B.Sc. Biotechnology (Regular) Syllabus- CBCS

This is approved in the Academic Council held on 08.11.2019

Department of Biotechnology,

GAUHATI UNIVERSITY

Gopinath Bordoloi Nagar, Guwahati 781014, Assam, India.

CHOICE BASED CREDIT SYSTEM (CBCS)

B.Sc. (General/Regular) Biotechnology

COURSE STRUCTURE

	Type	CORE	AEC	SEC	DSE
	Credit	6 (60T+ 40P)	4 (100T)	4 (60T + 40P)	6(4T+2P) 60T + 40P
Semester I		DSC-1 A (BIT-RC-1016)	AECC1 (ENG-AE-1014)		
Semester II		DSC-1 B (BIT-RC-2016)	AECC1 (ENG-AE-1014)		
Semester III		DSC-1 C (BIT-RC-3016)		SEC-1 (BIT-SE-3014)	
Semester IV		DSC-1 D (BIT-RC-4016)		SEC-2 (BIT-SE-4014)	
Semester V				SEC-3 (BIT-SE-5014	DSE-1 A (BIT-RE-5016)
Semester VI				SEC-4 (BIT-SE-6014	DSE-1 B (BIT-RE-6016)

LIST OF PAPERS:

Semester I	DSC-1 A	BIT-RC-1016	Biotechnology & Human Welfare	6 credits (60T + 40P marks)
	AECC1	ENG-AE-1014	English/ EVS/ MIL communication	4 credits
Semester II	DSC-1 B	BIT-RC-2016	Developmental Biology	6 credits (60T + 40P marks)
	AECC1	ENG-AE-1014	English/ EVS/ MIL communication	4 credits
Semester III	DSC-1C	BIT-RC-3016	Bioethics and Biosafety	6 credits (60T + 40P marks)
	SEC1	BIT-SE-3014	Enzymology	4 credits (60T + 40P marks)
Semester IV	DSC-1 D	BIT-RC-4016	Entrepreneurship Development	6 credits (60T + 40P marks)
	SEC2	BIT-SE-4014	Industrial Fermentations	4 credits (60T + 40P marks)
Semester V	SEC-3	BIT-SE-5014	Ecology & Environmental Management	4 credits (60T + 40P marks)
	DSE-1 A	BIT-RE-5016	Bioinformatics	6 credits (60T + 40P marks)
Semester VI	SEC-4	BIT-SE-6014	Biostatistics	4 credits (60T + 40P marks)
	DSE 1 B	BIT-RE-6016	Dissertation/ Project	6 credits (60T + 40P marks)

CONTENT:

BIOTECHNOLOGY AND HUMAN WELFARE

UNIT I **(10 Periods)**

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

UNIT II **(10 Periods)**

N_2 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 fermentaion 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

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

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

BIOETHICS AND BIOSAFETYUNIT

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

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 Km and Vmax 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 Ki, 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, Iysozyme, 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 transcarbomylase 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 ofenzymes. 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, Km value, Vmax 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.

ENTERPRENEURSHIP 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.)

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 (O_2, N_2, CO_2) 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 photobiorectors.

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)

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. (5thedition) 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)

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.

Contact Person: **Dr. S.S. Swargiary.**
Dr. Pranjan Barman, pranjan.barman@gauhati.ac.in (call +91 9859947743 M)

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.

Contact person –Dr. Dr H.K. Sarma (hridip@gauhati.ac.in), Dr S.S. Swargiary (swargiary.ss77@gauhati.ac.in)

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.