioprocess Technology	6 credits (60T + 40P marks)
	C12	BIT-HC-5026	Recombinant DNA Technology	6 credits (60T + 40P marks)
	DSE1	BIT-HE-5016	Bioinformatics	(4+2P) credits (60T + 40P marks)
	DSE2	BIT-HE-5026	Ecology & Environmental Management	(4+2P) credits (60T + 40P marks)
Semester VI	C13	BIT-HC-6016	Bio-Analytical Tools	6 credits (60T + 40P marks)
	C14	BIT-HC-6026	Genomics & Proteomics	6 credits (60T + 40P marks)
	DSE3	BIT-HE-6016	Biostatistics	(4+2P) credits (60T + 40P marks)
	DSE4	BIT-HE-6026	Dissertation/ Project	(4+2P) credits (60T + 40P marks)

CONTENT:

BIOCHEMISTRY AND METABOLISM

UNIT I: Introduction to Biochemistry: (20 Periods)

History of biochemistry- from the first enzyme purified to the first protein structure elucidated, and seeds of synthetic biology. Acids, bases, weak acids, pH, K_a , biological buffers, biological significance of normality, molarity, osmosis, diffusion and other phenomena involved in maintaining cellular morphology, cellular structure and dimension.

Amino acids & Proteins: Structure & Function. 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, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

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

UNIT II (10 Periods)

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: Nitrogen, physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines. Double helical model of DNA structure. Forces stabilizing DNA structure. Forms of DNA. DNA denaturation and renaturation. Introduction to nucleic acid metabolism.

UNIT III (15 Periods)

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway, Gluconeogenesis, Glycogenolysis and

glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. β -oxidation of fatty acids.

UNIT IV

(15 periods)

Bioenergetics and thermodynamics, Laws of thermodynamics and biology, concepts of free energy, Gibb's free energy, entropy, phosphoryl group transfer and ATP synthesis, oxidation and reduction reactions in biology: Photosynthetic electron transfer, Calvin cycle, TCA cycle, electron transfer chain (oxidative phosphorylation). Reducing and oxidising agents (oxidants and antioxidants), and free radicals in biology.

PRACTICALS

1. Preparation of buffers.
2. Principles of Colorimetry:
 - a. Verification of Beer's law, estimation of protein.
 - b. To study relation between absorbance and % transmission.
3. Concept of standard curve, preparation of standard curve of Glucose.
4. Estimation of blood glucose by glucose oxidase method.
5. Quantification of proteins, carbohydrates and fats.
6. To study activity of any enzyme under optimum conditions.
7. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
8. Separation of Amino acids by paper chromatography/TLC

SUGGESTED READING

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. Ltd.

Contact person: Dr Mohammad Imtiyaj Khan, 9844162330, imtiyaj@gauhati.ac.in.

CELL BIOLOGY

UNIT I

(10 Periods)

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

(15 Periods)

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.

UNIT III

(15 Periods)

Lysosomes: Vacuoles and microbodies: Structure and functions Ribosomes: Structures and function. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis

UNIT IV

(10 Periods)

Nucleus: Structure and function, chromosomes and their structure.

UNIT IV

(10 Periods)

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

PRACTICALS

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 in onion root tip.
3. Study of structure of any phytoplankton, zooplankton, diatom, blue green algae, algae and yeast.
4. Microtomy: Fixation, block making, section cutting, staining of animal tissues/plant tissue.
5. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

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

Contact person: Debasish Borbora, debasish.borbora@gauhati.ac.in (9577472620)

BIOTECHNOLOGY AND HUMAN WELFARE

UNIT I (10 Periods)

Protein engineering for industry: food, pharmaceutical, beverage, tanning and textile.

UNIT II (10 Periods)

N₂ fixing microbes for sustainable agriculture. Plant-microbe interaction, stress response in plants, qualitative improvement of livestock.

UNIT III (15 Periods)

Polyaromatic hydrocarbons, polycyclic biphenyls, non-chlorinated organic pollutants, biodegradation, bioremediation, degradation of hydrocarbons and agricultural wastes, bioplastics, biopolymers and biosurfactants.

UNIT IV (12 Periods)

Biotechnology in forensic science, criminology, paternity determination using various methods of DNA finger printing.

UNIT V (13 Periods)

Biotechnology in modern medicine- overview, therapeutic agents, vaccines, gene therapy, diagnostics, monoclonal antibodies, anti-venoms and chemotherapeutic agents.

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. Ethanolic fermentation using yeast.
2. Isolation of *Rhizobium*/*Azotobacter*/*Azospirillum*, etc from soil/plant parts.
3. Microscopic observation of infected plant parts (sugarcane/rice/brinjal/legumes).
4. Estimation of residual halogens (chlorine/fluorine) in waste water/effluent.
5. Human DNA isolation from buccal swab/hair/urine using isolation kit.
6. visit to advanced laboratory/Universities.

SUGGESTED READING

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international

Publishers

Contact person: Dr. Sujoy Bose, Department of Biotechnology, GU

SEMESTER II
MAMMALIAN PHYSIOLOGY

UNIT I: Digestion and Respiration **(15 Periods)**

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice

Respiration: Exchange of gases, Transport of O₂ and CO₂, Oxygen dissociation curve, Chloride shift.

UNIT II: Circulation **(15 Periods)**

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

UNIT III: Muscle physiology and osmoregulation **(15 Periods)**

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 **(15 Periods)**

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters. Mechanism of action of hormones (insulin and steroids)

Different endocrine glands- Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

PRACTICALS

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

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Herculourt Asia

PTE Ltd. /W.B. Saunders Company.

2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John Wiley & sons, Inc.

Contact person: Dr. Sujoy Bose, Department of Biotechnology, GU

PLANT ANATOMY AND PHYSIOLOGY

UNIT I: Anatomy

(10 Periods)

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

UNIT II: Plant water relations and micro & macro nutrients

(12 Periods)

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.

Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT III: Carbon and nitrogen metabolism

(20 Periods)

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT IV: Growth and development

(18 Periods)

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberellins, cytokinins, abscisic acid, ethylene)

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

PRACTICALS

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Study of stomatal distribution/Index in different leaves.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf of any plant.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Study of root nodules.

SUGGESTED READING

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahh, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjamin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.

8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA

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DEVELOPMENTAL BIOLOGY

5 credit (L) + 1 T

UNIT I: Gametogenesis and Fertilization

(10 Periods)

Definition, scope & historical perspective of development Biology, Gametogenesis, Spermatogenesis, Oogenesis, Differentiation of eggs, spermatogenesis, Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: Early embryonic development

(20 Periods)

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, Fate Maps in early embryos.

UNIT III: Embryonic Differentiation

(20 Periods)

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

(10 Periods)

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

TUTORIALS:

SUGGESTED READING

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.

Contact person: Dr. Sujoy Bose, Department of Biotechnology, GU

SEMESTER III

GENETICS

UNIT I

(12 Periods)

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 and *Drosophila*. Role of meiosis in life cycles of organisms.

Mendelian genetics : 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, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes,

UNIT II

(18 Periods)

Non allelic interactions: Complementary genes, epistasis (dominant & recessive), duplicate and inhibitory genes. Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINES & LINES, middle repetitive multiple copy genes, noncoding DNA. Genetic organization of prokaryotic and viral genome. 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

(15 Periods)

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, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

UNIT IV

(15 Periods)

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, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. Extra chromosomal inheritance: 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

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

SUGGESTED READING

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

Contact person: H.K. Sarma, Department of Biotechnology, GU

GENERAL MICROBIOLOGY

UNIT I

(15 Periods)

An introduction to microbiology and its underlying principles

Functional morphology of the microbial cell - Bacteria, Algae, Fungi, Protozoa, and viruses. Classification of microorganisms, Microbial taxonomy –principles and techniques including molecular approaches, Classification of bacteria - An introduction to Bergey's Manual of Systematic Bacteriology. Extremophiles.

UNIT II

(5 Periods)

Microbial nutrition, nutritional categories, methods of isolation and preservation

UNIT III

(20 Periods)

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

Microbial Metabolism: Autotrophic, heterotrophic, mixotrophic, lithotrophic, organotrophic, chemotrophic and phototrophic. Bacterial Reproduction: Transformation, transduction, and conjugation. Endospores and sporulation in bacteria.

UNIT IV

(20 Periods)

Physical and chemical control of microorganisms.

Water Microbiology: Bacterial pollutants of water, coliforms, and non-coliforms.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major foodborne infections and intoxications, an introduction to microbial food fermentation, food preservation.

PRACTICALS

1. Preparation of media & sterilization methods.
2. Isolation of bacteria & fungi and their biochemical characterization.
2. Staining methods: simple staining, Gram staining, fungal staining, spore staining, negative staining.

4. Determination of bacterial cell size by micrometry and bacterial cell count by haemocytometer.
5. Enumeration of microorganism - total & viable count.
6. Isolation of bacteriophages from sewage.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). *Introductory Mycology*. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7th edition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). *Introductory Phycology*. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). *Brock Biology of Microorganisms*. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). *Microbiology*. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). *General Microbiology*. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). *Microbiology: An Introduction*. 9 th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 7th edition. McGraw Hill Higher Education.

Contact person: Dr. Debasish Borbora, Department of Biotechnology, GU

ENZYMOLOGY

UNIT – I

(15 Periods)

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, complementarity, enzyme activity, Michaelis-Menten hypothesis, and Lineweaver Burke plot, specific activity, and common features of active sites.

Enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD⁺, NADP⁺, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

UNIT - II

(15 Periods)

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis.

Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation,

Different plots for the determination of K_m and V_{max} and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT - III

(15 Periods)

Two substrate reactions (Random, ordered and ping-pong mechanism). Enzyme inhibition and types of inhibition, determination of K_i , suicide inhibitor.

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples:- chymotrypsin, lysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.

Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

UNIT - IV

(12 Periods)

Allosteric enzymes with special reference to aspartate transcarbamylase and phosphofructokinase. Models of Allosteric enzymes. Negative cooperativity and half site reactivity. Macromolecular interaction: Enzyme interaction, Protein ligand binding, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes- types and significance with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Abzymes. Multifunctional enzyme-eg Pyruvate dehydrogenase complex.

UNIT - IV

(8 Periods)

Enzyme Technology: Methods for large scale production of enzymes.

Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Basic kinetics of immobilized enzymes.

PRACTICALS

1. Purification of an enzyme from any natural resource.
2. Quantitative estimation of proteins by Bradford/Lowry's method.
3. Perform assay for the purified enzyme.
4. Determination of - pH optima, temperature optima, K_m value, V_{max} value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.

SUGGESTED READING

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons, 1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999

6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

Contact person: Dr Mohammad Imtiyaj Khan, Department of Biotechnology, Gauhati University. 9844162330, imtiyaj@gauhati.ac.in.

BIOETHICS AND BIOSAFETY UNIT

UNIT- I: **(20 Periods)**
Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

UNIT II **(15 Periods)**
Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

UNIT IV **(15 Periods)**
Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level, Concept of BSL and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

PRACTICALS

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste

SUGGESTED READING

1. Entrepreneurship: New Venture Creation : David H. Holt
2. Patterns of Entrepreneurship : Jack M. Kaplan
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

Contact Person: Dr. H.K. Sarma, Department of Biotechnology. GU

SEMESTER IV MOLECULAR BIOLOGY

UNIT I: DNA structure and replication (15 Periods)

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 (10 Periods)

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair, base excision repair, nucleotide excision repair, mismatch repair, translation synthesis, Homologous recombination.

UNIT III: Transcription and RNA processing (17 Periods)

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 (18 Periods)

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

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

SUGGESTED READING

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

Contact person: Dr. Pranjan Barman, Department of Biotechnology, GU pranjan.barman@gauhati.ac.in
(Call +91 9859947743).

IMMUNOLOGY

UNIT I **(20 Periods)**

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), B-lymphocyte differentiation, Antigens.

UNIT II **(15 Periods)**

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity,

UNIT III **(13 Periods)**

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection, pathogen defense strategies, autoimmune diseases, Immunodeficiency-AIDS. Introduction to HLA system.

UNIT IV **(12 Periods)**

Types of Vaccines & adjuvants, cytokines, passive and active immunization. Introduction to immunodiagnosics –RIA, ELISA. Introduction to basics of plant immune system.

PRACTICALS

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood.
7. ELISA
9. Preparation and quantification of microbial antigen.

SUGGESTED READING

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
7. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Contact person: Dr. Sujoy Bose, Department of Biotechnology, GU

INDUSTRIAL FERMENTATIONS

UNIT I

(12 Periods)

Biotechnology and bioprocess engineering – principles and steps involved. Media ingredients for industrial fermentation, media formulation, optimization, and sterilization. Inoculum production for bacterial and fungal processes. Strain development. Fermentation material and energy balance, microbial growth kinetics, growth cycle, batch, fed-batch and continuous fermentation. Aeration (O₂, N₂, CO₂) antifoam and buffers.

UNIT II

(15 Periods)

Microbial products of pharmacological interest, chemotherapeutic products, antibiotics, amino acids, vitamins, steroids and enzymes. Secondary metabolism – its significance and products. Cell immobilization techniques in industrial processing, enzymes in organic synthesis, enzymes in food sciences, textile industries and tanning and leather industries. Production of industrial chemicals viz., acetic acid, propionic acid, butyric acid. Ethanol fermentation and bio-hydrogen. Production of microbial polysaccharides, microbial insecticides, microbial biosurfactants.

UNIT III

(13 Periods)

Downstream processing - Separation characteristics of proteins and enzymes, purification methodologies. Cell disruption methods for intracellular products, homogenization, sonication, enzyme digestion. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra-centrifugation, Supercritical fluid extraction, liquid extraction, ion-exchange recovery, precipitation, distillation, drying of biological products. Product recovery and yield.

UNIT IV

(20 Periods)

Rate equations for enzyme kinetics, simple and complex reactions. Mathematical derivation of growth kinetics, batch and continuous culture operations. Basic design of a fermenter, aseptic operation and containment, agitator and sparger design, and baffles. Process parameters, measurement of temperature, pressure, pH, dissolved oxygen, foaming, and flow rate of liquids and gases. Types of fermenters, Single stage Continuously Stirred Tank Reactor, bubble column, airlift, packed bed, fluidized bed, membrane type, solid state and photobioreactors.

PRACTICALS

1. Isolation of industrially important microorganisms
2. Production of Industrially important Enzyme by submerged fermentation (Lab scale)
3. Production of Industrially important Enzyme by solid state fermentation
4. Study of Microbial Growth Kinetics
5. Production of alcohol by viable yeast cells
6. Cell disruption by ultrasonication.
7. Soxhlet extraction of plant metabolites and usage of flash evaporator.

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.

3. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
4. Salisbury, Whitaker and Hall. Principles of fermentation Technology,
5. Bioprocess Engineering, Basic Concepts, II Ed. Michael L Shuler, Fikret Kargi, Prentice Hall of India pvt. Ltd. 2002.

Contact person – Mr. Debasish Borbora (Debasish.borbora@gauhati.ac.in.) and Dr. Dr H.K. Sarma (hridip@gauhati.ac.in)

ENTREPRENEURSHIP DEVELOPMENT

UNIT I (10 Periods)

Introduction - Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT II (12 Periods)

Establishing an enterprise, Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility. Finance in projects.

UNIT III (15 Periods)

Financing the enterprise, Importance of finance / loans and repayments, Characteristics of 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 (13 Periods)

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

UNIT V (10 Periods)

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.

SUGGESTED READING

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.

Contact person – Mr. Debasish Borbora (Debasish.borbora@gauhati.ac.in.)

SEMESTER -V

BIOPROCESS TECHNOLOGY

UNIT I

(10 Periods)

Introduction to bioprocess technology. Techniques and basic principle components of fermentation technology. Types of microbial fermentation and their uses.

UNIT II

(20 Periods)

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT III

(15 Periods)

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV

(15 Periods)

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

PRACTICALS

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

Contact person: Dr H.K. Sarma

RECOMBINANT DNA TECHNOLOGY

UNIT I

(15 Periods)

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**(20 Periods)**

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

UNIT III**(10 Periods)**

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**(15 Periods)**

Genetic engineering in plants: Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants,

PRACTICALS

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

SUGGESTED READING

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Appling the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

Contact person: Dr. Pranjan Barman, pranjan.barman@gauhati.ac.in (call: +91 9859947743)

BIOINFORMATICS**UNIT I****(10 Periods)**

Basic computer applications in biology, History of Bioinformatics. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II**(20 Periods)**

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR,

UNIT III

(20 Periods)

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Concept of Homology search, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT IV

(10 Periods)

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

PRACTICALS

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

SUGGESTED READING

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

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Dr. Pranjan Barman, pranjan.barman@gauhati.ac.in (call +91 9859947743 M)

ECOLOGY AND ENVIRONMENT MANAGEMENT

UNIT-I

(12 Periods)

Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure and strata of ecosystem. Types of ecosystem including habitats, niche and biomes. Evolution of early life and changes in earth's atmosphere. Whittaker's classification of kingdoms, monera, protists, fungi, plant, and animal kingdoms. Darwin's and Wallace theories of evolution and inheritance.

UNIT II

(20 Periods)

Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production and decomposition in a system. Ecological efficiencies, trophic structure and energy pyramids, Ecological energetics, principles pertaining to limiting factors, Bio-geochemical cycles (N,C,P cycles). Population ecology – populations and communities, attributes of populations, introduction to Mendelian

and population genetics, Hardy Weinberg's law, genetic drift, gene flow.. Intraspecific interactions, commensalism, mutualism, competition and predation. Species diversity, richness, stability and disturbance.

UNIT-III

(18 Periods)

Aquatic and terrestrial communities; rare communities. Primary and secondary productivity - basic concepts. Primary and secondary ecological succession – water, forests, and lands. Invasive species and control. Adaptation and behaviour under various ecological conditions.

Pollution and environmental health related to soil, water, air, food, pesticides, metals, solvents, radiations, carcinogen, and poisons. Basics of detecting environmental pollutants, indicators of pollution.

UNIT-IV

(10 Periods)

Environmental biotechnology, approaches for the protection and preservation of environment. Bioremediation, waste water management. Analysis of air pollutants and mitigation of greenhouse gases. Estimation of physico-chemical parameters of water and soil quality, BOD, COD, DO, heavy metals and suspended solids. Principle, instrumentation and application of UV spectroscopy, flame spectrometry and atomic absorption spectroscopy.

PRACTICALS

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem.
2. Determination of population density in a terrestrial or plant community and calculation of the Simpson's and Shannon- Weiner diversity index munity.
3. Study of fecundity table of three types of survivorship curves from zooplanktons collected from natural source.
4. Study of the types of soil, their texture by sieve method and rapid tests for –pH, phosphorous, chlorides, nitrates, carbonates and organic carbon
5. Study any five endangered/ threatened species- one from each class of Whittaker's classification.

SUGGESTED READING

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge, University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Joseph, B., Environmental studies, Tata Mc Graw Hill.
4. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5th edition) Books/Cole, Thompson Learning, Inc.
5. Thakur, I S, Environmental Biotechnology, I K Publication.

Contact person –Dr. Dr H.K. Sarma (hridip@gauhati.ac.in)

SEMESTER VI BIO-ANALYTICAL TOOLS

UNIT I

(10 Periods)

Microscopy: Principles and applications of light, Camera lucida, Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), photomicrography, absorption and emission spectroscopy

UNIT II

(20 Periods)

Spectroscopy: General principles and law of absorption, Types of spectra and their biochemical usefulness, fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), IR spectroscopy, CD spectroscopy, Mass spectrometry, NMR, X-ray diffraction: Principles and Application.
Centrifugation: Basic principles of sedimentation – Types of centrifuges and their uses –Preparative and Analytical centrifuge, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III

(10 Periods)

Chromatography: principle of chromatography – Adsorption and Partition Chromatography, Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV

(10 Periods)

Electrophoresis: General principles – apparatus, methods and applications. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting.

UNIT V

(10 Periods)

Molecular Techniques: PCR, RT-PCR, Gradient PCR, Real Time PCR, DNA Sequencer, DNA Synthesizer. Introduction to Biosensors and Nanotechnology and their applications.

PRACTICAL

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

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. 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

Contact person: Dr Mohammad Imtiyaj Khan, Department of Biotechnology, Gauhati University. 9844162330, imtiyaj@gauhati.ac.in.

GENOMICS & PROTEOMICS

UNIT I

(15 Periods)

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

(10 Periods)

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

(20 Periods)

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), Determination of covalent structures – Edman degradation.

UNIT IV

(15 Periods)

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, Solubilisation, reduction, resolution. 2D-PAGE, Mass spectrometry based method.

PRACTICALS

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

SUGGESTED READING

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
7. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). *iGenetics- A Molecular Approach*. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

Contact person:

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BIOSTATISTICS

UNIT I

(12 Periods)

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT II

(18 Periods)

Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT III

(18 Periods)

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV

(12 Periods)

Correlation and Regression. Emphasis on examples from Biological Sciences.

PRACTICALS

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

SUGGESTED READING

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield™ Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

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DR S.S. SWARGIARY

Important Notes:

1. **Faculty Numbers and Specialization requirements:** For Teaching in B.Sc. (Major/ Regular) in Biotechnology (5 compulsory permanent posts + 1 additional Guest Faculty post as per requirement of the semester)

Post no.	Specialization	Post no.	Specialization
1	Biochemistry & Physiology	4	Bioinformatics & Bioinstrumentation or Biostatistics
2	Molecular Biology & Genetic Engineering	5	Industrial Biotechnology or Plant Biotechnology
3	Microbiology and Immunology		

2. For each core paper, the distribution of marks will be as follow-
Theory : 60 marks (50 final exams + 10 internal assessment)
Practical : 40 mark

Internal assessment marks should be assessed as follows:

1 (one) Mid Term Examination, Theory papers	: 5 marks
1 (one) Seminar presentation per theory papers	: 3 marks
1 (one) Assignment (in group/ individually)	: 2 marks

3. Practicals will be assessed in the presence of external evaluator (Faculty) from the parent Department of the Affiliating University)
4. Dissertation projects can be done either individually or in groups but has to be done in house.