Dibrugarh University

ডিব্রুগড় বিশ্ববিদ্যালয়

Board of Studies

Centre for Biotechnology and Bioinformatics

জৈৱপ্রযুক্তি আৰু জৈৱতথ্যপ্রযুক্তি কেন্দ্র

Syllabus

for

Four Years Undergraduate Programme

in

Biotechnology and Bioinformatics

(Single Major)

Approved by BoS, Biotechnology and Bioinformatics,

Dibrugarh University

Dated:08/05/2024

Dibrugarh University ডিব্রুগড় বিশ্ববিদ্যালয়

Vision of University: To develop human resource by integrating knowledge and skill, human values and compassion for a better world.

Mission of University: To impart value oriented education and skill based training that foster leadership traits of the learners, thus generating sustainable development, social harmony and peace.

Centre for Biotechnology and Bioinformatics জৈৱপ্ৰযুক্তি আৰু জৈৱতথ্যপ্ৰযুক্তি কেন্দ্ৰ

Vision of Centre: Promote socio-economic growth by fostering bio-entrepreneurship and training skilled professionals to meet biotechnology needs, supporting regional exploration, conservation, and biodiversity.

Mission of Centre:

- Provide comprehensive support including resources, mentorship, and training to foster the growth of innovative biotech startups, encouraging entrepreneurship in the field.
- Deliver high-quality education and research opportunities in biotechnology and related fields, equipping students and professionals with the skills and knowledge necessary for academic, research, and industrial success.
- Promote environmental sustainability and biodiversity through active conservation initiatives, contributing to the region's ecological health and resilience.

Program Educational Objectives (PEOs):

PEO1: Graduates will have the knowledge and skills to pursue successful careers in diverse sectors such as biotechnology, pharmaceuticals, healthcare, agriculture, bioinformatics, and related industries.

PEO2: Graduates will be prepared to engage in research and innovation, contributing to the advancement of knowledge and the development of new technologies in biotechnology, bioinformatics, and allied fields.

PEO3: Graduates will demonstrate leadership, communication, and teamwork skills, enabling them to excel in their chosen professions and adapt to evolving trends and technologies in biotechnology and bioinformatics.

PEO4: Graduates will understand the ethical implications of biotechnological and bioinformatics practices and demonstrate a commitment to socially responsible and sustainable approaches in their work.

PEO5: Graduates will have the entrepreneurial mindset and capabilities to identify opportunities, innovate, and potentially establish their ventures in biotechnology, bioinformatics, or related fields, contributing to economic growth and societal well-being.

Program Outcomes (POs):

PO1: Complex Problem Solving: **Develop the ability to identify, analyze, and solve complex biological problems** using advanced biotechnological and bioinformatics tools and techniques.

PO2: Critical Thinking and Analytical Reasoning: **Apply critical thinking** and **analytical reasoning to interpret experimental data, evaluate research outcomes, and make informed decisions** in scientific research and practical applications.

PO3: Creativity and Innovation: **Foster creativity and innovation in designing experiments**, developing new biotechnological processes, and creating novel bioinformatics algorithms and software solutions.

PO4: Communication Skills: **Enhance written** and **oral communication skills** to effectively present research findings, collaborate with multidisciplinary teams, and engage with diverse audiences in both academic and professional settings.

PO5: Research-Related Skills: **Acquire and apply advanced research-related skills**, including experimental design, data collection, statistical analysis, and bioinformatics modeling, to conduct high-quality research in biotechnology and bioinformatics.

PO6: Collaboration and Leadership Readiness: **Demonstrate the ability to coordinate and collaborate with others in multidisciplinary teams**, while also developing leadership qualities to guide projects and initiatives in both academic and industry settings.

PO7: Digital and Technological Skills: **Gain proficiency in digital and technological skills**, including the use of bioinformatics software, databases, and biotechnological instrumentation, to address contemporary challenges in the life sciences.

PO8: Lifelong Learning and Autonomy: **Cultivate learning-how-to-learn skills, fostering a mindset of lifelong learning and professional development**, with an emphasis on autonomy and self-directed learning in rapidly evolving scientific fields.

PO9: Multicultural Competence and Inclusive Spirit: **Develop multicultural competence and an inclusive spirit** by engaging with diverse perspectives and fostering an inclusive environment in research and professional practice.

PO10: Environmental Awareness and Community Engagement: **Promote environmental awareness and take action on sustainability issues**, while actively participating in community engagement and service initiatives to address societal and environmental challenges with empathy and responsibility.

Program Specific Outcomes (PSOs):

PSO1: Demonstrate a comprehensive understanding of the fundamental concepts, theories, and principles in biotechnology and bioinformatics, including molecular biology, genetics, biochemistry, and computational biology.

PSO2: Acquire proficiency in laboratory techniques commonly used in biotechnology and bioinformatics, such as DNA manipulation, protein analysis, cell culture, sequencing, and bioinformatics tools and software.

PSO3: Utilize advanced biotechnological and bioinformatics tools, techniques, and methodologies to address real-world problems and make meaningful contributions to scientific research, industry, healthcare, and other sectors.

PSO4: Apply critical thinking and problem-solving skills to analyze biological data, design experiments, interpret results, and develop solutions to biotechnological and bioinformatics challenges.

PSO5: Integrate knowledge from multiple disciplines, including biology, chemistry, mathematics, and computer science, to address complex issues in biotechnology and bioinformatics effectively.

PSO6: Effectively communicate scientific concepts, research findings, and technical information to diverse audiences through written reports, oral presentations, and visual representations in biotechnology and bioinformatics.

COURSE STRUCTURE FYUGP

DIBRUGARH UNIVERSITY (SINGLE MAJOR)

NAME OF THE PROGRAMME: **B.Sc. in Biotechnology and Bioinformatics**
MAJOR: **Biotechnology and Bioinformatics**

Yr	Sem	Major	Minor	GEC	AEC	SEC	Internship/ Community Engagement	VAC	Research/ Dissertation	Total Credit
Individual Credit		4	4	3	4	3	4	2	4-8	
1st UG Certificate	I	BTNC01	BTNM01	BTGE-1	AEC-1	SEC-1		VAC-01/02		20
	II	BTNC02	BTNM02	BTGE-2	AEC-2	SEC-2		VAC-03/04		20
2nd UG Diploma	III	BTNC03	BTNM03	BTGE-3		SEC-3		VAC-05		20
		BTNC04								
	IV	BTNC05	BTNM04							20
		BTNC06								
		BTNC07								
		BTNC08								
3rd UG Degree	V	BTNC09	BTNM05				2+2 (I+CE) OR 4(I) / 4 (CE)			20
		BTNC10								
		BTNC11								
	VI	BTNC12	BTNM06							20
		BTNC13								
		BTNC14								
		BTNC15								
4th UG Honors Degree	VII	BTNC16	BTNM07						4 RM (Research Methodology)	20
		BTNC17								
		BTNC18								
	VIII	BTNC19	BTNM08						8 BTNDS (Dissertation)	20
		BTNC20								

*Details of each Course Codes are provided in the subsequent pages.

Name of the Programme: **Four Years Under-Graduate Programme**

Nature of Degree: **Single Major**

Name of the Programme: **B.Sc. in Biotechnology and Bioinformatics**

Major: **Biotechnology and Bioinformatics**

Year	Semester	Course	Title of the Course: B.Sc. in Biotechnology and Bioinformatics	Total Credit
Year 01	1st Semester	BTNC01	Fundamentals of Biochemistry	4
		BTNM01	Biochemistry and Bio-instrumentation	4
		BTGE-1	Biotechnological Innovation in Food Preservation Technology	3
		AEC-1	Modern Indian Language	4
		VAC-1 VAC-2	Understanding India Health and Wellness	2
		SEC-1	As provided by the Institute/Dept/Centre	3
	Total Credits			**20**
	2nd Semester	BTNC02	Molecular Basis of Cell Biology	4
		BTNM02	Cell Biology and Microbiology	4
		BTGE-2	Biotechnological Innovation in Horticulture	3
		AEC-2	English Language and Communication Skills	4
		VAC-3 VAC-4	Environmental Science Yoga Education	2
		SEC-2	As provided by the Institute/Dept/Centre	3
	Total Credits			**20**
The students on exit shall be awarded Undergraduate Certificate (in the Field of Biotechnology and Bioinformatics) after securing the requisite 40 Credits in Semester 1 and 2				
Year 02	3rd Semester	BTNC03	Fundamentals of Microbiology	4
		BTNC04	Molecular Biology	4
		BTNM03	Genetics and Biostatistics	4
		BTGE-3	Biotechnology in Human Welfare	3
		VAC-5	Digital and Technological Solutions / Digital Fluency	2
		SEC–3	As provided by the Institute/Dept/Centre	3
	Total Credits			**20**
	4th Semester	BTNC05	Genetics	4
		BTNC06	Bioinstrumentation	4
		BTNC07	Biostatistics and Data Analysis	4
		BTNC08	Fundamental of Bioinformatics	4
		BTNM04	Molecular Biology	4
	Total Credits			**20**
The students on exit shall be awarded Undergraduate Diploma (in the Field of Biotechnology and Bioinformatics) after securing the requisite 80 Credits on completion of Semester IV				

Year	Semester	Course	Title of the Course: B.Sc. in Biotechnology and Bioinformatics	Total Credit
Year 03	5th Semester	BTNC09	Immunology	4
		BTNC10	Bioethics and Biosafety	4
		BTNC11	Molecular Evolution and Phylogeny	4
		BTNM05	Fundamental of Bioinformatics	4
		CE I CE+I Any one	Community Engagement Internship Community Engagement+ Internship As provided by the Institute/Dept/Centre	4 4 2+2
	Total Credits			**20**
	6th Semester	BTNC12	Human Diseases and Disorders	4
		BTNC13	Bio-Entrepreneurship and Commercialization	4
		BTNC14	Genomics and Proteomics	4
		BTNC15	Fundamentals of Programming	4
		BTNM06	Bioinformatics Tools and Techniques	4
	Total Credits			**20**
The students on exit shall be awarded Bachelor of Science (in the Field of Biotechnology and Bioinformatics) (3 years) after securing the requisite 120 Credits on completion of Semester 6				
	7th Semester	BTNC16	Genetic Engineering	4
		BTNC17	Plant Biotechnology	4
		BTNC18	Data Science	4
		BTNM07	Human Diseases and Disorders	4
		RM	Research Methodology	4
	Total Credits			**20**
	8th Semester	BTNC19	Bioprocess Technology	4
		BTNC20	Structural Bioinformatics	4
		BTNM08	Genetic Engineering	4
		BTNDS	Dissertation	8
	Total Credits			**20**
	The students on exit shall be awarded Bachelor of Science(in the Field of Biotechnology and Bioinformatics) (Honors with Research) (4 years) after securing the requisite 160 Credits on completion of Semester 8			

NAME OF THE COURSE : FUNDAMENTALS OF BIOCHEMISTRY
COURSE TYPE : MAJOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: This course delves into the structure and function of biological macromolecules, such as proteins, nucleic acids, lipids, and carbohydrates, and explores their roles in metabolic pathways, gene expression, and signal transduction. Students will thoroughly understand enzymatic catalysis, bioenergetics, and the regulation of biochemical reactions. The course includes both theoretical lectures and practical laboratory sessions, covering techniques like estimation of biomolecules, enzyme assays, chromatography, electrophoresis, and PCR. With a strong foundation in chemistry and biology recommended, this course prepares students for advanced studies and careers in biochemistry, molecular biology, medicine, and biotechnology.

Prerequisites

- Chemical bonding, thermodynamics, kinetics, and equilibrium.
- Introductory courses in biology
- Introductory courses in Animal and plant physiology

COURSE OBJECTIVES: The objectives of this Course are to -

- Identify the basic structure and function of biomolecules, their chemical and physical properties and catalysis.
- Explain the biological catalysts, their mechanisms of action, and kinetics and provide an overview of the major metabolic pathways.
- Analyze the role of enzymes in the various metabolisms in vivo.
- Understand and explain the insight into bodily processes that occur in living organisms through the metabolism of biomolecules

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Understand the fundamentals of biochemistry and gain knowledge on the application of different physical laws in biochemistry

- LO 1.1: Describe how physical laws, such as thermodynamics, kinetics, and equilibrium mechanics, apply to biochemical processes.
- LO 1.2: Discuss how 1st and 2nd laws of thermodynamics apply in living organisms
- LO 1.2: Demonstrate physical principles to experimental techniques in biochemistry, such as spectroscopy, chromatography, and electrophoresis.

CO2: Understand the role of water in different bodily processes in living organisms

- LO 2.1: Describe the unique chemical and physical properties of water, such as its polarity, hydrogen bonding, and solvent capabilities.
- LO 2.2: Discuss why water is essential for life, highlighting its role as a universal solvent.
- LO 2.3: Describe how water is vital for cellular processes, including cell structure maintenance, transport of nutrients and waste, and biochemical reactions.

CO3: Understand the chemical properties and reactivity of biomolecules, including the types of chemical bonds they form, their interactions with other molecules, and how they participate in biochemical reactions.

- LO 3.1: Define biomolecules and describe their occurrence in living organisms.
- LO 3.2: Classify biomolecules based on their chemical and physical properties.
- LO 3.3: Describe the functions of biomolecules in living organisms

CO4: Describe the structure, mechanism and functions of enzymes and associated molecules that can affect the efficiency of enzyme action.

- LO 4.1: Define enzyme and classify based on reactions it catalyse
- LO 4.2: Describe how enzyme provides a unique microenvironment that is conducive to the reaction.
- LO 4.3: Discuss the role of vitamins and other associated molecules that involved in enzyme catalysed reaction

CO5: Classify the roles of enzymes in various biological processes, including metabolism, signal transduction, DNA replication, protein synthesis and other bodily processes in living organisms.

- LO 5.1: Explain the functions of enzymes in various bodily process
- LO 5.2: Comprehend the roles of enzymes in various catabolic and anabolic pathways, including energy production and biosynthesis.
- LO 5.3: Analyze how enzymes regulate metabolic processes and maintain cellular homeostasis.

C06: Apply their knowledge of enzymology to analyse and solve problems in biochemistry, molecular biology, and related fields, including the design of experiments and the interpretation of experimental data.

- LO 5.1: Develop experimental data involving enzyme activity assays, enzyme kinetics and inhibition.
- LO 5.2: Examine the effect of temperature, pH and substrate concentration on enzyme activity
- LO 5.3: Compare the enzyme involved in central metabolic pathways in different living organism

CO7: Compare how cells and organisms adapt their metabolism in response to environmental changes, such as fasting, exercise, and exposure to toxins.

- LO 7.1: Identify key metabolic pathways involved in fasting, exercise, and detoxification.
- LO 7.2: Explain the biochemical processes underlying metabolic changes during fasting, LO LO 7.3: exercise, and toxin exposure.
- LO 7.4: Compare and contrast the metabolic responses of cells and organisms to the same environmental stressors.
- LO 7.5: Examine the role of specific genes and proteins in mediating these responses.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge		CO1, CO2				CO5
Conceptual Knowledge		CO7		CO3	CO4	
Procedural Knowledge			CO6			
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1.3**
CO2	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1.1**
CO3	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**1.4**
CO4	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**1**	**1.5**
CO5	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**1**	**1.5**
CO6	**3**	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**1**	**2.0**
CO7	**2**	**3**	**1**	**1**	**2**	**1**	**1**	**2**	**1**	**3**	**1.7**
Average	**2.0**	**2.3**	**1.1**	**1.0**	**1.7**	**1.1**	**1.6**	**1.9**	**1.0**	**1.3**	

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**Biochemistry**					
Category	Major	Year	1	Credits	4	Course code	**BTNC01**
		Semester	I				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		37		**08**		**30**	**75**

Course Outline

Unit 1: Foundation of Biochemistry **Marks: 12, L: 6, T: 2, P: 6**

1.1 Physical, chemical, and molecular foundation of biochemistry.
1.2 Significance of water in biochemistry; acid-base concept, buffers, pH and pK.
1.3 Chemical interactions, Energy-rich compounds, sources and utilization, Laws of thermodynamics

Practical:

a) Numerical problems based on the preparation of standard solutions of different molarity, normality, strength and percentage

Unit 2: Introduction to Biomolecules **Marks: 16, L: 9, T: 2, P: 12**

2.1 Classification, structure and functions of Biomolecules
2.2 Carbohydrate: Structure, general properties and functions of polysaccharides and complex carbohydrates; amino sugars, proteoglycans and glycoproteins
2.3 Proteins: Chemistry of amino acids and proteins. Hierarchy of protein structure. Ramachandran Plot
2.4 Nucleic acids: Nucleic acids as genetic information carriers, experimental evidence e.g., genetic transformation, Hershey-Chase experiment. Chemistry, structure and function of nucleosides and nucleotides.
2.5 Lipids: Chemistry and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrosides, steroids, bile acids, prostaglandins, lipoproteins, proteolipids, phosphatidopeptides, lipopolysaccharides

Practical:

a) Estimation of proteins by Lowry and Bradford assays.
b) Estimation of total carbohydrates by Anthrone method.
c) Quantification of reducing sugars by Dinitrosalicylic acid method.
d) Estimation of DNA by diphenylamine method.
e) Quantification of RNA by orcinol method.

Unit 3: Enzymes and Enzymology **Marks: 16, L: 11, P: 12**

3.1 Introduction to enzymes: General characteristics, IUB enzyme classification, biological roles; Definitions of IU, Katal, enzyme turnover and specific activity. Allosteric enzymes, Isoenzymes, Ribozymes, Restriction enzymes.
3.2 Cofactors and coenzymes: Nomenclature and classification, role in enzyme catalysis.
3.3 Vitamins: classification, their coenzyme forms and functions
3.4 Mechanism of Enzyme Action: Acid-base catalysis, covalent catalysis. Chemical modification of active site groups. Mechanism of action of enzymes - chymotrypsin or lysozyme.
3.5 Multienzyme system: Significance & properties: Mechanism of action and regulation of multienzyme complex (pyruvate dehydrogenase/ fatty acid synthase).
3.6 Enzyme Regulation: General mechanisms of enzyme regulation, product inhibition, reversible and irreversible modifications of enzymes, feedback inhibition, and feed-forward stimulation.
3.7 Enzyme Inhibition: Reversible and irreversible inhibition. Competitive, non-competitive, uncompetitive, linear-mixed type inhibitions. Suicide inhibitor.

Practical:

a) Isolation and purification of enzyme from microbial/ plant/ animal source
b) Assay of enzyme activity: Time dependence of enzyme catalysed reaction.
c) Effect of pH and temperature and substrate concentration on the rate of enzymatic reaction.
d) Inhibition of enzyme activity and Determination of Ki.

Unit 4: Metabolism of Biomolecules **Marks: 16, L:11, P: 0**

4.1 General concept of metabolism, Types of metabolism
4.2 Carbohydrates: Glycolysis- pathway, regulation & energetic, feeder pathway of glycolysis, citric acid cycle- reactions and regulation, pentose phosphate pathway and its significance, gluconeogenesis, glycogenesis and glycogenolysis, Cori cycle, Hormonal regulation of carbohydrate metabolism.
4.3 Amino Acids: General reactions of amino acid metabolism – transamination, decarboxylation, oxidative & non-oxidative deamination of amino acids. Urea cycle and its regulation.
4.4 Lipids: Biosynthesis of fatty acids and lipids, Hydrolysis of tri-acylglycerols, α-, β-, ω- oxidation of fatty acids.
4.5 Nucleotides: Metabolism of purines and pyrimidines- reactions and regulation

Where	*L: Lectures*	*T: Tutorials*	*P: Practical*

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Nelson, D.L., Cox, M.M. (2021) Lehninger Principles of Biochemistry, 8th Edition, WH Freeman and Company, New York, USA.
2. Jeremy Berg; Gregory Gatto Jr.; Justin Hines; John L. Tymoczko; Lubert Stryer, Tenth Edition, 2023, W.H Freeman and Co.
3. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons
5. Victor W. Rodwell, David Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil (2018). Harper's Illustrated Biochemistry, 31st Edition, McGraw Hill / Medical
6. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

NAME OF THE COURSE	**:**	**BIOCHEMISTRY AND BIOINSTRUMENTATION**
COURSE TYPE	**:**	**MINOR COURSE**
TOTAL CREDIT	**:**	**4**
TOTAL MARKS	**:**	**60 (End Sem) + 40 (In Sem)**

Course Description: The Biochemistry and Bioinstrumentation course integrates the study of the chemical processes in living organisms with the practical application of instruments used in biological and medical research. Students will explore the structure and function of macromolecules, enzyme kinetics, metabolic pathways, and the molecular basis of gene expression and cell signaling, alongside learning to operate and interpret data from key bioanalytical instruments such as spectroscopes, microscopes, chromatographs, and electrophoresis equipment. Through a combination of theoretical learning and hands-on laboratory experience, the course aims to equip students with a comprehensive understanding of biochemical processes and the technical proficiency to utilize advanced bioinstrumentation techniques in research and diagnostics.

Prerequisites

- Chemical bonding, thermodynamics, kinetics, and equilibrium.
- Introductory courses in biology
- Introductory courses in Animal and plant physiology
- Knowledge of chemical principles and reactions.
- General Physical principles of optics, electromagnetism, and mechanics.

COURSE OBJECTIVES: The objectives of this Course are to -

- Understand Macromolecular Structure and Function:
- Explain how macromolecules contribute to the structural and functional integrity of cells.
- Analyze enzyme kinetics and understand the mechanisms of enzyme action and regulation.
- Explore Metabolic Pathways and understand the bioenergetics and thermodynamics of metabolic processes.
- Understand the principles and applications of various bioanalytical instruments, including spectroscopy, microscopy, chromatography, and electrophoresis.
- Apply biochemical and bioinstrumentation knowledge in practical laboratory experiments.
- Promote Ethical and Safe Laboratory Practices

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Understand the fundamentals of biochemistry and gain knowledge on the application of different physical laws in biochemistry

- LO 1.1: Describe how physical laws, such as thermodynamics, kinetics, and equilibrium mechanics, apply to biochemical processes.
- LO 1.2: Discuss how 1st and 2nd laws of thermodynamics apply in living organisms
- LO 1.2: Demonstrate physical principles to experimental techniques in biochemistry, such as spectroscopy, chromatography, and electrophoresis.

CO2: Understand the chemical properties and reactivity of biomolecules, including the types of chemical bonds they form, their interactions with other molecules, and how they participate in biochemical reactions.

- LO 2.1: Define biomolecules and describe their occurrence in living organisms.
- LO 2.2: Classify biomolecules based on their chemical and physical properties.
- LO 2.3: Describe the functions of biomolecules in living organisms

CO3: Describe the structure, mechanism and functions of enzymes and associated molecules that can affect the efficiency of enzyme action.

- LO 3.1: Define enzyme and classify based on reactions it catalyse

- LO 3.2: Describe how enzyme provides a unique microenvironment that is conducive to the reaction.
- LO 3.3: Discuss the role of vitamins and other associated molecules that involved in enzyme catalysed reaction

CO4: Acquire in-depth knowledge of the theory, instrumentation, and applications of various microscopy and spectrophotometry techniques.

- LO 4.1: Classify microscopic and spectrophotometric techniques according to their working principle.
- LO 4.2: Identify the key components and instrumentation required for each type of microscopy and spectroscopy
- LO 4.3: Explain the applications, strengths and limitations of each microscopic and spectrophotometric technique used in biological research.

CO5: Compare working principles and application of different chromatographic techniques

- LO 5.1: Explain how each chromatographic technique separates mixtures based on different principles
- LO 5.2: Use knowledge of chromatographic principles to choose appropriate techniques for specific separation tasks.
- LO 5.3: Compare the advantages and limitations of different chromatographic techniques in terms of resolution, sensitivity, and suitability for various applications

CO6: Compare working principles and application of different centrifugation techniques

- LO 6.1: Explain the working principles of each centrifugation technique, including how particles are separated based on size, shape, and density.
- LO 6.2: Demonstrate the use of different centrifugation techniques in laboratory settings to separate and purify biological samples.
- LO 6.3: Compare and contrast the advantages and limitations of different centrifugation techniques in terms of resolution, speed, scalability, and sample compatibility.
- LO 6.4: Analyze experimental data from centrifugation experiments to interpret separation efficiency and identify factors influencing experimental outcomes.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge		CO1, CO2				CO5
Conceptual Knowledge		CO7		CO3	CO4	
Procedural Knowledge			CO6			
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**Average**
CO1	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1.3**
CO2	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1.1**
CO3	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**1.4**
CO4	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**1**	**1.5**
CO5	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**2**	**1**	**1**	**1.5**
CO6	**3**	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**1**	**2.0**
CO7	**2**	**3**	**1**	**1**	**2**	**1**	**1**	**2**	**1**	**3**	**1.7**
Average	**2.0**	**2.3**	**1.1**	**1.0**	**1.7**	**1.1**	**1.6**	**1.9**	**1.0**	**1.3**	

Centre for Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**BIOCHEMISTRY AND BIOINSTRUMENTATION**					
Category	Minor	Year	1	Credits	4	Course code	**BTNM01**
		Semester	I				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		40		**05**		**30**	**75**

Course Outline

Unit 1: Foundation of Biochemistry **Marks: 16, L: 6, T: 1, P: 10**

1.1 Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
1.2 Fundamentals of thermodynamic principles applicable to biological processes.
1.3 Significance of water in biochemistry; acid-base concept, buffers, pH and pK.
1.7 Energy rich compounds- sources and utilization
1.8 Structure of atoms, molecules and chemical bonds.
1.2 Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins) and their metabolism

Practical:

a) Numerical problems based on the preparation of standard solutions of different molarity, normality, strength and percentage
b) Estimation of proteins by Lowry and Bradford assays.
c) Estimation of total carbohydrates by Anthrone method.
d) Estimation of DNA by diphenylamine method.
e) Quantification of RNA by orcinol method.

Unit 2: Enzymology **Marks: 16, L: 9, T: 0, P: 10**

2.1 Introduction to enzymes: General characteristics, IUB enzyme classification, biological roles; Definitions of IU, Katal, enzyme turnover and specific activity. Allosteric enzymes, Isoenzymes, Ribozymes, Restriction enzymes.
2.2 Cofactors and coenzymes: Nomenclature and classification, role in enzyme catalysis.
2.3 Vitamins: classification, their coenzyme forms and functions
2.4 Mechanism of Enzyme Action, Enzyme Regulation, Enzyme Inhibition

Practical

a) Assay of enzyme activity: Time dependence of enzyme catalysed reaction.
b) Effect of pH and temperature and substrate concentration on the rate of enzymatic reaction.

Unit 3: Biophysical Method **Marks: 12, L: 7, T: 2 P: 0**

3.1 Spectroscopy: Theory, instrumentation & applications of- UV-VIS spectrophotometry, IR spectroscopy, Mass Spectrometry and NMR.
3.2 Microscopic techniques: Principle, working and applications. Light, electron and Confocal Microscopy, Electron Microscopy

Unit 4: Separation technique **Marks: 16, L:11, T: 2 P: 10**

4.1 Chromatography: Principle, types and applications of different chromatographic methods. Partition and Adsorption chromatography, Ion-exchange chromatography, Size exclusion and affinity chromatography.
4.2 Basic principles of centrifugal force; RCF and RPM; Types of Centrifugation; applications of different centrifuges
4.2: Theory, instrumentation and applications. Native PAGE, SDS PAGE, Agarose gel electrophoresis. Centrifugation: Working principle, types and applications

Practical

a) Hands-on training on setting up and running gel electrophoresis experiments (e.g., native PAGE, SDS-PAGE, agarose gel electrophoresis).

b) Demonstration of centrifugation protocols for isolating cellular components and biomolecules from biological samples.

Where	*L: Lectures*	*T: Tutorials*	*P: Practical*

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Nelson, D.L., Cox, M.M. (2021) Lehninger Principles of Biochemistry, 8th Edition, WH Freeman and Company, New York, USA.
2. Jeremy Berg; Gregory Gatto Jr.; Justin Hines; John L. Tymoczko; Lubert Stryer, Tenth Edition, 2023, W.H Freeman and Co.
3. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons
5. Victor W. Rodwell, David Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil (2018). Harper's Illustrated Biochemistry, 31st Edition, McGraw Hill / Medical
6. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.
7. Principles of Instrumental Analysis" by Douglas A. Skoog, F. James Holler, Stanley R. Crouch
8. Biological Safety: Principles and Practices" by Diane O. Fleming, Debra L. Hunt
9. Basic Laboratory Methods for Biotechnology" by Lisa A. Seidman, Cynthia J. Moore
10. Analytical Chemistry: A Practical Approach" by Bryan M. Ham, Aihui MaHam
11. Calibration and Validation of Analytical Methods: A Sampling of Current Approaches" by Mark Stauffer
12. Maintenance and Troubleshooting of Laboratory Instruments" by Prakash Singh Bisen, Anjana Sharma
13. Good Laboratory Practice: Nonclinical Laboratory Studies Concise Reference" by M. S. Traul
14. Chemical Laboratory Safety and Security: A Guide to Developing Standard Operating Procedures" by National Research Council
15. Fundamentals of Light Microscopy and Electronic Imaging" by Douglas B. Murphy and Michael W. Davidson

NAME OF THE COURSE : BIOTECHNOLOGICAL INNOVATION IN FOOD PRESERVATION TECHNOLOGY
COURSE TYPE : GENERIC ELECTIVES
TOTAL CREDIT : 3
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: This course explores the applications of biotechnological innovations in food preservation, focusing on techniques to extend shelf life, improve safety, and enhance nutritional quality. Students will examine the principles and methods of food preservation, including fermentation, biopreservation, and genetic modification, and analyze their impact on food quality and sustainability.

Prerequisites

- Foundation in Biology and Chemistry
- Proficiency in basic laboratory techniques, such as pipetting, measuring, and following experimental protocols

Course Objectives: The objectives of this Course are to -

- Understand the principles and mechanisms of traditional and biotechnological methods of food preservation.
- Explore the applications of biotechnological innovations such as fermentation, probiotics, and genetic modification in food preservation.
- Evaluate the impact of biotechnological food preservation techniques on food safety, quality, and sustainability.
- Develop critical thinking skills to assess the ethical, social, and environmental implications of biotechnological innovations in food preservation.
-

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Understand the principles of food preservation

- LO 1.1: Explain the differences between traditional and biotechnological methods of food preservation.
- LO 1.2: Identify factors influencing food spoilage and shelf life.
- LO 1.3: Analyze regulatory frameworks governing food preservation techniques.

CO2: Apply fermentation in food preservation.

- LO 2.1: Explain the fundamentals of fermentation, including microbial metabolism, substrate utilization, and product formation.
- LO 2.2: Demonstrate practical skills in fermentation techniques, such as inoculum preparation, fermentation monitoring, and product analysis.
- LO 2.3: Analyze the role of fermentation in food preservation, comparing the sensory, nutritional, and health benefits of fermented products to non-fermented counterparts, and evaluating their suitability for commercialization and consumer acceptance.

CO3: Apply Biopreservation Techniques

- LO 3.1: Describe the principles of biopreservation, to control spoilage and pathogenic microorganisms in food.
- LO 3.2: Demonstrate practical skills in biopreservation methods, showing competence in selecting and applying appropriate biopreservation strategies to different food matrices.
- LO 3.3: Evaluate the effectiveness of biopreservation techniques in extending the shelf life and ensuring the safety of perishable foods.

CO4: Apply genetic modification in food preservation

- LO 4.1: Explain the techniques of genetic engineering used in food preservation, illustrating how genetic modification can enhance traits such as pest resistance, shelf-life extension, and nutrient content in food crops.
- LO 4.2: Analyze case studies of genetically modified organisms (GMOs) in food preservation, evaluating their impact on food safety, environmental sustainability, and socioeconomic factors, and discussing the controversies and ethical considerations surrounding their use.
- LO 4.3: Assess the regulatory landscape and public perceptions of GMOs in food, understanding the role of government agencies, scientific institutions, and consumer advocacy groups in shaping policies and public discourse on genetically modified foods.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge						
Conceptual Knowledge		CO1				
Procedural Knowledge			CO2	CO3, CO4		
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	2	3	2	1	3	1	2	1	1	1	1.7
CO2	3	2	2	1	3	1	2	1	1	1	1.7
CO3	3	2	2	1	3	1	2	1	1	1	1.7
CO4	3	2	3	1	3	1	2	1	1	1	1.8
Average	2.8	2.3	2.3	1.0	3.0	1.0	2.0	1.0	1.0	1.0	

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**Biotechnological Innovation in Food Preservation Technology**					
Category	GE	Year	1	Credits	3	Course code	**BTGE-1**
		Semester	I				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		25		**05**		**30**	**60**

Course Outline

Unit 1: Introduction to Food Preservation **Marks: 12, L: 5, T: 1, P: 6**

1.1 Overview of food preservation methods: traditional vs. biotechnological approaches
1.2 Principles of food spoilage and factors influencing shelf life
1.3 Regulatory frameworks and safety considerations in food preservation

Practical

a) Isolate microbes from preserved or fermented food
b) Isolate microbes from spoiled food
c) Stain microbes isolated from different foods (simple and gram staining in bacteria and yeast/ lactophenol cotton blue staining in filamentous fungi or mold)

Unit 2: Fermentation in Food Preservation **Marks: 12, L: 5, T: 1, P: 6**

2.1 Fundamentals of fermentation: microbial metabolism and product formation
2.2 Applications of fermentation in food preservation: yogurt, cheese, sauerkraut, and kimchi
2.3 Fermentation techniques and microbial cultures used in food fermentation

Practical

a) Conduct a fermentation experiment using a simple substrate (e.g. sugar) and monitor the changes in pH (Methyl Red Test) and gas production (using Durham's tube).
b) Compare the nutritional content of fermented (curd) vs. non-fermented products (paneer)

Unit 3: Biopreservation Techniques **Marks: 12, L: 5, T: 1, P: 8**

3.1 Principles of biopreservation: inhibition of spoilage and pathogenic microorganisms
3.2 Biopreservation methods: bacteriocins, lactic acid bacteria, and protective cultures
3.3 Application of biopreservation in meat, fish, dairy, and bakery products

Practical

a) Conduct a shelf-life study on a food product, monitoring its quality over time and identifying factors that influence its spoilage
b) Design an experiment to evaluate the effectiveness of a biopreservation technique in controlling spoilage microorganisms in a perishable food product.

Unit 4: Genetic Modification in Food Preservation **Marks: 12, L: 5, T: 1, P: 10**

4.1 Genetic engineering techniques for food preservation: transgenic crops, RNA interference, and genome editing
4.2 Case studies of genetically modified organisms (GMOs) in food preservation: pest resistance, shelf-life extension, and nutrient enhancement
4.3 Regulatory issues and public perceptions of GMOs in food

Practical

a) Comparison of shelf-life between GM and non-GM fruits. Analysis of spoilage factors such as microbial growth and enzyme activity.
b) Quantitative analysis of nutrients (e.g., beta-carotene) in GM and non-GM crops using spectrophotometry.

Unit 5: Novel Approaches in Food Preservation **Marks: 12, L: 5, T: 1, P: 0**

5.1 Emerging biotechnological innovations in food preservation: nanotechnology, edible coatings, and antimicrobial peptides
5.2 Applications of novel approaches in extending shelf life, reducing food waste, and improving food safety
5.3 Challenges and opportunities in adopting novel food preservation technologies

Where	*L: Lectures*	*T: Tutorials*	*P: Practical*

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Project Report on case study
   b) Group discussion
   c) Report of Field Visit
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Jay. J.M., Loessner. M.J. and Golden. D.A. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.
2. Currell. B.C., Dam-Mieras. R.C.E. (1991). Biotechnological Innovations in Food Processing. Elsivier.
3. Verma D.K., Ami R. Patel A.R., Sandhu K.S., Baldi A., Garcia S. (2021). Biotechnical Processing in the Food Industry: New Methods, Techniques, and Applications. Apple Academic Press
4. Barbosa J, Teixeira P. (2022). Biotechnology Approaches in Food Preservation and Food Safety. Foods.
5. Bicas J.M.,Maróstica Jr.M.R., Pastore G.M. (2016). Biotechnological production of natural ingredients for food industry: First edition. Bentham Books.

NAME OF THE COURSE : MOLECULAR BASIS OF CELL BIOLOGY
COURSE TYPE : MAJOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: This course will provide a comprehensive overview of the structure and functions of cells and their way of interacting and communicating with neighboring cells. Students will be able to acquire a profound knowledge of the ultrastructure of eukaryotic cells, including both plant and animal cells and the cellular organelles. They will be able to delve into the morphology and structural organization of chromosomes, cell division and regulation of cell cycle. Students will explore signaling molecules, cell receptors and quorum sensing. By the end of the course, students will have a substantial knowledge in cell biology, and will enable them to understand the basic cellular structures, functions, and communication processes.

Prerequisites

- Basic knowledge on cells
- Concept of chromosomes
- Basic knowledge on cell division and cell cycle

COURSE OBJECTIVES:

- To have a basic understanding of the fundamentals of cell structure and function.
- To have a lucid understanding of the cellular processes of signaling and transport
- To have a comprehensive understanding of the cellular changes that lead to malignancy
- To elucidate the different developmental pathways lead to both morphogenesis and organogenesis in both animals and plants
- To develop skills through lab experiments and exercises in specific methodologies used in the study of modern cell biology.

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Explain and compare the structure and functions of plant and animal cells
- LO 1.1: Describe the history of cell and cell theory
- LO 1.2: Demonstrate the ultrastructure of the plant and animal cells
- LO 1.3: Identify the components of the plasma membrane and cell wall and their functions
- LO 1.2: Compare the structural differences between plant and animal cells

CO2: Explain the various organelles that make up the plant and animal cells and their functions
- LO 2.1: Demonstrate the structure of various cell organelles
- LO 2.2: Explain the functions of various cell organelles
- LO 2.3: Identify the various organelles based on their structure

CO3: Analyse the basic structure and functions of chromosomes and regulation of cell cycle
- LO 3.1: Describe the morphology and structural organization of chromosomes
- LO 3.2: Explain the process of cell division
- LO 3.3: Explain the regulation of cell cycle
- LO 3.4: Identify the various stages of cell division

CO4: Apply the knowledge on cells and their way of signalling and interacting with neighbouring cells and response to external environment
- LO 4.1: Describe the various cell junctions and ways of cell adhesion
- LO 4.2: Explain the process of programmed cell death
- LO 4.3: Apply the various cell signalling molecules in interacting with neighbouring cells

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge						
Conceptual Knowledge		CO2		CO1, CO3		
Procedural Knowledge			CO4			
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	2	2	1	2	1	1	1	2	1	1	1.4
CO2	2	2	1	2	1	1	1	2	1	1	1.4
CO3	3	3	1	1	3	1	2	2	1	1	1.8
CO4	3	3	2	2	3	2	3	3	1	1	2.3
Average	2.5	2.5	1.25	1.75	2	1.25	1.75	2.25	1	2.5	

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the Course		**Molecular Basis of Cell Biology**					
Category:	**Major**	Year	**1**	Credits	4	Course Code	**BTCN02**
		Semester	**II**				
Instructional hours		Lecture		Tutorial	Lab Practical		Total
		30		**15**	**30**		**75**

Course Outline

Unit I: Membrane Structure and Function: **Marks:15, L:8,T:4,P:4**

1.1 Structure and function of Plasma Membrane
1.2 Molecular transport across the membrane: Passive and Active transport
1.3 Molecular transporters.
Structural Organization and Function of Intracellular Organelles :
1.4 Organelles- their morphologies and functions
1.5 Structure & function of the cytoskeleton and their role in motility.
Practical

a) Demonstration of cells using microscope

Unit II: Cellular Interaction: **Marks:15, L:7,T:3,P:8**

2.1 Interaction between Cells and their environment
2.2 Extra-cellular space and components of extracellular matrix,
2.3 Interaction of cells with ECM, Plant Cell walls,
2.4 Cellular Junctions, Cell adhesion.
Practical

a) Demonstration of cell organelles using microscope
b) Staining of mitochondria in human cheek epithelial cells.

Unit III: Cell Communications and Signal Transduction: **Marks:15, L:8,T:4,P:8**

3.1 Mechanisms of cell communication: Cell signaling and mechanism of signal transduction and receptors
3.2 Types of signaling molecules
3.3 Classification of receptors,
3.4 Signal transduction pathways,
3.5 Regulation of signaling pathways,
3.6 Secondary messengers,
3.7 Interconnectedness of signaling pathways.
Practical

a) Study of barr body in the epithelial buccal cell
b) Study of Cell viability assay by trypan blue exclusion
c) Study of polytene chromosome in *Drosophila* larvae.

Unit IV: Cell Cycle: **Marks:15, L:7,T:4, P:10**

4.1 Cell division-Mitosis and meiosis
4.2 Steps in cell cycle, Their regulation
4.3 Molecular basis of cell cycle4.4 Cellular checkpoints of the cell cycle
4.5 Regulation and control of cell cycle.
Cell death
4.6 Apoptosis and other cell death processes,
4.7 Biochemical changes in Apoptosis,
4.8 Molecular basis of Apoptosis
Practical

a) Study of different stages of mitosis in Onion root tip cell/ growing tail of tadpole
b) Study of different stages of meiosis in Grasshopper testes/Anther of flower

Where ***L: Lectures*** ***T: Tutorials*** ***P: Practical***

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

Suggested Reading:

1. Molecular Biology of the Cell. Alberts et al. Garland Science, 18-Nov-2014
2. Molecular Cell Biology, Harvey Lodish, W. H. Freeman, 2008
3. Schaum's Outline of Molecular and Cell Biology, William Stansfield, Jaime S. Colomé, Raúl J. Cano, McGraw Hill Professional, 22-Sep-1996
4. Essential Cell Biology. Bruce Alberts. Garland Pub., 199

NAME OF THE COURSE	**:**	**CELL BIOLOGY AND MICROBIOLOGY**
COURSE TYPE	**:**	**MAJOR**
TOTAL CREDIT	**:**	**4**
TOTAL MARKS	**:**	**60 (End Sem) + 40 (In Sem)**

Course Description: This course will provide a comprehensive overview of the structure and functions of cells and their way of interacting and communicating with neighboring cells. Students will be able to acquire a profound knowledge of the ultrastructure of eukaryotic cells, including both plant and animal cells and the cellular organelles. They will be able to delve into the morphology and structural organization of chromosomes, cell division and regulation of cell cycle. ……

Prerequisites

- Basic knowledge on cells
- Concept of chromosomes
- Basic knowledge on cell division and cell cycle
- Basics in Biochemistry
- Basics in Microbial Physiology

COURSE OBJECTIVES:

- To identify the basic understanding of the fundamentals of cell structure and function.
- To explain the mechanisms of the cellular processes of signaling and transport of biomolecules.
- To analyze the specific methodologies used in the study of modern cell biology, through lab experiments and exercises
- To have an in-depth knowledge about the diversity of microorganisms and a comprehensive understanding of the basic techniques employed for their isolation, characterization and culture.

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Explain and compare the structure and functions of plant and animal cells

- LO 1.1: Describe the history of cell and cell theory
- LO 1.2: Demonstrate the ultrastructure of the plant and animal cells
- LO 1.3: Identify the components of the plasma membrane and cell wall and their functions
- LO 1.2: Compare the structural differences between plant and animal cells

CO2: Explain the various organelles that make up the plant and animal cells and their functions

- LO 2.1: Demonstrate the structure of various cell organelles
- LO 2.2: Explain the functions of various cell organelles
- LO 2.3: Identify the various organelles based on their structure

CO3: Analyse the basic structure and functions of chromosomes and regulation of cell cycle

- LO 3.1: Describe the morphology and structural organization of chromosomes
- LO 3.2: Explain the process of cell division
- LO 3.3: Explain the regulation of cell cycle
- LO 3.4: Identify the various stages of cell division

CO4: Analyze the role of bacteria in environmental processes and biotechnology.

- LO 4.1: Evaluate bacterial roles in natural ecosystems.
- LO 4.2: Apply bacterial biotechnology for environmental remediation.
- LO 4.3: Assess the potential of bacterial bioproducts in biotechnology.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge						
Conceptual Knowledge		CO2		CO1, CO3		
Procedural Knowledge			CO4			
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	2	2	1	2	1	1	1	2	1	1	1.4
CO2	2	2	1	2	1	1	1	2	1	1	1.4
CO3	3	3	1	1	3	1	2	2	1	1	1.8
CO4	3	3	2	2	3	2	3	3	1	1	2.3
Average	2.5	2.5	1.25	1.75	2	1.25	1.75	2.25	1	2.5	

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the Course		**Cell Biology and Microbiology**					
Category:	**Major**	Year	**1**	Credits	4	Course Code	**BTNM02**
		Semester	**II**				
Instructional hours		Lecture		Tutorial	Lab Practical		Total
		41		**4**	**30**		**75**

Course Outline

Unit I: **Marks: 15, L: 11, T:6**

1

1.1 Membrane structure and function (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps).

1.2 Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).

Practical:

1. Study of polytene chromosome in *Drosophila*/ *Chironomous* larvae.
2. Study of barr body in the epithelial buccal cell

Unit II: **Marks: 15, L: 10, T: 1, P: 8**

2.1 Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

Practical:

1. Study of mitosis in onion root tips/ tadpole tail.
2. Study of meiosis in flower bud/ grasshopper testes.

Unit III: **Marks: 15, L: 10, T: 1, P: 8**

3.1 Structure of bacteria; nutrition, growth medium.

3.2 Methods of sterilization: pure culture, isolation, selective method of isolation, cultivation, preservation

Practical:

1. Microbial sub-culturing and preservation techniques.
2. Various Staining techniques.

Unit IV: **Marks: 15, L:10, T: 8**

4.1 Metabolic diversity among microorganisms: Heterotrophs, autotrophs, phototrophs; chemolithotrophs; (iron, sulfur utilizing microbes).

4.2 Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells-pathogen-induced diseases in animals and plants

Practical:

1. IMViC test.
2. Starch hydrolysis test.
3. Catalase test
4. Fermentation of carbohydrates.

Where ***L: Lectures*** ***T: Tutorials*** ***P: Practical***

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

Suggested Reading:

1. Molecular Biology of the Cell. Alberts et al. Garland Science, 18-Nov-2014
2. Molecular Cell Biology, Harvey Lodish, W. H. Freeman, 2008
3. Schaum's Outline of Molecular and Cell Biology, William Stansfield, Jaime S. Colomé, Raúl J. Cano, McGraw Hill Professional, 22-Sep-1996
4. Essential Cell Biology. Bruce Alberts. Garland Pub., 199
5. Microbiology: A Text Book of Microorganisms,General and Applied,Charles Edward marshall,F.TBioletti Published P. P.Blakiston's son &co.
6. Microbiology , M.J Pelczer and R.D Reid.
7.General Microbiology- by R. Y. Stanier .et.al

NAME OF THE COURSE:		**BIOTECHNOLOGICAL INNOVATIONS IN HORTICULTURE**
COURSE TYPE	**:**	**GENERIC ELECTIVE COURSE**
TOTAL CREDIT	**:**	**3**
TOTAL MARKS	**:**	**60 (End Sem) + 40 (In Sem)**

Course Description: This course explores the cutting-edge biotechnological innovations that are revolutionizing the field of horticulture. Students will delve into the application of biotechnology techniques such as genetic engineering, tissue culture, and molecular breeding to enhance crop productivity, improve plant traits, and address agricultural challenges. Through lectures, hands-on laboratory exercises, and field visits, students will gain a comprehensive understanding of how biotechnology is reshaping the future of horticulture.

Prerequisites

- Foundation in Biology
- Familiarity with horticulture or plant science concepts.
- Proficiency in basic laboratory techniques, such as pipetting, measuring, and following experimental protocols

Course Objectives: The objectives of this Course are to -

- Understand the principles and techniques of biotechnology as applied to horticulture.
- Explore the applications of genetic engineering in modifying plant traits for improved productivity, quality, and resilience.
- Learn tissue culture techniques for mass propagation of horticultural crops and conservation of genetic resources.
- Gain insights into molecular breeding strategies for developing new plant varieties with desirable traits.
- Examine the ethical, social, and environmental implications of biotechnological innovations in horticulture.
- Develop critical thinking and problem-solving skills through hands-on laboratory experiments and case studies.

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Understand the principles and techniques of biotechnology as applied to horticulture.

- LO 1.1: Demonstrate comprehension of key principles underlying biotechnological applications in horticulture.
- LO 1.2: Apply biotechnological terminology and concepts to analyze horticultural biotechnology literature and research.
- LO 1.3: Engage in hands-on activities and laboratory exercises to demonstrate proficiency in biotechnological techniques relevant to horticulture.

CO2: Analyze the impact of genetic engineering on plant traits and crop productivity in horticulture.

- LO 2.1: Demonstrate a comprehensive understanding of genetic engineering techniques employed in horticulture.
- LO 2.2: Evaluate the impact of genetic modifications on various plant traits relevant to horticulture.
- LO 2.3: Examine the societal and environmental implications of genetic engineering in horticulture.

CO3: Apply tissue culture techniques for mass propagation and conservation of horticultural crops.

- LO 3.1: Demonstrate an understanding of various molecular breeding techniques.
- LO 3.2: Apply molecular breeding techniques to identify and select plants with desirable traits.

- LO 3.3: evaluate the effectiveness and efficiency of molecular breeding approaches in developing new plant varieties with desirable traits.

CO4: Utilize molecular breeding strategies for developing new plant varieties with desirable traits.

- LO 4.1: Recognize common fungal pathogens.
- LO 4.2: Apply diagnostic techniques for fungal infections.
- LO 4.3: Evaluate treatment strategies for fungal infections.

CO5: Evaluate the efficacy of biotechnological solutions for crop protection and environmental remediation in horticulture.

- LO 5.1: Analyze the effectiveness of biopesticides and RNA interference (RNAi) technologies in managing pests and diseases in horticultural crops.
- LO 5.2: Evaluate the potential of phytoremediation techniques for environmental cleanup and soil/water remediation in horticultural systems.
- LO 5.3: Interpret experimental data and research findings to make informed decisions regarding the adoption of biotechnological solutions for crop protection and environmental remediation in horticulture.

C06: Critically analyze the ethical, social, and environmental implications of biotechnological innovations in horticulture.

- LO 6.1: Evaluate the ethical considerations surrounding the use of biotechnological innovations in horticulture.
- LO 6.2: Examine the social and cultural impacts of biotechnological innovations on agriculture and society.
- LO 6.3: Assess the environmental implications of biotechnological innovations for sustainable agriculture.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge						
Conceptual Knowledge		CO1		CO2, CO3, CO4		
Procedural Knowledge					CO5	
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	2	2	2	1	1	1	1	1	1	-	1.3
CO2	2	2	2	1	1	1	1	1	1	1	1.3
CO3	2	2	2	1	1	1	1	1	1	1	1.3
CO4	2	2	2	1	1	1	1	1	1	3	1.5
CO5	2	2	2	1	2	1	3	1	1	-	1.7
Average	2.0	2.0	2.0	1.0	1.2	1.0	1.4	1.0	1.0	1.7	

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**Biotechnological Innovations in Horticulture**					
Category	GEC	Year	1	Credits	3	Course code	BTGE-2
		Semester	II				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		26		**04**		**30**	**60**

Course Outline

Unit 1: Introduction to Biotechnological Innovations in Horticulture

Marks: 16, L: 7, T: 1, P: 10

1.1 Overview of biotechnology and its applications in horticulture
1.2 Historical perspectives and current trends in biotechnological innovations
1.3 Ethical considerations and regulatory frameworks in biotechnology

Genetic Engineering in Horticulture

1.4 Principles of genetic engineering: gene cloning, gene editing, and transgenic technologies
1.5 Applications of genetic engineering in horticulture: pest resistance, herbicide tolerance, and nutritional enhancement
1.6 Case studies of genetically modified crops and their impact on agriculture

Practical:

a) Preparation of Immobilized Seeds
b) Isolation and visualization of protoplast under microscope
c) Demonstration of gene cloning: restriction enzyme digestion, gel electrophoresis, and ligation
d) Transformation of E. coli cells.

Unit 2: Tissue Culture Techniques for Horticultural Crops

Marks: 16, L: 6, T: 1, P: 10

2.1 Introduction to tissue culture and micropropagation
2.2 Techniques for in vitro culture of plant tissues: explant selection, sterilization, and culture media preparation

Molecular Breeding for Crop Improvement

2.3 Principles of molecular breeding: marker-assisted selection, genomic selection, and gene pyramiding
2.4 Applications of molecular breeding in horticulture: disease resistance, abiotic stress tolerance, and yield improvement
2.5 Case studies of successful molecular breeding programs in horticultural crops

Practical:

a) Establishment of tissue culture cultures
b) Preparation of explants
c) Sterilization and culture initiation
d) Subculturing and multiplication of explant

Unit 3: Biotechnological Approaches to Crop Protection

Marks: 16, L: 7, T: 1, P: 10

3.1 Biotechnological strategies for pest and disease management in horticulture
3.2 Use of biopesticides, plant-derived compounds, and RNA interference (RNAi) technologies

Bioremediation and Phytoremediation Techniques

3.3 Biotechnological approaches for soil and water remediation using plants
3.4 Use of horticultural crops for phytoremediation of heavy metals, organic pollutants, and contaminants
3.5 Case studies of successful phytoremediation projects and their implications for sustainable agriculture

Practical:

a) Preparation of biopesticide extracts
b) Testing the efficacy of *Trichoderma* against fungal pathogen

c) Testing the efficacy of biopesticides against common pests and diseases
d) Investigate the phytoremediation potential of horticultural crops for soil or water cleanup

Unit 4: Precision Agriculture and Remote Sensing Technologies

Marks: 12, L:6, T:1, P: 0

4.1 Integration of biotechnology with precision agriculture techniques for optimal crop management
4.2 Use of remote sensing technologies, GIS (Geographic Information System), and drones in horticulture

Future Directions and Challenges in Biotechnological Innovations

4.4 Emerging trends in biotechnology and their potential impact on horticulture
4.5 Challenges and opportunities in translating biotechnological innovations into practical solutions for agriculture
4.6 Final project presentations and discussions on innovative biotechnological applications in horticulture

Where	*L: Lectures*	*T: Tutorials*	*P: Practical*

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Project Report on case study
   b) Group discussion/Presentation
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Suza. W. and Lee. D.(2021). Genetics, Agriculture, and Biotechnology. Iowa State University.
2. Ratledge. C. and Kristiansen. H. (2006). Basic Biotechnology. 3rd Edition. Cambridge University Press.
3. Peter. K.V. (2013). Biotechnology in Horticulture: Methods and Applications. New India Publishing Agengy, New Delhi
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.

NAME OF THE COURSE : FUNDAMENTALS OF MICROBIOLOGY
COURSE TYPE : MAJOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: The Fundamentals of Microbiology course aims to provide students with a comprehensive understanding of microorganisms, including their structure, function, growth, genetics, and the roles they play in various environments. The course includes both theoretical and practical components to give students hands-on experience in microbiological techniques.

Prerequisites

- Basics of Cell Biology
- Basics in Biochemistry
- Basics in Microbial Physiology

Course Objectives: The objectives of this Course are to -

- Identify and describe the major types of microorganisms, including bacteria, viruses, fungi, algae, and protozoa.
- Understand the structural and functional differences between prokaryotic and eukaryotic microorganisms.
- Develop practical laboratory skills for handling and studying bacteria.

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Define the fundamental principles of microbiology.
- LO 1.1: Identify and describe the basic structure and morphology of bacteria.
- LO 1.2: Explain the principles of bacterial growth and metabolism.
- LO 1.3: Discuss the significance of bacterial taxonomy and classification.

CO2: Identify common bacterial pathogens and their mechanisms of pathogenesis.
- LO 2.1: Identify major bacterial pathogens.
- LO 2.2: Understand the mechanisms of bacterial pathogenesis.
- LO 2.3: Analyze the epidemiology and clinical manifestations of bacterial infections.

CO3: Apply microbiological techniques for bacterial isolation, cultivation, and characterization.
- LO 3.1: Proficiently execute bacterial isolation techniques.
- LO 3.2: Cultivate bacterial cultures using appropriate media and conditions.
- LO 3.3: Characterize bacterial isolates through biochemical and molecular methods.

CO4: Analyze the role of bacteria in environmental processes and biotechnology.
- LO 4.1: Evaluate bacterial roles in natural ecosystems.
- LO 4.2: Apply bacterial biotechnology for environmental remediation.
- LO 4.3: Assess the potential of bacterial bioproducts in biotechnology.

CO5: Evaluate the impact of antibiotics and antimicrobial resistance.
- LO 5.1: Analyze mechanisms of antibiotic action and resistance.
- LO 5.2: Assess the epidemiology and public health implications of antimicrobial resistance.
- LO 5.3: Propose strategies for antimicrobial stewardship and resistance mitigation.

CO6: Synthesize knowledge of bacteriology to address real-world challenges.

- LO 6.1: Apply bacteriological principles to analyze and propose solutions for public health challenges.
- LO 6.2: Utilize bacteriological concepts in environmental and ecological contexts.
- LO 6.3: Innovate and collaborate to tackle emerging issues in biotechnology and industry.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO1					
Conceptual Knowledge		CO2		CO4	CO5	
Procedural Knowledge			CO3			
Metacognitive Knowledge						CO6

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	2	2	1	1	2	1	1	2	1	1	**1.4**
CO2	3	3	2	2	3	2	1	2	1	1	**2.0**
CO3	2	2	2	2	2	2	2	2	1	1	**1.8**
CO4	2	2	2	2	2	2	2	2	1	3	**2.0**
CO5	2	3	2	2	3	2	1	2	1	1	**1.9**
CO6	3	3	3	2	3	3	2	3	2	2	**2.6**
Average	2.3	2.5	2.0	1.8	2.5	2.0	1.5	2.2	1.2	1.5	

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Centre for Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**Fundamentals of Microbiology**					
Category	Major	Year	2	Credits	4	Course code	**BTNC03**
		Semester	III				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		37		**08**		**30**	**75**

Course Outline

Unit 1: Basics of microbiology

Marks: 12, L: 6, T: 2, P: 6

1.1 Structural organisation in bacteria: bacterial nutrition, growth medium and growth curve.

1.2 Methods of sterilization; pure culture, isolation, selective method of isolation, cultivation, preservation.

Practical:

a) Aseptic techniques: Practice sterile handling of equipment and media to prevent contamination.

b) Bacterial isolation: Learn various methods for isolating bacteria from environmental samples or clinical specimens.

c) Culture media preparation: Prepare and sterilize different types of culture media suitable for cultivating bacteria.

Unit 2: Diversity

Marks: 16, L: 9, T: 2, P: 12

2.1 Metabolic diversity among microorganisms: Heterotrophs, organotrophs (methane utilization, hydrocarbon transformation); autotrophs, phototrophs; chemolithotrophs; (iron, sulfur utilizing microbes) and their importance in biotechnology.

2.2 Microbial diversity, Systematic bacteriology, new approaches to bacterial taxonomy (ribotyping).

Practical:

a) Microscopic examination: Use microscopy to observe bacterial morphology, Simple Staining, Gram staining, and other staining techniques.

b) Biochemical tests: Perform biochemical assays to identify bacterial species based on metabolic properties.

Unit 3: Bacterial and Archaeal Kingdom:

Marks: 16, L: 11, P: 6

3.1 Classification (Bergy's Manual for Systematic Bacteriology).

3.2 General characters, Model organism: *Eschericia coli*, *Staphyllococcus* spp., *Streptococcus* spp., *Bacillus, Spirullina, Clostridium* spp.

3.3 Archaea: General characters, chemical nature, Phyllum: Crenarchaeota, Euryarchaeota.

3.4 Classification and properties: acidophilic, alkalophilic, thermophilic, barophilic and osmophilic microbes, methanogens, methane production; Biotechnological potential of extremophiles.

Practical:

a) Perform culture-based methods to isolate bacteria from clinical samples and determine their antibiotic susceptibility profiles.

b) Design and conduct experiments to evaluate the ability of bacteria to degrade pollutants and remediate contaminated environments.

Unit 4: Viruses and Other Infectious Agents:

Marks: 16, L:11, P: 6

4.1 General characters, chemical nature, structure of TMV, HIV, bacteriophages.

4.2 Lytic and lysogenic cycles. Viroids and Prions.

Fungi and Molds:

4.3 General characters, structure, reproduction, diversity, life cycle. Model organism: *Saccharomyces*, *Aspergillus* spp, *Penicillum* spp. *Neurospora* spp.

Protozoa:

4.4 General characters, structure, reproduction, diversity, life cycle. Model protozoan: *Plasmodium* spp., *Amoeba*, *Paramecium*.

Practical:

a) Gram staining of yeast
b) Lactophenol cottonblue staining for mold
c) Staining of protozoan and identification

Where	***L: Lectures***	***T: Tutorials***	***P: Practical***

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Marshall, C. E., & Bioletti, F. T. (1971). Microbiology: A Text Book of Microorganisms, General and Applied. P. Blakiston's Son and Company.
2. Pelczer, M. J., & Reid, R. D. (2001). Microbiology. McGraw Hill Education; 5th edition.
3. Stanier, R. Y., et al. (1999). General Microbiology. Palgrave Macmillan 5e (Intern Ed).
4. Waksman, S. A. (2020). Soil Microbiology. Alpha Edition.
5. Willey, J. M; Sherwood, L. Woolverton, C. J; Prescott, L. M., New York : McGraw-Hill Higher Education. (2008). Prescott, Harley, and Klein's microbiology.

NAME OF THE COURSE : MOLECULAR BIOLOGY
COURSE TYPE : MAJOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: This course provides an in-depth exploration of the molecular mechanisms that underlie the function and regulation of genes and genomes. It covers the fundamental processes of DNA replication, repair, transcription, and translation and the regulation of gene expression in prokaryotic and eukaryotic systems. The course also delves into modern techniques used in molecular biology research and their applications in biotechnology, medicine, and genetics.

Prerequisites

- Cell Biology
- General Chemistry
- Organic Chemistry
- Biochemistry
- Microbiology

COURSE OBJECTIVES: The objectives of this Course are to -

- Understand the structure and function of nucleic acids.
- Comprehend the molecular mechanisms of DNA replication, transcription, and translation.
- Explore the regulation of gene expression in different organisms.
- Gain practical experience with key molecular biology techniques.
- Appreciate the applications of molecular biology in various fields.

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Describe the organisation and packaging of genetic material in prokaryotes and eukaryotes.

- LO1.1: Define the key terms and concepts associated with genetic material,
- LO1.2: Illustrate the structure of nucleic acids, chromatin, histones, and nucleosomes
- LO1.3: Explain how genetic material is organized in prokaryotic and eukaryotic cells

CO2: Apply knowledge of nucleases and restriction enzymes to DNA manipulation techniques.

- LO2.1: Recall the functions and types of nucleases and restriction enzymes.
- LO2.2: Understanding: Explain how nucleases and restriction enzymes interact with DNA.
- LO2.3: Use knowledge of nucleases and restriction enzymes in practical DNA manipulation techniques.

CO3: Analyze the differences between prokaryotic and eukaryotic replication mechanisms.

- LO3.1: Explain the basic processes of DNA replication in prokaryotic and eukaryotic cells.
- LO3.2: Apply knowledge of replication mechanisms to identify and differentiate replication components in various cell types.
- LO3.3: Compare and contrast the replication mechanisms in prokaryotic and eukaryotic cells, identifying the major differences and reasons behind these differences

CO4: Apply knowledge of the genetic code and aminoacyl tRNA synthases in translation.

- LO4.1: Recall the components and roles of the genetic code and aminoacyl tRNA synthases in translation.

- LO4.2: Explain how the genetic code directs protein synthesis and how aminoacyl tRNA synthases charge tRNAs with the correct amino acids.
- LO4.3: Understand the genetic code and aminoacyl tRNA synthases to predict the sequence of amino acids from a given mRNA sequence.

CO5: Examine how chromatin structure, histone modifications, and chromatin remodelling complexes influence gene expression.

- LO5.1: Explain the roles of chromatin structure, histone modifications, and chromatin remodelling complexes in regulating gene expression.
- LO5.2: Use knowledge of chromatin dynamics to predict how changes in histone modifications or chromatin remodelling might affect gene expression in a given context.
- LO5.3: Analyze experimental data showing the effects of specific histone modifications or chromatin remodelling on gene expression, identifying patterns and drawing conclusions.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO1					
Conceptual Knowledge				CO3		
Procedural Knowledge			CO2, CO4			
Metacognitive Knowledge					CO5	

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	**3**	**2**	**1**	**2**	**2**	**1**	**2**	**2**	**1**	**1**	**1.7**
CO2	**3**	**2**	**2**	**1**	**3**	**2**	**3**	**2**	**1**	**1**	**2.0**
CO3	**3**	**3**	**1**	**2**	**2**	**1**	**2**	**2**	**1**	**1**	**1.8**
CO4	**3**	**2**	**2**	**1**	**2**	**2**	**3**	**2**	**1**	**1**	**1.9**
CO5	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**1**	**1**	**2.2**
Average	**3.0**	**2.4**	**1.6**	**1.6**	**2.4**	**1.6**	**2.6**	**2.0**	**1.0**	**1.0**	

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**MOLECULAR BIOLOGY**					
Category	Major	Year	2	Credits	4	Course code	**BTNC04**
		Semester	III				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		40		**05**		**30**	**75**

Course Outline

UNIT 1: GENETIC MATERIAL AND ITS PACKAGING **Marks: 15, L: 10, T: 1, P: 15**

1.1 Nucleic acid as genetic material, Genome organization in prokaryotes and eukaryotes
1.2 Chromatin structure and function. Heterochromatin, euchromatin.
1.3 Histones and non-histone proteins, general properties of histone, nucleosomes, solenoid structure, packaging of DNA, satellite DNA.
1.4 Nucleases and restriction enzymes, Denaturation of DNA and Reassociation, Kinetics. C-value paradox.

Practical

a) Isolation of Genomic DNA from Eukaryotic Cells and Prokaryotic cells
b) Quantification and purity assessment of DNA using spectrophotometry
c) Digestion of extracted DNA with restriction enzymes
d) Analysis of restriction fragments using agarose gel electrophoresis

UNIT 2: REPLICATION **Marks: 15, L: 10, T: 2, P: 15**

2.1 DNA replication: mechanism, the replicons, origin, primosome & replisomes.
2.2 Properties of prokaryotic and eukaryotic DNA polymerases.
2.3 Synthesis of leading and lagging strand. Difference between prokaryotic and eukaryotic replication.

Practical

a) Extraction of total RNA from eukaryotic cells.
b) Quantification and assessment of RNA.
c) Synthesis of cDNA from extracted RNA.
d) Amplification of specific genes using RT-PCR.

UNIT 3: TRANSCRIPTION & TRANSLATION **Marks: 15, L:10, T: 1 P: 12**

3.1 Prokaryotic transcription; promoters, properties of bacterial RNA polymerase. Steps: initiation, elongation and termination; Properties of RNA polymerase I, II and III.
3.2 RNA processing and RNA editing. Inhibitors of transcription.
3.3 Ribosomes structure and function, genetic code, aminoacyl tRNA synthases.
3.4 Direction of protein synthesis (Dintzis experiment). Formation of translation initiation complex, chain elongation, translocation & termination and the role of respective factors involved therein.
3.5 Post-translational modifications- Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulfide bond formation. Inhibitors of translation.

UNIT 4: REGULATION OF GENE EXPRESSION **Marks: 15, L: 10, T:1, P:**

4.1 Overview of Gene Expression; Constitutive vs. Regulated Genes, Levels of Gene Regulation, Differences between Prokaryotic and Eukaryotic Gene Expression
4.2 Regulation of Transcription in Prokaryotes; Operon Model: Structure and Function of Operons; Lac Operon: Inducible System, Trp Operon: Repressible System; Transcription Factors and Sigma Factors:
4.3 Regulation of Transcription in Eukaryotes; Chromatin Structure and Remodeling, Role of Histones and Nucleosomes, Histone Modification (Acetylation, Methylation), Chromatin Remodeling Complexes
4.4 Transcription Factors and Enhancers; General vs. Specific Transcription Factors;, Enhancers and Silencers, Mediator Complex
4.5 Epigenetic Regulation: DNA Methylation, Non-coding RNAs (lncRNAs, miRNAs), X-Chromosome Inactivation and Genomic Imprinting

Where ***L: Lectures*** ***T: Tutorials*** ***P: Practical***

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Molecular Biology of the Gene, James D. Watson, Pearson/Benjamin Cummings, 2008
2. Molecular Biology, Robert Weaver, McGraw-Hill Education, 11-Feb-2011
3. Molecular Biology of the Cell. Alberts et al. Garland Science, 18-Nov-2014
4. Molecular Cell Biology, Harvey Lodish, W. H. Freeman, 2008
5. Essential Molecular Biology: A Practical Approach" by Terry Brown
6. Molecular Biology: Principles and Practice" by Michael M. Cox, Jennifer Doudna, and Michael O'Donnell

NAME OF THE COURSE : GENETICS AND BIOSTATISTICS
COURSE TYPE : MINOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: Students will gain a comprehensive understanding of genes, chromosomes, mendelian genetics, and their deviations. They will be able to solve Mendelian genetics problems. They will also gain a firm knowledge of the molecular basis of mutations, their origin, and the role of mutagens. The students will gain in-depth knowledge of genetic disorders and diseases. They will be able to understand population genetics and the application of Hardy Weinberg equilibrium in population-based studies. This course provides an introduction to fundamental concepts and techniques in statistical analysis. Students will learn to describe and summarize data, analyze relationships between variables, make predictions, and draw inferences from data

Prerequisites

Basics of Cell Biology
Basics of Molecular Biology
Basics of Biochemistry

COURSE OBJECTIVES: The objectives of this Course are to -

- To identify the fundamentals of genetics and principles of mendelian genetics.
- To explain the condition relating to mutation and chromosomal disorder.
- To explain the impact of different practices in cultivation of mushroom
- To analyze and develop problems relating to genetics and other biological data using statistics.
- Basic knowledge of mathematics and familiarity with computer applications.

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Have a basic understanding of the founding concepts of genetics and deviations from Mendelian genetics

- LO 1.1: Understand the importance of mendelian genetics
- LO 1.2: Describe monohybrid and dihybrid cross
- LO 1.3: Explain the various deviations from mendelian genetics
- LO 1.4: Apply test cross and back cross tests to solve problems related to genetics

CO2: Understand the significance of extra-chromosomal inheritance and its effect on consecutive generations

- LO 2.1: Analyse the structure and function of mitochondria and plastids
- LO 2.2: Analyse the effect of plastid and mitochondrial inheritance in the consecutive generations
- LO2.3: Demonstrate the association of mitochondrial and plastid inherited disorders

CO3: Demonstrate the concept of mutation in genes and its association with genetic diseases

- LO 3.1: Understand mutation and its types and cause of mutation
- LO 3.2: Demonstrate the genetic diseases associated with mutation in genes.

CO4: Analyse genetic changes in the population and its association with diseases

- LO 4.1: Understand Hardy Weinberg equilibrium and its importance in population-based studies
- LO 4.2: Analyse the effects of additive gene action in phenotype expression

CO5: Apply chromosome mapping methods in gene map construction

- LO 2.1: Describe linkage and crossing over
- LO 2.2: Understand the various chromosome mapping techniques in genetic map construction
- LO 2.3: Apply the concept of chromosome mapping methods in gene mapping

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge						
Conceptual Knowledge		CO1, CO2		CO4		
Procedural Knowledge			CO3, CO5			
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	2	3	1	1	2	1	2	3	1	1	1.7
CO2	2	3	1	1	2	1	2	3	1	-	1.6
CO3	3	2	2	1	3	1	3	2	1	-	1.8
CO4	3	3	2	1	2	1	2	2	1	-	1.7
CO5	3	2	2	1	3	1	3	2	1	-	1.8
Average	2.6	2.6	1.6	1.0	2.4	1.0	2.4	2.4	1.0	1	

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**GENETICS AND BIOSTATISTICS**					
Category	Minor	Year	**2**	Credits	4	Course code	**BTNC03**
		Semester	**III**				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		37		**08**		**30**	**75**

Course Outline

Unit 1: **Marks: 15, L: 6, T: 2, P: 10**

Mendelian principles :

1.1 Dominance, segregation, independent assortment.

1.2 Concept of gene : Allele, multiple alleles.

Extensions of Mendelian principles :

1.3 Codominance, incomplete dominance, gene interactions, pleiotropy, penetrance and expressivity, phenocopy, linkage and crossing over.

Practical:

- Study the inheritance pattern of flower color in pea plants (*Pisum sativum*) and determine if it follows Mendelian genetics.
- Explore and analyze genetic inheritance patterns that deviate from classical Mendelian genetics, focusing on incomplete dominance, co-dominance, and epistasis in plant pigmentation.

→ Species: *Mirabilis jalapa* (Four o'clock flower) for incomplete dominance.

→ Species: *ABO* Blood Type in humans (simulated using plant analogs for educational purposes) for co-dominance.

→ Species: Corn (*Zea mays*) for epistasis in kernel color.

Unit 2: **Marks 15: L:6 T:2 P:10**

Mutations and Chromosomal aberration

2.1 Molecular basis of mutation—types, spontaneous mutation, induced mutations

2.2 Radiation and chemical mutagens.

Practical:

Determine the genetic linkage between specific genes in *Drosophila melanogaster* and map their positions on a chromosome.

Unit 3 **Marks 15 L:8 T:2 P: 10**

Descriptive Statistics:

3.1 Introduction to data types;

3.2 Measures of central tendency and dispersion.

Probability distributions:

3.3 Binomial,

3.4 Poisson and normal

Practical:

a) Solving of statistical problem on descriptive statistics and probability distribution using Excel.
b) Solving of statistical problem on descriptive statistics and probability distribution using SPSS

Unit 4: **Marks 15 L:6 T: 2 P:10**

Test of significance:

4.1 Students t-test (one and two),

4.2 Chi-square test, non-parametric tests.

4.3 Analysis of variance (one way and two way classifications

Practical

a) Solving test of significance using Excel.
b) Solving test of significance using SPSS

Where ***L: Lectures*** ***T: Tutorials*** ***P: Practical***

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**

a) Assignment
b) Group discussion
c) Seminar/Presentation
d) Multiple Choice Questions

3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Genetics: The continuity of life, D. J. Fairbanks and W. H. Andersen, Brooks/Cole Pub., 1999
2. Introduction to Genetic Analysis- Vol. 10, Anthony J.F. Griffiths, W. H. Freeman, 2008
3. Applied Statistics Process , B. Biswas, New Central Book Agency, Kolkata
4. Genetics of Population, J.P Jain and V.T Pravakaran South Asian Publishers (P) Ltd. New Delhi.
5. Statistical techniques for studying genotype-environment introduction, V.T Pravakaran and J.P. Jain.
6. A Biostatistical and population oriented Approach, South Asian Publisher (P) Ltd. New Delhi.

NAME OF THE COURSE	**:**	**BIOTECHNOLOGY FOR HUMAN WELFARE**
COURSE TYPE	**:**	**GENERIC ELECTIVE COURSE**
TOTAL CREDIT	**:**	**3**
TOTAL MARKS	**:**	**60 (End Sem) + 40 (In Sem)**

Course Description: This course explores the applications of biotechnology in addressing various challenges related to human welfare, including healthcare, agriculture, environment, and industry. Students will learn about the principles, techniques, and ethical considerations of biotechnology and its role in improving human quality of life.

Prerequisites

- Foundation in Biology
- Proficiency in basic laboratory techniques, such as pipetting, measuring, and following experimental protocols

Course Objectives: The objectives of this Course are to -

- Understand the fundamental concepts and principles of biotechnology.
- Explore the applications of biotechnology in human health, agriculture, environment, and industry.
- Analyze the ethical, social, and environmental implications of biotechnological advancements.
- Develop critical thinking and problem-solving skills through case studies and hands-on activities.

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Understand the basic biotechnological concepts.

- LO 1.1: Demonstrate comprehension of key principles underlying biotechnology.
- LO 1.2: Describe the basic principles of molecular biology and genetics, showcasing foundational knowledge in biological sciences.
- LO 1.3: Demonstrate proficiency in using key tools and techniques in biotechnology.

CO2: Understand the application of biotechnology in medicine.

- LO 2.1: Comprehend the principles and applications of genetic engineering and gene therapy.
- LO 2.2: Analyze the process of drug development and production in pharmaceutical biotechnology.
- LO 2.3: Demonstrate proficiency in diagnostic techniques in disease diagnosis and monitoring.

CO3: Understand the applications of biotechnology in agriculture.

- LO 3.1: Explain the concept of genetically modified organisms (GMOs) and their role in crop improvement.
- LO 3.2: Describe agricultural biotechnology strategies, showcasing knowledge of biotechnological interventions aimed at enhancing crop productivity and resilience.
- LO 3.3: Discuss the use of bio-fertilizers and bio-pesticides in sustainable agriculture practices.

CO4: Understand the role of biotechnology in Environmental Conservation

- LO 4.1: Explain the process of bioremediation and the role of microorganisms in the degradation of environmental pollutants.
- LO 4.2: Analyze waste management strategies employing biotechnological methods, showcasing understanding of sustainable waste treatment options.
- LO 4.3: Discuss the principles of conservation biotechnology and its applications in preserving biodiversity

CO5: Gain proficiency in Industrial Biotechnology.

- LO 5.1: Comprehend the principles of bioprocess engineering, enabling them to design and optimize fermentation processes for the production of desired bioproducts.
- LO 5.2: Demonstrate knowledge of the production of biofuels, bioplastics, and biomaterials.
- LO 5.3: Apply enzyme technology in industrial settings, identifying enzymes suitable for various applications and optimizing reaction conditions to enhance efficiency and yield in biotechnological processes.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge						
Conceptual Knowledge		CO1		CO2, CO3, CO4		
Procedural Knowledge					CO5	
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	2	2	2	1	1	1	1	1	1	-	1.3
CO2	2	2	2	1	1	1	1	1	1	1	1.3
CO3	2	2	2	1	1	1	1	1	1	1	1.3
CO4	2	2	2	1	1	1	1	1	1	3	1.5
CO5	2	2	2	1	2	1	3	1	1	-	1.7
Average	2.0	2.0	2.0	1.0	1.2	1.0	1.4	1.0	1.0	1.7	

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**BIOTECHNOLOGY FOR HUMAN WELFARE**					
Category	GEC	Year	2	Credits	3	Course code	**BTGE-3**
		Semester	III				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		25		**05**		**30**	**60**

Course Outline

Unit 1: Introduction to Biotechnology

Marks: 12, L: 5, T: 1, P: 6

1.1 Overview of biotechnology: history, definition, and scope
1.2 Basic principles of molecular biology and genetics
1.3 Tools and techniques in biotechnology: PCR, DNA sequencing, gene editing

Practical

a) Microbial culture and staining
b) Isolation of DNA from plant

Unit 2: Biotechnology in Medicine

Marks: 12, L: 5, T: 1, P: 6

2.1 Genetic engineering and gene therapy
2.2 Pharmaceutical biotechnology: drug development and production
2.3 Diagnostic techniques: PCR, ELISA, biosensors

Practical

a) ELISA for protein detection
b) Antimicrobial susceptibility test by Disc diffusion Test

Unit 3: Biotechnology in Agriculture

Marks: 16, L: 5, T: 1, P: 6

3.1 Genetically modified organisms (GMOs) and crop improvement
3.2 Agricultural biotechnology: pest resistance, herbicide tolerance, and stress tolerance
3.3 Bio-fertilizers and bio-pesticides

Practical

a) Seed Germination and Growth Observation of GM and non GM crops
b) Assess the microbial diversity in soil samples.
c) Isolation and staining of *Rhizobium* spp. from leguminous plant root
d) Isolation and staining of arbuscular mycorrhiza in grass roots.

Unit 4: Biotechnology and the Environment

Marks: 12, L: 5, T: 1, P: 6

4.1 Bioremediation: microbial degradation of pollutants
4.2 Waste Management Using Biotechnological Approaches
4.3 Conservation biotechnology: preserving biodiversity

Practical

a) Investigate the biodegradability of bioplastics.
b) Evaluate water quality using microbial indicators.
c) Isolation of *Trichoderma* from soil and study of its morphology.

Unit 5: Industrial Biotechnology

Marks: 12, L: 5, T: 1, P: 6

5.1 Bioprocess engineering: fermentation and bioreactors
5.2 Production of biofuels, bioplastics, and biomaterials
5.3 Enzyme technology and its industrial applications

Practical

a) Isolation and staining of yeast from grapes.
b) Demonstrate the process of fermentation in bread making.
c) Estimate alcohol quantity in fruit juices by specific gravity method.

Where	*L: Lectures*	*T: Tutorials*	*P: Practical*

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Project Report on case study
   b) Group discussion
   c) Report of Field Visit
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
2. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
3. Purohit S.S. (2010). Agricultural Biotechnology. 3rd Edition. Agrobios (India)
4. Walker. J.M.,Spencer.,J.F.T. and Spencer.A.L.R. (2004). Environmental Microbiology: Methods and Protocols. Humana Totowa, NJ
5. Leadbetter, J. (Ed.). (2005). Environmental microbiology (Vol. 397). Gulf Professional Publishing.
6. Brooks. G.F., Carroll K.C., Butel J.S. and Morse S.A. (2007). Medical Microbiology. 24th edition. McGraw Hill Publication.
7. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology.4th edition. Elsevier.

NAME OF THE COURSE : GENETICS
COURSE TYPE : MAJOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: Students will gain a comprehensive understanding of genes, chromosomes, mendelian genetics, and their deviations. They will be able to solve Mendelian genetics problems. They will also gain a firm knowledge of the molecular basis of mutations, their origin, and the role of mutagens. The students will gain in-depth knowledge of genetic disorders and diseases. They will be able to understand population genetics and the application of Hardy Weinberg equilibrium in population-based studies. The students will acquire a comprehensive understanding of chromosome mapping and apply it in the construction of genetic maps. By the end of the course, students will grasp a concrete knowledge of genetics, be able to analyze genetic data, understand patterns of genetic inheritance, and contribute to the advancements of research based on genetic studies.

Prerequisites:

- Concept of genes and chromosomes
- Genetic diseases
- Concept of mitochondria and plastids

Course Objectives: The objectives of this Course are to -

- Understand the founding concepts of Genetics and cytogenetics
- Discern the significance of extra-chromosomal inheritance and its effect on consecutive generations
- Comprehend the significant consequences of any change in genetic constitution resulting in disease and disorder
- Understand the dynamics of population genetics
- Decipher the use of markers to create linkage maps

COURSE OUTCOME (CO): On completion of this course, students will be able to –

CO1: Have a basic understanding of the founding concepts of genetics and deviations from Mendelian genetics

- LO 1.1: Understand the importance of mendelian genetics
- LO 1.2: Describe monohybrid and dihybrid cross
- LO 1.3: Explain the various deviations from mendelian genetics
- LO 1.4: Apply test cross and back cross tests to solve problems related to genetics

CO2: Understand the significance of extra-chromosomal inheritance and its effect on consecutive generations

- LO 2.1: Analyse the structure and function of mitochondria and plastids
- LO 2.2: Analyse the effect of plastid and mitochondrial inheritance in the consecutive generations
- LO2.3: Demonstrate the association of mitochondrial and plastid inherited disorders

CO3: Demonstrate the concept of mutation in genes and its association with genetic diseases

- LO 3.1: Understand mutation and its types and cause of mutation
- LO 3.2: Demonstrate the genetic diseases associated with mutation in genes.

CO4: Analyse genetic changes in the population and its association with diseases

- LO 4.1: Understand Hardy Weinberg equilibrium and its importance in population-based studies
- LO 4.2: Analyse the effects of additive gene action in phenotype expression

CO5: Apply chromosome mapping methods in gene map construction

- LO 2.1: Describe linkage and crossing over
- LO 2.2: Understand the various chromosome mapping techniques in genetic map construction
- LO 2.3: Apply the concept of chromosome mapping methods in gene mapping

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge						
Conceptual Knowledge		CO1, CO2		CO4		
Procedural Knowledge			CO3, CO5			
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	2	3	1	1	2	1	2	3	1	1	1.7
CO2	2	3	1	1	2	1	2	3	1	-	1.6
CO3	3	2	2	1	3	1	3	2	1	-	1.8
CO4	3	3	2	1	2	1	2	2	1	-	1.7
CO5	3	2	2	1	3	1	3	2	1	-	1.8
Average	2.6	2.6	1.6	1.0	2.4	1.0	2.4	2.4	1.0	1	

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the Course		**GENETICS**					
Category:	Major	Year	2	Credits	4	Course	**BTNC05**
		Semester	IV				
Instructional hours		Lecture		Tutorial	Lab Practical	Total	
		30		**15**	**30**	**75**	

Course Outline

Mendelian Genetics **Marks: 12, L:8, T:4, P:12**

Background, history and Concept of inheritance, Mendel's experiment: Monohybrid experiment and principle of Segregation, Dihybrid experiment and law of Independent Assortment, Dominance Mendelian Inheritance in Humans with examples.
Variation in Mendelian Genetics: Deviation from Mendelism- Multiple Alleles and Dominance Relations, Epistasis Penetrance and Expressivity

Practical

a) Solving Problems related to Mendelian Genetics
b) Solving Problems related to deviation Mendelian Genetics
c) Working with OMIM database

Extranuclear inheritance **Marks:12, L:7, T:4**

The Origins of Mitochondria and Plastids, Cellular structure and Functions of Mitochondria, Mitochondrial Inheritance, Cellular structure and Functions of Plastids, Plastid Inheritance.
Mitochondial inheritance associated genetic disorders in Humans, Plastid Inheritance associated genetic disorders in plants

Mutations and Chromosomal aberration **Marks:12, L:8,T:4**

Molecular basis of mutation—types, spontaneous mutation, induced mutations, Radiation and chemical mutagens
Genetic disorder and their inheritance
Chromosomal aberration in Humans with examples of consequential disorders and diseases;
Sex-Linked disease inheritance

Population genetics **Marks:12, L:7,T:3,P:12**

Hardy-Weinberg equilibrium,
Genetic changes in population, Random and non-random mating, Selection, Genetic drift
Speciation: Types, isolation mechanisms leading to speciation
Quantitative genetics
Additive Gene Action and Continuous Variation, Heterosis and Inbreeding Depression, Environmental Variation

Practical

a) Solving Problems related to population genetics
b) Solving Problems related to quantitative genetics

Chromosome mapping **Marks:12, L: 8, T: 4, P: 6**

Linkage studies: The Discovery of Linkage and Crossing-Over, Two-Factor Linkage, Map Distance Correction and mapping function, Three-Factor Linkage, Physical Chromosome Mapping, Practical Applications of Chromosome Mapping, Recombination, Crossing-Over and Complementation.

Practical

1. Solving Problems related to linkage analysis and chromosome mapping

Where	*L: Lectures*	*T: Tutorials*	*P: Practical*

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGETED READINGS

- Genetics: The continuity of life, D. J. Fairbanks and W. H. Andersen, Brooks/Cole Pub., 1999
- Introduction to Genetic Analysis- Vol. 10, Anthony J.F. Griffiths, W. H. Freeman, 2008
- Genetics: Analysis of Genes and Genomes, Daniel L. Hartl, Elizabeth W. Jones, Jones & Bartlett Learning, 2009
- Genetics, Monroe W. Strickburger, Macmillian 1976

NAME OF THE COURSE : BIOINSTRUMENTATION
COURSE TYPE : MAJOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: Bioinstrumentation is a multidisciplinary course focusing on the principles and applications of instruments used in biological and different research fields. It covers the design, function, and use of bioanalytical instruments essential for life science, biotechnology, pharmacology, Chemistry, and physics. Students explore sensors, transducers, signal processing, and data acquisition systems, gaining knowledge in measuring physiological parameters and analyzing biological data. The course includes theoretical lectures, hands-on laboratory sessions, and projects on real-world applications in biological sciences and research. With prerequisites in biology, physics, and Chemistry, this course prepares students for careers in biomedical engineering, medical device development, and clinical engineering, equipping them with the skills to operate and maintain advanced bioinstrumentation systems.

Prerequisites

- Fundamental understanding of biological molecules and cellular structures.
- Knowledge of chemical principles and reactions.
- Understanding of organic molecules, their structures, and reactions
- General Physical principles of optics, electromagnetism, and mechanics.

COURSE OBJECTIVES: The objectives of this Course are to -

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Understand key terms related to analytical instruments and equipment used in biological research.
- LO 1.1: List various types of analytical instruments used in biological research.
- LO 1.2: Explain the basic principles and functions of common analytical instruments.
- LO 1.3: Classify the common analytical instruments according to their working principle

CO2: Analyze the laboratory's waste disposal practices for compliance with environmental regulations.
- LO 2.1: Identify the different types of waste generated in a laboratory.
- LO 2.2: Explain the environmental and health impacts of improper waste disposal.
- LO 2.3: Implement proper waste disposal procedures in the laboratory.

CO3: Acquire in-depth knowledge of the theory, instrumentation, and applications of various microscopy and spectrophotometry techniques.

- LO 3.1: Classify microscopic and spectrophotometric techniques according to their working principle.
- LO 3.2: Identify the key components and instrumentation required for each type of microscopy and spectroscopy
- LO 3.3: Explain the applications, strengths and limitations of each microscopic and spectrophotometric technique used in biological research.

CO4: Compare working principles and application of different chromatographic techniques

- LO 4.1: Explain how each chromatographic technique separates mixtures based on different principles
- LO 4.2: Use knowledge of chromatographic principles to choose appropriate techniques for specific separation tasks.
- LO 4.3: Compare the advantages and limitations of different chromatographic techniques in terms of resolution, sensitivity, and suitability for various applications

CO5: Compare working principles and application of different centrifugation techniques

- LO 5.1: Explain the working principles of each centrifugation technique, including how particles are separated based on size, shape, and density.
- LO 5.2: Demonstrate the use of different centrifugation techniques in laboratory settings to separate and purify biological samples.
- LO 5.3: Compare and contrast the advantages and limitations of different centrifugation techniques in terms of resolution, speed, scalability, and sample compatibility.
- LO 5.4: Analyze experimental data from centrifugation experiments to interpret separation efficiency and identify factors influencing experimental outcomes.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge		CO1				
Conceptual Knowledge						
Procedural Knowledge				CO2	CO3, CO4, CO5	
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	1	2	1	2	2	1	3	2	1	1	1.6
CO2	2	3	1	1	2	2	2	1	1	3	1.8
CO3	3	2	2	1	3	2	3	2	1	1	2.0
CO4	3	3	2	1	3	1	3	2	1	1	2.0
CO5	3	3	2	1	3	1	3	2	1	1	2.0
Average	2.4	2.6	1.6	1.2	2.6	1.4	2.8	1.8	1.0	1.4	

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**BIOINSTRUMENTATION**					
Category	Major	Year	2	Credits	4	Course code	**BTNC06**
		Semester	IV				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		40		**05**		**30**	**75**

Course Outline

Marks: 12, L: 8, T: 1, P: 10

Unit 1: General introduction to analytical instruments and equipment, Operation and safety measures in biology, Handling of samples and equipment, Troubleshooting common issues, Calibration and maintenance of different instruments, Good Laboratory Practices, Waste disposal and environmental considerations

Practical

a) Demonstration of basic operation and safety protocols for commonly used analytical instruments
b) Hands-on practice with instrument setup, calibration, and shutdown procedures.
c) Hands-on training on proper sample handling techniques, including pipetting, weighing, and dilution.
d) Hands-on demonstration of safe disposal practices for hazardous chemicals and biohazardous materials

Unit 2: Introduction to Microscopy and Spectrophotometry **Marks: 12, L: 8, T: 2, P: 8**

2.1 Overview of microscopy, Historical development of microscopes, Basic principles of light microscopy, Resolution and magnification, Contrast mechanisms

2.2 Theory, instrumentation & applications of- Brightfield microscopy, Darkfield Microscopy, Phase contrast microscopy, Differential Interference Contrast (DIC) microscopy, Fluorescence Microscopy, Confocal microscopy,

2.3 Theory, instrumentation & applications of UV-VIS spectrophotometry, IR spectroscopy, Mass Spectrometry and NMR.

Practical

a) Hands-on training on operating and adjusting light microscopes for optimal imaging.
b) Observation of prepared slides to understand the principles of light microscopy.
c) Measurement of absorbance spectra for various chemical compounds using a UV-VIS spectrophotometer.

Unit 3: Separation technique – Chromatography **Marks: 12, L: 8, T: 1, P: 6**

Overview of chromatography, Historical development, Principle, types and applications of different chromatographic methods. Partition and Adsorption chromatography, Ion-exchange chromatography, Size exclusion and affinity chromatography.

Practical

a) Hands-on practice with column chromatography setups for separation of mixtures.

Unit: 4: Separation technique – Electrophoresis **Marks: 12, L: 8, T: 1, P: 6**

Basic principles of electrophoresis, Factors affecting electrophoretic mobility, Theory, instrumentation and applications of Native PAGE, SDS PAGE, Agarose gel electrophoresis, Isoelectric focusing, Two-Dimensional Gel Electrophoresis

Practical

a) Hands-on training on setting up and running gel electrophoresis experiments (e.g., native PAGE, SDS-PAGE, agarose gel electrophoresis).

Unit 5: Centrifugation

Basic principles of centrifugal force; Factors affecting sedimentation: particle size, shape, density, and medium viscosity; RCF and RPM; Types of Centrifugation; Working principle, types and applications of different centrifuges

Practical

a) Demonstration of centrifugation protocols for isolating cellular components and biomolecules from biological samples.

Where ***L: Lectures*** ***T: Tutorials*** ***P: Practical***

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Principles of Instrumental Analysis" by Douglas A. Skoog, F. James Holler, Stanley R. Crouch
2. Biological Safety: Principles and Practices" by Diane O. Fleming, Debra L. Hunt
3. Basic Laboratory Methods for Biotechnology" by Lisa A. Seidman, Cynthia J. Moore
4. Analytical Chemistry: A Practical Approach" by Bryan M. Ham, Aihui MaHam
5. Calibration and Validation of Analytical Methods: A Sampling of Current Approaches" by Mark Stauffer
6. Maintenance and Troubleshooting of Laboratory Instruments" by Prakash Singh Bisen, Anjana Sharma
7. Good Laboratory Practice: Nonclinical Laboratory Studies Concise Reference" by M. S. Traul
8. Chemical Laboratory Safety and Security: A Guide to Developing Standard Operating Procedures" by National Research Council
9. Fundamentals of Light Microscopy and Electronic Imaging" by Douglas B. Murphy and Michael W. Davidson
10. Introduction to Optical Microscopy" by Jerome Mertz
11. Spectrophotometry & Spectrofluorimetry: A Practical Approach" by Michael G. Gore
12. Chromatography: Concepts and Contrasts" by James M. Miller
13. Principles and Techniques of Biochemistry and Molecular Biology" by Keith Wilson and John Walker
14. Methods of Cell Separation" by D. Rickwood

NAME OF THE COURSE : BIOSTATISTICS AND DATA ANALYSIS
COURSE TYPE : MAJOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: This course provides an introduction to fundamental concepts and techniques in statistical analysis. Students will learn to describe and summarize data, analyze relationships between variables, make predictions, and draw inferences from data.

Prerequisites

- Basic knowledge of mathematics and familiarity with computer applications.

Course Objectives: By studying this course, the students will be able to

- Understand and apply measures of central tendency and dispersion to describe and summarize data.
- Analyze relationships between variables using correlation and regression analysis.
- Apply probability theory to solve problems involving random experiments and sample spaces.
- Use probability distributions to generate random samples and analyze their properties.

Course Outcomes (COs): On completion of this Course, students will be able to –

CO1: Define data types, explain their characteristics, and calculate measures of central tendency and dispersion for a given dataset.

LO1: Define and differentiate between different types of data.

LO2: Calculate and interpret measures of central tendency and dispersion for a given dataset.

LO3: Explain the characteristics and appropriate uses of each measure of central tendency and dispersion.

CO2: Apply correlation and regression analysis to analyze relationships between variables.

LO1: Understand the concept of correlation and its significance in data analysis.

LO2: Calculate and interpret the correlation coefficient to determine the strength and direction of a relationship between two variables.

LO3: Perform simple linear regression analysis to predict one variable from another and interpret the results.

CO3: Describe concepts of probability, including random experiments, sample spaces, basic laws, conditional probability, and independence.

LO1: Define and describe random experiments and sample spaces.

LO2: Apply the basic laws of probability to solve problems.

LO3: Calculate conditional probabilities and determine whether events are independent or dependent.

CO4: Apply probability distributions to generate random samples and analyze their properties using statistical software.

LO1: Understand the characteristics and applications of the Binomial, Poisson, and Normal distributions.

LO2: Use statistical software to generate random samples from these distributions and analyze their properties.

LO3: Apply the properties of these distributions to solve real-world problems in various fields.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge		CO1				
Conceptual Knowledge			CO3	CO2		
Procedural Knowledge				CO4		
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	1	3	1	1	2	1	1	1	1	1	1.3
CO2	1	3	1	1	2	1	2	1	1	1	1.4
CO3	1	3	1	1	2	1	1	1	1	1	1.3
CO4	1	-	1	1	3	1	2	1	1	1	1.3
Average	1.0	3.0	1.0	1.0	2.3	1.0	1.5	1.0	1.0	1.0	

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**BIOSTATISTICS AND DATA ANALYSIS**					
Category	Major	Year	**2**	Credits	**4**	Course code	**BTNC07**
		Semester	**IV**				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		45		**15**		**30**	**60**

Course Outline

Unit 1: Descriptive Statistics **Marks 15 L:7, T:3, P:6**

1.1 Introduction to data types, Simple correlation and regression analysis

1.2 Concepts of Probability: Random experiment and sample space, Probability definition and basic laws,

1.3 Conditional probability and independence, Random variables and probability distributions.

Practicals

a. Calculate measures of central tendency (mean, median, mode) and dispersion (variance, standard deviation) for a given dataset.

b. Generate random samples from Binomial, Poisson, and Normal distributions using a statistical software and analyze the properties of these distributions.

Unit 2: Sample Survey **Marks 15 L:8, T:4, P:8**

2.1 Basics of sample survey design, Various sampling methods.

2.2 Statistical Inference: Classical estimation theory, Classical testing of hypothesis, p-Value interpretation,

2.3 Tests of significance, Analysis of variance.

Practicals

a. Conduct hypothesis tests (e.g., t-test, chi-square test) using a statistical software to analyze real-world datasets.

Unit 3: Multivariate Statistical Techniques **Marks 15 L:8, T:4, P:8**

3.1 Cluster analysis

3.2 Principal component analysis

3.3 Discriminant analysis and its use in classification problems.

Practicals

a. Apply cluster analysis to group similar data points together based on their characteristics.

b. Use principal component analysis (PCA) to reduce the dimensionality of a dataset and visualize the data in a lower-dimensional space.

Unit 4: Data Analysis using Statistical Softwares **Marks 15 L:7, T:4, P:8**

4.1 Knowledge on basic statistical softwares: excel, R, Rstudio, Python with NumPy, SciPy, and Pandas, PSPP, OpenStat.

Practicals

a. Use a statistical software (like R, Python, or Excel) to generate summary statistics and create graphical representations (histograms, box plots) of the data.

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

Suggested Readings

1. Biswas, B. Applied Statistics Process, New Central Book Agency, Kolkata.
2. Jain, J.P., & Pravakaran, V.T. Genetics of Population, South Asian Publishers (P) Ltd. New Delhi.
3. Pravakaran, V.T., & Jain, J.P. Statistical techniques for studying genotype-environment interaction, South Asian Publishers (P) Ltd. New Delhi.
4. South Asian Publisher (P) Ltd. A Biostatistical and population oriented Approach, New Delhi.
5. Ewens, W.J., & Grant, G.R. Statistical methods in Bioinformatics, Springer New York.
6. Bang, H., Zhou, X.K., Epps, H.L., & Mazumdar, M. Statistical methods in molecular Biology, Springer, ISBN 978-1-60761-578-1.

NAME OF THE COURSE : FUNDAMENTALS OF BIOINFORMATICS
COURSE TYPE : MAJOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: This course offers a comprehensive introduction to the key concepts and essential tools in bioinformatics. Students will delve into various biological databases and bioinformatics applications, with a focus on both sequence and structural data. The course addresses fundamental principles of sequence analysis, such as sequence similarity, identity, and homology. By the end of the course, students will be adept at using bioinformatics tools for sequence analysis, grasp the theoretical foundations of alignment algorithms, and confidently execute both pairwise and multiple sequence alignments.

Prerequisites

- **Basic Biology:** Understanding of fundamental biological concepts, including DNA, RNA, and protein structure and function.
- **Introduction to Computer Science:** Familiarity with basic computing concepts, including the use of software applications and basic programming.

Course Objectives: By studying this course, the students will be able to

- Analyze bioinformatics fundamentals, including databases and sequence analysis.
- Demonstrate proficiency in using scoring matrices for sequence alignment.
- Apply advanced techniques for pairwise and multiple sequence alignments.
- Conduct meticulous sequence analysis.
- Cultivate collaboration for interdisciplinary research.

Course Outcomes (COs): On completion of this Course, students will be able to –

CO1: Understand the fundamentals of bioinformatics, including biological databases and sequence analysis.

LO 1.1: Demonstrate a comprehensive understanding of the fundamentals of bioinformatics, including the role and importance of biological databases.

LO 1.2: Identify and utilize key bioinformatics tools for analyzing sequence and structure databases.

LO 1.3: Apply basic bioinformatics tools to effectively manage and interpret biological data.

CO2: Apply scoring matrices (PAM, BLOSUM) and distinguish between different types of homologues (orthologues, paralogues, xenologues).

LO 2.1: Apply scoring matrices (PAM, BLOSUM) to analyze sequence data and differentiate between various types of homologues (orthologues, paralogues, xenologues).

LO 2.2: Demonstrate a thorough understanding of sequence similarity, identity, and homology, along with the definitions and distinctions among homologues, orthologues, paralogues, and xenologues.

LO 2.3: Utilize scoring matrices (PAM, BLOSUM) effectively for both nucleic acid and protein sequences, demonstrating proficiency in selecting and applying the appropriate matrix for a given analysis.

CO3: Perform pairwise sequence alignments using dynamic programming (Needleman-Wunsch, Smith-Waterman) and interpret results.

LO 3.1: Demonstrate the ability to perform pairwise sequence alignments using dynamic programming algorithms, including Needleman-Wunsch and Smith-Waterman, to compare biological sequences effectively.

LO 3.2: Interpret alignment results by understanding the concepts of global and local alignment, scoring matrices, gap penalties, and significance scores, and apply this knowledge to evaluate sequence similarities and differences.

LO 3.3: Utilize bioinformatics tools such as EVD, FASTA, and BLAST algorithms to conduct pairwise sequence alignments, demonstrating a practical understanding of sequence analysis techniques.

CO4: Apply multiple sequence alignment (MSA) techniques, such as CLUSTALW, to conduct evolutionary analysis.

LO 4.1: Demonstrate the ability to apply various MSA methods, including CLUSTALW, PILEUP, and iterative methods, for aligning multiple sequences.

LO 4.2: Evaluate the quality of alignments to make informed decisions in evolutionary analysis.

LO 4.3: Apply advanced MSA techniques, such as profile and block analysis, pattern searching, and algorithms like MEME and Gibbs Sampler, for detailed evolutionary and functional analysis of biological sequences.

CO5: Analyze biological data using Hidden Markov Models (HMMs) for gene finding and multiple sequence alignment, demonstrating proficiency in advanced bioinformatics techniques.

LO 5.1: Implement the use of HMMs for gene finding, including the development of training sets and prediction of CpG islands.

LO 5.2: Demonstrate proficiency in using HMMs for multiple sequence alignment, including techniques such as frequent words in DNA, consensus word analysis, and transaction and emission matrices.

LO 5.3: Gain the ability to analyze biological sequences using HMMs, particularly in the context of gene finding and multiple sequence alignment, to enhance understanding of genomic structures and functions.

CO6: Analyze information theory and implement algorithms such as FASTA and BLAST for the purpose of database searching and comparison in bioinformatics.

LO 6.1: Use algorithms like FASTA and BLAST effectively to search biological databases, interpret results, and compare sequences.

LO 6.2: Demonstrate proficiency in applying information theory concepts and database search algorithms to solve bioinformatics problems and analyze biological data.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge						
Conceptual Knowledge		CO1	CO2			
Procedural Knowledge			CO3, CO4	CO5, CO6		
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	3	3	2	1	3	1	3	2	1	1	2.0
CO2	3	3	2	1	2	1	2	2	1	1	1.8
CO3	3	3	1	1	2	1	2	2	1	1	1.7
CO4	2	2	1	1	2	1	2	2	1	1	1.5
CO5	3	3	3	2	3	2	3	2	1	1	2.3
CO6	2	3	2	2	2	2	3	2	1	1	2.0
Average	2.7	2.8	1.8	1.3	2.3	1.3	2.5	2.0	1.0	1.0	

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**FUNDAMENTALS OF BIOINFORMATICS**					
Category	Major	Year	2	Credits	4	Course code	**BTNC08**
		Semester	**IV**				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		30		**15**		**30**	**75**

Course Outline

Unit 1: Biological Databases **Marks 15 L:7, T:3, P:6**

Fundamentals of Bioinformatics, Biological Databases and Tools: Sequence and Structure Databases, Basic Bioinformatics Tools.

Practical:

a) Perform biological database searches and retrieve information.

Unit 2: Sequence Analysis and Alignment **Marks 15 L:8, T:4, P:8**

Sequence Analysis: Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues. **Scoring matrices:** Basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences (PAM and BLOSUM), **Sequence alignment:** Basic concepts of sequence alignment, Uses of Sequence Alignment.

Practical

a) Build PAM and BLOSUM matrices.
b) Perform a database search using tools like BLAST or FASTA.

Unit 3: Pairwise Sequence Alignment **Marks 15 L:8, T:4, P:8**

Concept of Global and Local Alignment, Dot matrix method, Dynamic programming (Needleman-Wunsch algorithm, Smith-Waterman algorithm, Choosing of best scoring matrix, gap penalties, Significance of score, EVD, FASTA and BLAST algorithms, Information theory and Shanon Entropy.

Practical

a) Perform pairwise sequence alignments using online tools or software like EMBOSS.
b) Interpret alignment results to understand sequence similarity and identify conserved regions.

Unit 4: Multiple Sequence alignment **Marks 15 L:7, T:4, P:8**

Multiple Sequence Alignment methods (MSA), Scoring of a MSA, Progressive (CLUSTALW and PILEUP), Iterative (Genetic) and Hidden Markov Model (HMM) methods of MSA, Local MSA
(Profile and BLOCK analysis, and Pattern searching, and Expectation Maximization (EM) Algorithm (MEME) and Gibbs Sampler.

Practical

a) Use tools like CLUSTALW or MUSCLE to perform multiple sequence alignments.
b) Compare and analyze the results to understand evolutionary relationships and conserved regions.

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

Suggested Readings

1. Cynthia Gibas, Per Jambeck**.** Developing Bioinformatics Computer Skills, O'Reilly
2. Dan E. Krane 2003. Fundamental Concepts of Bioinformatics. Pearson Education India
3. Stanley. LetovskyBioinformatics: Databases and Systems, Springer
4. David W. Mount**.** Bioinformatics: Sequence and Genome Analysis, Published CSHL Press
5. Des Higgins, Willie R. Taylor**.** *Bioinformatics*: Sequence, Structure and Databanks: *A Practical Approach*, Oxford University Press.
6. Higgs, P. G. & Attwood, T. K. 2005. Bioinformatics and Molecular Evolution. Blackwell Science. Distributed by Ane Books, New Delhi.
7. Stekel, D. 2003. Microarray Bioinformatics. Cambridge University Press. London.
8. Xu, J. & Zhang. 2004. Current Topics in Computational Molecular Biology. MIT Press. Distributed by Ane Books, New Delhi.
9. Jones. 2004. Introduction to Bioinformatics Algorithms. Ane Books, India.
10. Wang. 2005. Data Mining in Bioinformatics. Ane Books, India.
11. Hall. 2004. Phylogenetic Trees Made Easy. W H Freeman & Co. USA.
12. Felsenstein. 2003. Inferring Phylogenies. W H Freeman & Co. USA.

NAME OF THE COURSE : MOLECULAR BIOLOGY
COURSE TYPE : MINOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: This course provides an in-depth exploration of the molecular mechanisms that underlie the function and regulation of genes and genomes. It covers the fundamental processes of DNA replication, repair, transcription, and translation and the regulation of gene expression in prokaryotic and eukaryotic systems. The course also delves into modern techniques used in molecular biology research and their applications in biotechnology, medicine, and genetics.

Prerequisites

- Cell Biology
- General Chemistry
- Organic Chemistry
- Biochemistry
- Microbiology

COURSE OBJECTIVES: The objectives of this Course are to -

- Understand the structure and function of nucleic acids.
- Comprehend the molecular mechanisms of DNA replication, transcription, and translation.
- Explore the regulation of gene expression in different organisms.
- Gain practical experience with key molecular biology techniques.
- Appreciate the applications of molecular biology in various fields.

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Describe the organisation and packaging of genetic material in prokaryotes and eukaryotes.

- LO1.1: Define the key terms and concepts associated with genetic material,
- LO1.2: Illustrate the structure of nucleic acids, chromatin, histones, and nucleosomes
- LO1.3: Explain how genetic material is organized in prokaryotic and eukaryotic cells

CO2: Apply knowledge of nucleases and restriction enzymes to DNA manipulation techniques.

- LO2.1: Recall the functions and types of nucleases and restriction enzymes.
- LO2.2: Understanding: Explain how nucleases and restriction enzymes interact with DNA.
- LO2.3: Use knowledge of nucleases and restriction enzymes in practical DNA manipulation techniques.

CO3: Analyze the differences between prokaryotic and eukaryotic replication mechanisms.

- LO3.1: Explain the basic processes of DNA replication in prokaryotic and eukaryotic cells.
- LO3.2: Apply knowledge of replication mechanisms to identify and differentiate replication components in various cell types.
- LO3.3: Compare and contrast the replication mechanisms in prokaryotic and eukaryotic cells, identifying the major differences and reasons behind these differences

CO4: Apply knowledge of the genetic code and aminoacyl tRNA synthases in translation.

- LO4.1: Recall the components and roles of the genetic code and aminoacyl tRNA synthases in translation.

- LO4.2: Explain how the genetic code directs protein synthesis and how aminoacyl tRNA synthases charge tRNAs with the correct amino acids.
- LO4.3: Understand the genetic code and aminoacyl tRNA synthases to predict the sequence of amino acids from a given mRNA sequence.

CO5: Examine how chromatin structure, histone modifications, and chromatin remodelling complexes influence gene expression.

- LO5.1: Explain the roles of chromatin structure, histone modifications, and chromatin remodelling complexes in regulating gene expression.
- LO5.2: Use knowledge of chromatin dynamics to predict how changes in histone modifications or chromatin remodelling might affect gene expression in a given context.
- LO5.3: Analyze experimental data showing the effects of specific histone modifications or chromatin remodelling on gene expression, identifying patterns and drawing conclusions.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO1					
Conceptual Knowledge				CO3		
Procedural Knowledge			CO2, CO4			
Metacognitive Knowledge					CO5	

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	**3**	**2**	**1**	**2**	**2**	**1**	**2**	**2**	**1**	**1**	**1.7**
CO2	**3**	**2**	**2**	**1**	**3**	**2**	**3**	**2**	**1**	**1**	**2.0**
CO3	**3**	**3**	**1**	**2**	**2**	**1**	**2**	**2**	**1**	**1**	**1.8**
CO4	**3**	**2**	**2**	**1**	**2**	**2**	**3**	**2**	**1**	**1**	**1.9**
CO5	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**1**	**1**	**2.2**
Average	**3.0**	**2.4**	**1.6**	**1.6**	**2.4**	**1.6**	**2.6**	**2.0**	**1.0**	**1.0**	

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**MOLECULAR BIOLOGY**					
Category	MINOR	Year	2	Credits	4	Course code	**BTNM04**
		Semester	IV				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		40		**05**		**30**	**75**

Course Outline

UNIT 1: GENETIC MATERIAL AND ITS PACKAGING **Marks: 15, L: 10, T: 1, P: 15**

1.1 Nucleic acid as genetic material, Genome organization in prokaryotes and eukaryotes
1.2 Chromatin structure and function. Heterochromatin, euchromatin.
1.3 Histones and non-histone proteins, general properties of histone, nucleosomes, solenoid structure, packaging of DNA, satellite DNA.
1.4 Nucleases and restriction enzymes, Denaturation of DNA and Reassociation, Kinetics. C-value paradox.

Practical

a) Isolation of Genomic DNA from Eukaryotic Cells and Prokaryotic cells
b) Quantification and purity assessment of DNA using spectrophotometry
c) Digestion of extracted DNA with restriction enzymes
d) Analysis of restriction fragments using agarose gel electrophoresis

UNIT 2: REPLICATION **Marks: 15, L: 10, T: 2, P: 15**

2.1 DNA replication: mechanism, the replicons, origin, primosome & replisomes.
2.2 Properties of prokaryotic and eukaryotic DNA polymerases.
2.3 Synthesis of leading and lagging strand. Difference between prokaryotic and eukaryotic replication.

Practical

a) Extraction of total RNA from eukaryotic cells.
b) Quantification and assessment of RNA.
c) Synthesis of cDNA from extracted RNA.
d) Amplification of specific genes using RT-PCR.

UNIT 3: TRANSCRIPTION & TRANSLATION **Marks: 15, L:10, T: 1 P: 12**

3.1 Prokaryotic transcription; promoters, properties of bacterial RNA polymerase. Steps: initiation, elongation and termination; Properties of RNA polymerase I, II and III.
3.2 RNA processing and RNA editing. Inhibitors of transcription.
3.3 Ribosomes structure and function, genetic code, aminoacyl tRNA synthases.
3.4 Direction of protein synthesis (Dintzis experiment). Formation of translation initiation complex, chain elongation, translocation & termination and the role of respective factors involved therein.
3.5 Post-translational modifications- Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulfide bond formation. Inhibitors of translation.

UNIT 4: REGULATION OF GENE EXPRESSION **Marks: 15, L: 10, T:1, P:**

4.1 Overview of Gene Expression; Constitutive vs. Regulated Genes, Levels of Gene Regulation, Differences between Prokaryotic and Eukaryotic Gene Expression
4.2 Regulation of Transcription in Prokaryotes; Operon Model: Structure and Function of Operons; Lac Operon: Inducible System, Trp Operon: Repressible System; Transcription Factors and Sigma Factors:
4.3 Regulation of Transcription in Eukaryotes; Chromatin Structure and Remodeling, Role of Histones and Nucleosomes, Histone Modification (Acetylation, Methylation), Chromatin Remodeling Complexes
4.4 Transcription Factors and Enhancers; General vs. Specific Transcription Factors;, Enhancers and Silencers, Mediator Complex
4.5 Epigenetic Regulation: DNA Methylation, Non-coding RNAs (lncRNAs, miRNAs), X-Chromosome Inactivation and Genomic Imprinting

Where ***L: Lectures*** ***T: Tutorials*** ***P: Practical***

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Molecular Biology of the Gene, James D. Watson, Pearson/Benjamin Cummings, 2008
2. Molecular Biology, Robert Weaver, McGraw-Hill Education, 11-Feb-2011
3. Molecular Biology of the Cell. Alberts et al. Garland Science, 18-Nov-2014
4. Molecular Cell Biology, Harvey Lodish, W. H. Freeman, 2008
5. Essential Molecular Biology: A Practical Approach" by Terry Brown
6. Molecular Biology: Principles and Practice" by Michael M. Cox, Jennifer Doudna, and Michael O'Donnell

NAME OF THE COURSE	**:**	**IMMUNOLOGY**
COURSE TYPE	**:**	**MAJOR**
TOTAL CREDIT	**:**	**4**
TOTAL MARKS	**:**	**60 (End Sem) + 40 (In Sem)**

Course Description: Students will have a concrete knowledge of immunity, its types, cells and organs of the immune system. They will be able to comprehend the structure, functions, and generation of antibody and antibody-mediated immune defence. They will also have insights into cell mediated immune response and antigen presentation through MHC molecules. They will be able to interpret the body's response towards antigens, adverse reactions, immune suppression and their related diseases and disorders. They will be able to understand how innate and adaptive immune systems coordinate to fight invading pathogens. Students will be able to explain the generation, differentiation, activation, and suppression of T and B cells. They will be able to understand the applications of immunological techniques like ELISA, RT-PCR, Flow cytometry, etc., for the detection and quantification of antigens and antibodies. Towards the end of the syllabus, they will be able to interpret the use of immunological molecules in the development of tailored medicines and precision medicines based on immunotherapy.

Prerequisites

- Introductory Biology
- General Chemistry
- Organic Chemistry
- Biochemistry
- Microbiology
- Human Physiology

COURSE OBJECTIVES: The objectives of this Course are to -

- Conceptualize how the innate and adaptive immune responses coordinate to fight invading pathogens.
- Have an in-depth understanding of different diseases which result from genetic or congenital defects of immune system components
- Develop skills through lab experiments and exercises in specific cell culture assays and imaging techniques for detecting and quantifying immune responses.

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Analyze innate and adaptive immunity and their role in disease outcome

- LO 1.1: Understand the key molecules of immune system and their role during infection
- LO 1.2: Describe the interaction between innate and adaptive immune responses in combating infection.
- LO 1.3: Analyze autoimmune disorders and immunodeficiency diseases, their pathogenesis, and clinical manifestations.

CO2: Understand the concept of antigen and antibody and their interaction in disease outcome.

- LO 1.1: Understand the structure, classes, and functions of antibodies
- LO 1.2: Compare the process of T cell and B cell generation, differentiation, and activation.
- LO 1.3: Apply knowledge of gene rearrangement in antibody diversity generation for antibody specificity and diversity.

CO3: Apply the different immunological techniques in detection and quantification of antibodies and antigens.

- LO 3.1: Understand the principle and procedure of different immunological techniques
- LO 3.1: Compare and contrast various immunological assays based on their principle, and applications.

- LO 3.2: Analyse the results of the various assays in detection and quantification of antigen or antibody

CO4: Interpret the use of immunological molecules in the development of tailored medicines and precision medicines based on immunotherapy

- LO 1.1: Understand the application of immunological molecules, such as monoclonal antibodies, antibodies and cytokines for designing immunotherapies.
- LO 1.2: Interpret the mechanisms of action of various immunotherapeutic agents and how they interact with immune cells or molecules to enhance or suppress immune function.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge				CO1		
Conceptual Knowledge		CO2				
Procedural Knowledge			CO3			
Metacognitive Knowledge					CO4	

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	**3**	**3**	**2**	**1**	**2**	**1**	**2**	**2**	**1**	**2**	
CO2	**2**	**3**	**2**	**1**	**2**	**1**	**2**	**2**	**1**	**2**	
CO3	**3**	**2**	**3**	**1**	**3**	**2**	**3**	**2**	**1**	**2**	
CO4	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**1**	**2**	
Average	**2.8**	**2.8**	**2.5**	**1.3**	**2.5**	**1.5**	**2.5**	**2.0**	**1.0**	**2.0**	

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**IMMUNOLOGY**					
Category	Major	Year	3	Credits	4	Course code	**BTNC09**
		Semester	V				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		37		**08**		**30**	**75**

Course Outline

Unit 1: Fundaments of immunology **Marks: 16, L: 11, T: 2, P: 8**

Types of immunity: innate and acquired immunity; active and passive immunity; Herd immunity, humoral and cell-mediated immunity.

Cells and organs involved in immunity; Cell-mediated effector responses, Leucocyte and macrophage migration; inflammation; Diversity in other Immune molecules- Natural Killer cell Receptors and MHC molecules,
Complement system: Activation pathway and its biological consequences; structure and function of MHC I and MHC II molecules,
Hypersensitivity reactions, immune suppression and immune tolerance. Autoimmune disorders, immunodeficiency

Practical

a) Preparation of blood smears to identify different types of blood cells under a microscope
b) Staining and counting of different types of leukocytes using a hemocytometer

Unit 2: **Marks: 16, L: 11, T: 2, P:4**

Immunoglobulins: Structure, classes and functions; allotypic and idiotypic variations; Catalytic antibodies; T Cell and B Cell generation and differentiation, activation and suppression; Multigene organization of Ig and TCR genes, rearrangement of DNA and generation of Ig and TCR diversity, Ig class switching.

Antigens: Characteristics, antigenicity and immunogenicity; Factors affecting immunogenicity, Role and properties of epitopes, haptens and adjuvants; Processing and presentation of antigens, Immune modulators; B & T cell epitopes; Antigen – Antibody interaction, affinity, cross reactivity, specificity, epitope mapping; Antigen processing pathways, Superantigens; Phage display libraries

Practical

a) Determination of blood group in human

Unit 3: **Marks: 16, L: 8, T: 10, P: 18**

Immuological Techniques: Antibody production by hybridoma technology; Antibodies as in vitro and in vivo probes; Immuno assays RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, Flow cytometry; vaccine technology, Principle of Immunofluorescence Microscopy

Practicals

a) Detection of antigen-antibody reaction using dot ELISA
b) Estimation of antibody using sandwich- ELISA
c) Radial immunodiffusion to study antigen-antibody interaction
d) Identification of specific proteins in a sample using Western blotting

Unit 3: **Marks: 12, L:7, T: , P: 0**

Cell Functional Assays – lymphoproliferation, mixed lymphocyte reaction, Cytokine expression; Cell Imaging Techniques, Transplantation, Clinical manifestations of graft vs host interaction, Tumor immunology, Passive Immunization: Antibody, Transfusion of immuno-competent cells, Stem cell therapy

Where ***L: Lectures*** ***T: Tutorials*** ***P: Practical***

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

SUGGESTED READINGS:

1. Immunology: Kuby et al, W. H. Freeman, 2013
2. Essential Immunology: Roitt et al, Wiley-Blackwell, April 2011
3. Janeway's Immunology, Kenneth Murphy, Casey Weaver, March 2016
4. Cellular and Molecular Immunology: Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Elsevier, 2021
5. Immunological techniques, Alyaa Farid, 2019
6. The Immune System, Peter Parham, 2014

NAME OF THE COURSE : BIOETHICS AND BIOSAFETY
COURSE TYPE : MAJOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: This course provides an in-depth exploration of the principles and practices integral to bioethics, biosafety, ethical standards, quality control, and intellectual property rights within the biotechnology field.

Prerequisites

- Basic Knowledge in Biology and Biotechnology

Course Objectives: By studying this course, the students will be able to

- Assess and apply bioethical principles to biotechnological issues.
- Develop strategies to mitigate biosafety risks.
- Implement WHO and IPR standards to enhance quality control in relevant industries.

Course Outcomes (COs): On completion of this Course, students will be able to –

CO1: Outline the principles of bioethics and explain the biosafety concerns with safeguard measures.

LO 1.1: Identify and describe key bioethical principles such as autonomy, beneficence, justice, and equality.

LO 1.2: Explain the major biosafety concerns at various societal levels, including individual, institutional, and global contexts.

LO 1.3: Propose and evaluate effective safeguard measures to mitigate biosafety risks in biotechnological practices.

CO2: Compile the BSA statement for the industrial production of pharmaceuticals.

LO 2.1: Summarize the British Sociological Association's ethical guidelines for the biotechnological production of pharmaceuticals.

LO 2.2: Evaluate the ethical practices outlined by the BSA in the context of pharmaceutical production.

LO 2.3: Apply BSA ethical guidelines to hypothetical scenarios in pharmaceutical production, ensuring compliance and ethical integrity.

CO3: Adapt the WHO quality standards in food process technology.

LO 3.1: Describe the WHO quality standards relevant to food process technology.

LO 3.2: Assess the implementation of WHO quality control measures in food processing.

LO 3.3: Develop detailed plans to adapt and implement WHO quality standards in a specific food processing context.

CO4: Discuss on the global scenario of patenting.

LO 4.1: Analyze current trends and challenges in the global patenting landscape.

LO 4.2: Compare patenting systems and practices across different countries and regions.

LO 4.3: Evaluate India’s position and strategies within the global patenting framework.

CO5: Comprehend the forms of patents, patentability and process of patenting.

LO 5.1: Identify and explain the various forms of patents and their specific criteria.

LO 5.2: Understand the criteria for patentability, including novelty, non-obviousness, and utility.

LO 5.3: Outline the steps involved in the patenting process, from application to approval, both in India and internationally.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge						
Conceptual Knowledge		CO1				
Procedural Knowledge			CO2, CO5		CO4	CO3
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	1	3	1	2	1	1	1	1	1	1	1.3
CO2	3	1	1	2	1	1	1	1	1	1	1.3
CO3	1	1	1	1	3	1	2	1	1	1	1.3
CO4	1	3	1	2	1	1	1	1	1	1	1.3
CO5	1	3	1	2	1	1	1	1	1	1	1.3
Average	1.4	2.2	1.0	1.8	1.4	1.0	1.2	1.0	1.0	1.0	

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**BIOETHICS AND BIOSAFETY**					
Category	Major	Year	3	Credits	4	Course code	**BTNC10**
		Semester	**V**				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		45		**15**		**-**	**60**

Course Outline

Unit 1: Principles of Bioethics **Marks 12 L:9, T:3**

1.1 Definition- Bioethics, Legality, morality and ethics- An introduction
1.2 Intoduction to the principles of Bioethics
1.3 Principles of autonomy, Human rights
1.4 Beneficence and privacy justice equality.

Unit 2: Biosafety concerns **Marks 12 L:9, T:4**

2.1 Introduction to Biosafety, Concept and issues of Biosafety
2.2 Rational Vs subjective perceptions of risks and benefits
2.3 Relationship between risk hazard, exposure, and safe guard
2.4 Biosafety concerns at the level of individuals, institutions, society, region, country and the world
2.5 Lab associated infections.

Unit 3: Statement of Ethical practice **Marks 12 L:9, T:4**

3.1 Introduction to BSA, History of BSA , British Sociological Association (BSA) statement of ethical practices of biotechnology in the production of pharmaceutical products
3.2 BSA statement ethical practices of biotechnology in the production of drugs
3.3 BSA statement ethical practices of biotechnology in the production vaccines
3.4 BSA statement ethical practices of biotechnology in the production biomolecules.

Unit 4: WHO quality standards **Marks 12 L:9, T:4**

4.1 Introduction to WHO and its functions, WHO standards – Quality control
4.2 Quality control in food process technology
4.3 Quality control in dairy product technology
4.4 Quality control for potable water
4.5 Quality control measures in pharmaceutical industries.

Unit 5: IPR and Patenting **Marks 12 L:9, T:4**

5.1 Introduction to IPR and Patenting
5.2 GATT and IPR, forms of IPR, IPR in India, WTO Act, Convention on Biodiversity (CBD)
5.3 Patent Co-operation Treaty (PCT), Forms of patents and patentability, process of Patenting
5.4 Indian and international agencies involved in IPR & patenting
5.5 Global scenario of patents and India's position, patenting of biological material, GLP, GMP.

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **20 Marks**
2. Any one of the following activities listed below - **20 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions

Attainment Strategies

- Feedback for each LO
- Activities

Suggested Readings

1. Beauchamp, T.L., & Childress, J.F. (2019). Principles of Biomedical Ethics, 8th Edition. Oxford University Press.
2. Resnik, D.B. (2012). Environmental Health Ethics. Cambridge University Press.
3. Murray, T.H., & Mehlman, M.J. (2000). Encyclopedia of Ethical, Legal, and Policy Issues in Biotechnology. John Wiley & Sons.
4. Parker, L.S., & Ackerly, D.C. (2020). Ethical Challenges in the Biotechnology Industry. Academic Press.
5. WHO. (2011). Quality Practices in Basic Biomedical Research. World Health Organization.
6. Bentley, J. (2009). Intellectual Property Rights: A Critical History. Edward Elgar Publishing.

NAME OF THE COURSE	**:**	**MOLECULAR EVOLUTION AND PHYLOGENY**
COURSE TYPE	**:**	**MAJOR**
TOTAL CREDIT	**:**	**4**
TOTAL MARKS	**:**	**60 (End Sem) + 40 (In Sem)**

Course Description: This course explores the principles of evolutionary genetics and phylogenetic analysis. Students will learn about the mechanisms of evolution, natural selection, and genetic variation within populations. The course covers models of molecular evolution, genome dynamics, and methods for constructing and interpreting phylogenetic trees. Practical components include simulations of genetic equilibrium, analysis of codon usage patterns, and constructing phylogenetic trees using various algorithms. This course emphasizes both theoretical understanding and practical skills in evolutionary analysis and phylogenetics.

Prerequisites

- **Bioinformatics (recommended):** Familiarity with bioinformatics tools and databases for sequence analysis and phylogenetic studies.
- **Statistics:** Basic knowledge of statistical methods and data analysis to comprehend genetic variation and population genetics.

Course Objectives: By studying this course, the students will be able to

- Understand evolution, natural selection, and genetic variation.
- Analyze genetic variation using models like Hardy-Weinberg equilibrium.
- Conduct sequence analysis and construct phylogenetic trees.
- Develop practical skills in interpreting phylogenetic data.
- Approach scientific inquiry with curiosity and critical thinking.

Course Outcomes (COs): On completion of this Course, students will be able to –

CO1: Understand the Fundamental Principles of Evolution and Molecular Archeology.

LO 1.1: Explain the concepts of evolution, natural selection, phylogeny, convergent evolution, and co-evolution.

LO 1.2: Describe the Hardy-Weinberg equilibrium and its implications for genetic variation in populations.

LO 1.3: Identify measures of genetic diversity and discuss the neutral and nearly-neutral theories of molecular evolution.

CO2: Analyze the Mechanisms of Genetic Variation and Molecular Evolution.

LO 2.1: Analyze the effects of mutation, migration, selection, and genetic drift on gene frequencies within populations.

LO 2.2: Compare different theories of molecular evolution, focusing on neutral and nearly-neutral theories.

LO 2.3: Conduct simulations to observe the Hardy-Weinberg equilibrium in populations.

CO3: Evaluate Models of Molecular Evolution and Genome Dynamics.

LO 3.1: Evaluate models of molecular evolution considering functional constraints and substitution patterns.

LO 3.2: Discuss the mechanisms of genome evolution, including gene families, lateral gene transfer, and chromosomal evolution.

LO 3.3: Analyze gene duplication events and their role in evolutionary processes.

CO4: Conduct Phylogenetic Analysis Using Sequence Data.

LO 4.1: Calculate evolutionary distances among sequences using pairwise comparison methods.

LO 4.2: Test the molecular clock hypothesis through practical applications.

LO 4.3: Perform sequence analysis to study natural selection and evolutionary clocks.

CO5: Design and Construct Phylogenetic Trees to Illustrate Evolutionary Relationships.

LO 5.1: Design phylogenetic trees using distance-based methods such as UPGMA and Neighbor-Joining.

LO 5.2: Construct phylogenetic trees to represent evolutionary relationships and clades.

LO 5.3: Develop strategies to assess the reliability of phylogenetic trees using bootstrap and randomization tests.

CO6: Develop Practical Skills in Evolutionary and Phylogenetic Analysis.

LO 6.1: Conduct practical simulations of Hardy-Weinberg equilibrium to understand genetic variation.

LO 6.2: Analyze codon usage patterns and base composition through practical exercises.

LO 6.3: Construct and evaluate phylogenetic trees using practical tools and methods such as UPGMA and Neighbor-Joining.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge		CO1				
Conceptual Knowledge				CO2		
Procedural Knowledge			CO4	CO6	CO3	CO5
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	2	3	2	1	2	1	1	2	1	1	1.6
CO2	2	3	1	1	2	1	1	2	1	1	1.5
CO3	2	3	2	1	2	2	1	2	1	1	1.7
CO4	2	3	1	1	2	1	2	2	1	1	1.6
CO5	2	2	3	2	2	2	2	2	2	2	2.1
CO6	2	3	1	1	2	2	2	2	1	1	1.7
Average	2.0	2.8	1.7	1.2	2.0	1.5	1.5	2.0	1.7	1.7	

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**MOLECULAR EVOLUTION AND PHYLOGENY**					
Category	Major	Year	3	Credits	4	Course code	**BTNC11**
		Semester	V				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		30		**15**		**30**	**75**

Course Outline

Unit 1: Molecular Archeology **Marks 15 L:7, T:3, P:4**

Introduction to evolution, natural selection, phylogeny, convergent evolution, co-evolution. Evolution of genes in populations. Hardy-Weinberg equilibrium. Mutation; Migration; Selection; Genetic drift; measures of genetic diversity. The neutral and nearly-neutral theories of molecular evolution.

Practical

a) Simulation of Hardy-Weinberg Equilibrium.

Unit 2: Evolutionary Analysis **Marks 15 L:7, T:4, P:8**

Models of Molecular evolution, Functional constraints and the rate of substitution patterns of codon usage and base composition.
Evolution of genome and gene families: Lateral gene transfer and transposition. Chromosomal evolution: Genome duplications. Orthology and paralogy. Gene duplication and divergence. Domain shuffling, concerted evolution and molecular drive.

Practical

a) Analysis of Codon Usage Patterns and Base Composition
b) Gene Duplication and Divergence Analysis

Unit 3: Phylogenetic Trees **Marks 15 L:8, T:4, P:8**

Sequence Analysis, natural selection and clocks: Calculating evolutionary distances among sequences; correlation and models. Molecular clocks.

Practical

- Estimating Evolutionary Distances Using Pairwise Sequence Comparison.
- Testing the Molecular Clock Hypothesis.

Unit 4: Phylogeny Algorithms **Marks 15 L:8, T:4, P:10**

Concepts: Kinds of trees, rooting, clades, reconstructing character evolution, consensus trees. Parsimony and distance based phylogenetic methods. Phylogenetic analysis algorithms: Distance-based: UPGMA, Neighbor-Joining, Maximum Parsimony, Reliability of trees: Bootstrap, Jackknife, randomization tests.

Practical

a) Constructing a Phylogenetic Tree Using UPGMA.
b) Constructing a Phylogenetic Tree Using Neighbor-Joining.
c) Assessing the Reliability of Phylogenetic Trees Using Bootstrap Analysis

Where ***L: Lectures*** ***T: Tutorials*** ***P: Practical***

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Futuyma, D.J. 2017. Evolution, Sinauer Associates.
2. Hillis, D.M., Moritz, C., and Mable, B.K. 2019. Molecular Systematics, Sinauer Associates.
3. Yang, Z. 2014. Molecular Evolution: A Statistical Approach, Oxford University Press.
4. Felsenstein, J. 2003. Inferring Phylogenies, Sinauer Associates.
5. Pagel, M. 2012. Evolutionary Analysis, Oxford University Press.
6. Nei, M., and Kumar, S. 2000. Molecular Evolution and Phylogenetics, Oxford University Press.
7. Garland, T., and Rose, M.R. 2009. Experimental Evolution: Concepts, Methods, and Applications of Selection Experiments, University of California Press.
8. Swofford, D.L. et al. 2003. Phylogenetic Analysis Using Parsimony (and other methods), Sinauer Associates.
9. Yang, Z., and Rannala, B. 2012. Molecular Phylogenetics: Principles and Practice, Oxford University Press.
10. Hill, W.G., and Robertson, A. 1966. The Effect of Linkage on Limits to Artificial Selection, Genetical Research.

NAME OF THE COURSE : FUNDAMENTALS OF BIOINFORMATICS
COURSE TYPE : MINOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: This course offers a comprehensive introduction to the key concepts and essential tools in bioinformatics. Students will delve into various biological databases and bioinformatics applications, with a focus on both sequence and structural data. The course addresses fundamental principles of sequence analysis, such as sequence similarity, identity, and homology. By the end of the course, students will be adept at using bioinformatics tools for sequence analysis, grasp the theoretical foundations of alignment algorithms, and confidently execute both pairwise and multiple sequence alignments.

Prerequisites

- **Basic Biology:** Understanding of fundamental biological concepts, including DNA, RNA, and protein structure and function.
- **Introduction to Computer Science:** Familiarity with basic computing concepts, including the use of software applications and basic programming.

Course Objectives: By studying this course, the students will be able to

- Analyze bioinformatics fundamentals, including databases and sequence analysis.
- Demonstrate proficiency in using scoring matrices for sequence alignment.
- Apply advanced techniques for pairwise and multiple sequence alignments.
- Conduct meticulous sequence analysis.
- Cultivate collaboration for interdisciplinary research.

Course Outcomes (COs): On completion of this Course, students will be able to –

CO1: Understand the fundamentals of bioinformatics, including biological databases and sequence analysis.

LO 1.1: Demonstrate a comprehensive understanding of the fundamentals of bioinformatics, including the role and importance of biological databases.

LO 1.2: Identify and utilize key bioinformatics tools for analyzing sequence and structure databases.

LO 1.3: Apply basic bioinformatics tools to effectively manage and interpret biological data.

CO2: Apply scoring matrices (PAM, BLOSUM) and distinguish between different types of homologues (orthologues, paralogues, xenologues).

LO 2.1: Apply scoring matrices (PAM, BLOSUM) to analyze sequence data and differentiate between various types of homologues (orthologues, paralogues, xenologues).

LO 2.2: Demonstrate a thorough understanding of sequence similarity, identity, and homology, along with the definitions and distinctions among homologues, orthologues, paralogues, and xenologues.

LO 2.3: Utilize scoring matrices (PAM, BLOSUM) effectively for both nucleic acid and protein sequences, demonstrating proficiency in selecting and applying the appropriate matrix for a given analysis.

CO3: Perform pairwise sequence alignments using dynamic programming (Needleman-Wunsch, Smith-Waterman) and interpret results.

LO 3.1: Demonstrate the ability to perform pairwise sequence alignments using dynamic programming algorithms, including Needleman-Wunsch and Smith-Waterman, to compare biological sequences effectively.

LO 3.2: Interpret alignment results by understanding the concepts of global and local alignment, scoring matrices, gap penalties, and significance scores, and apply this knowledge to evaluate sequence similarities and differences.

LO 3.3: Utilize bioinformatics tools such as EVD, FASTA, and BLAST algorithms to conduct pairwise sequence alignments, demonstrating a practical understanding of sequence analysis techniques.

CO4: Apply multiple sequence alignment (MSA) techniques, such as CLUSTALW, to conduct evolutionary analysis.

LO 4.1: Demonstrate the ability to apply various MSA methods, including CLUSTALW, PILEUP, and iterative methods, for aligning multiple sequences.

LO 4.2: Evaluate the quality of alignments to make informed decisions in evolutionary analysis.

LO 4.3: Apply advanced MSA techniques, such as profile and block analysis, pattern searching, and algorithms like MEME and Gibbs Sampler, for detailed evolutionary and functional analysis of biological sequences.

CO5: Analyze biological data using Hidden Markov Models (HMMs) for gene finding and multiple sequence alignment, demonstrating proficiency in advanced bioinformatics techniques.

LO 5.1: Implement the use of HMMs for gene finding, including the development of training sets and prediction of CpG islands.

LO 5.2: Demonstrate proficiency in using HMMs for multiple sequence alignment, including techniques such as frequent words in DNA, consensus word analysis, and transaction and emission matrices.

LO 5.3: Gain the ability to analyze biological sequences using HMMs, particularly in the context of gene finding and multiple sequence alignment, to enhance understanding of genomic structures and functions.

CO6: Analyze information theory and implement algorithms such as FASTA and BLAST for the purpose of database searching and comparison in bioinformatics.

LO 6.1: Use algorithms like FASTA and BLAST effectively to search biological databases, interpret results, and compare sequences.

LO 6.2: Demonstrate proficiency in applying information theory concepts and database search algorithms to solve bioinformatics problems and analyze biological data.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge						
Conceptual Knowledge		CO1	CO2			
Procedural Knowledge			CO3, CO4	CO5, CO6		
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	3	3	2	1	3	1	3	2	1	1	2.0
CO2	3	3	2	1	2	1	2	2	1	1	1.8
CO3	3	3	1	1	2	1	2	2	1	1	1.7
CO4	2	2	1	1	2	1	2	2	1	1	1.5
CO5	3	3	3	2	3	2	3	2	1	1	2.3
CO6	2	3	2	2	2	2	3	2	1	1	2.0
Average	2.7	2.8	1.8	1.3	2.3	1.3	2.5	2.0	1.0	1.0	

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**FUNDAMENTALS OF BIOINFORMATICS**					
Category	Minor	Year	3	Credits	4	Course code	**BTNM05**
		Semester	**V**				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		30		**15**		**30**	**75**

Course Outline

Unit 1: Biological Databases **Marks 15 L:7, T:3, P:6**

Fundamentals of Bioinformatics, Biological Databases and Tools: Sequence and Structure Databases, Basic Bioinformatics Tools.

Practical:

a) Perform biological database searches and retrieve information.

Unit 2: Sequence Analysis and Alignment **Marks 15 L:8, T:4, P:8**

Sequence Analysis: Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues. **Scoring matrices:** Basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences (PAM and BLOSUM), **Sequence alignment:** Basic concepts of sequence alignment, Uses of Sequence Alignment.

Practical

a) Build PAM and BLOSUM matrices.
b) Perform a database search using tools like BLAST or FASTA.

Unit 3: Pairwise Sequence Alignment **Marks 15 L:8, T:4, P:8**

Concept of Global and Local Alignment, Dot matrix method, Dynamic programming (Needleman-Wunsch algorithm, Smith-Waterman algorithm, Choosing of best scoring matrix, gap penalties, Significance of score, EVD, FASTA and BLAST algorithms, Information theory and Shanon Entropy.

Practical

a) Perform pairwise sequence alignments using online tools or software like EMBOSS.
b) Interpret alignment results to understand sequence similarity and identify conserved regions.

Unit 4: Multiple Sequence alignment **Marks 15 L:7, T:4, P:8**

Multiple Sequence Alignment methods (MSA), Scoring of a MSA, Progressive (CLUSTALW and PILEUP), Iterative (Genetic) and Hidden Markov Model (HMM) methods of MSA, Local MSA
(Profile and BLOCK analysis, and Pattern searching, and Expectation Maximization (EM) Algorithm (MEME) and Gibbs Sampler.

Practical

a) Use tools like CLUSTALW or MUSCLE to perform multiple sequence alignments.
b) Compare and analyze the results to understand evolutionary relationships and conserved regions.

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

Suggested Readings

1. Cynthia Gibas, Per Jambeck**.** Developing Bioinformatics Computer Skills, O'Reilly

2. Dan E. Krane 2003. Fundamental Concepts of Bioinformatics. Pearson Education India

3. Stanley. LetovskyBioinformatics: Databases and Systems, Springer

4. David W. Mount**.** Bioinformatics: Sequence and Genome Analysis, Published CSHL Press

5. Des Higgins, Willie R. Taylor**.** *Bioinformatics*: Sequence, Structure and Databanks: *A Practical Approach*, Oxford University Press.

6. Higgs, P. G. & Attwood, T. K. 2005. Bioinformatics and Molecular Evolution. Blackwell Science. Distributed by Ane Books, New Delhi.

7. Stekel, D. 2003. Microarray Bioinformatics. Cambridge University Press. London.

8. Xu, J. & Zhang. 2004. Current Topics in Computational Molecular Biology. MIT Press. Distributed by Ane Books, New Delhi.

9. Jones. 2004. Introduction to Bioinformatics Algorithms. Ane Books, India.

10. Wang. 2005. Data Mining in Bioinformatics. Ane Books, India.

11. Hall. 2004. Phylogenetic Trees Made Easy. W H Freeman & Co. USA.

12. Felsenstein. 2003. Inferring Phylogenies. W H Freeman & Co. USA.

NAME OF THE COURSE	**:**	**HUMAN DISEASE AND DISORDER**
COURSE TYPE	**:**	**MAJOR**
TOTAL CREDIT	**:**	**4**
TOTAL MARKS	**:**	**60 (End Sem) + 40 (In Sem)**

Course description: This course will provide a comprehensive knowledge of diseases, their mode of transmission, and prevention strategies. Students will be able to describe the transmission cycle of diseases and the roles of agents, hosts, vectors, and their interactions in the outcome of a disease. The course will provide a description of the various communicable diseases such as cholera, HIV/AIDS, and malaria, and non-communicable diseases including cardiovascular diseases, diabetes, cancer etc. The students will be able to analyze the critical genetic factors that play a crucial role in development of prenatal and neonatal diseases.

Prerequisites:

- Basic knowledge of Host and pathogen
- Health and hygiene
- Disease transmission

Course Objectives: The objectives of this Course are to –

1. Decipher knowledge for ecology and natural of a disease
2. Decipher origin of disease in a population with a known etiology
3. Understand the causation of a disease with specific purpose for formulation and selection/rejection of hypothesis, survey.
4. Understand the components of Nutrition and Health.
5. Understand the management of biomedical waste

COURSE OUTCOME (CO): On completion of this Course, students will be able to –

CO1: Understand the concepts of hosts, vectors and pathogen in the transmission cycle of disease, including role of environment in disease outcome.

LO 1.1: Understand the concept of host, vector and pathogen in disease implications

LO 1.2: Demonstrate the factors that contribute to the origin and transmission of infectious diseases.

LO 1.2: Analyze the virulence of a pathogen and its implications in severity of a disease.

CO2: Identify the etiological factors, signs and symptoms, control and prevention of communicable diseases

LO2.1: Explain the role of vectors in disease transmission

LO2.2: Identify the mechanisms of transmission of various communicable diseases, including contact-dependent, airborne, vector-borne transmission, etc.

LO2.3: Apply the cumulative knowledge of mode of transmission and signs and symptoms of an infection in identifying the cause of diseases and appropriate measures to be taken for treatment and prevention.

CO3: Apply and the risk factors and etiological factors, associated with non-communicable diseases

LO3.1: Explain the complex role of genes, environment, and lifestyle factors in outcome of non-communicable diseases.

LO3.2: Identify the risk factors of communicable diseases and their implications in disease outcome

LO3.3: Apply the impact of risk factors in disease severity

CO4: Analyze the critical factors associated with etiological factors of Prenatal disease/ Neonatal Disease.

LO4.1: Demonstrate the genetic factors responsible for the causation of prenatal and neonatal diseases

LO4.2: Identify the risk factors associated with maternal health on the outcome of prenatal and neonatal diseases

LO4.3: Analyze the critical factors associated with prenatal and neonatal disease outcomes and strategies for prevention

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO1					
Conceptual Knowledge		CO2				
Procedural Knowledge			CO3	CO4		
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1.5**
CO2	**2**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**1**	**1.8**
CO3	**1**	**2**	**3**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1.4**
CO4	**1**	**2**	**2**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1.4**
Average	**1.75**	**2.25**	**2.25**	**1.75**	**1.5**	**1.25**	**1**	**1**	**1.5**	**1**	

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the Course		**HUMAN DISEASE AND DISORDER**					
Category:	Major	Year	**3**	Credits	4	Course	**BTNC12**
		Semester	**VI**				
Instructional hours		Lecture		Tutorial	Lab Practical		Total
		30		**15**	**30**		**75**

Course Outline

Unit 1: Disease and disease transmission **Marks:15, L:8, T:4**

Introduction to the transmission cycle of disease, Agent, Environment, Host, Vector, Pathogen, Categories, Carriers, pathogenic organisms and their characteristics.

Unit 2: Introduction to Communicable diseases (Etiological factors signs and symptoms, control and prevention) **Marks:15, L:7, T:4, P:10**

Acute diarrheal diseases, - Cholera, - Typhoid fever (Enteric fever), - HIV/AIDS, - Leprosy, - Malaria, - Filaria, - Dengue, - Japanese Encephalitis, Hepatitis
Introduction to Viral, Rickettsial, Bacterial and Parasitic Zoonosis

Practical
Demonstration and identification of causative organism of various diseases by microscopy

Unit 3: Introduction to non-communicable diseases (Etiological factors signs and symptoms, control and prevention) **Marks:15, L:8, T:4, P:10**

Cardiovascular Diseases: - Rheumatic Heart Disease, - coronary artery disease - Hypertension, Cancer

Practical
Demonstration of arterial blood pressure measurement

Unit 4: Prenatal disease/ Neonatal Disease **Marks:15, L:7, T:3, P:10**

Down Syndrome, CML & AML, Sickle Cell Anemia, Thalassemia

Practical: Differentiation of normal and abnormal blood cells

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Nelson, D.L., Cox, M.M. (2021) Lehninger Principles of Biochemistry, 8th Edition, WH Freeman and Company, New York, USA.

2. Jeremy Berg; Gregory Gatto Jr.; Justin Hines; John L. Tymoczko; Lubert Stryer, Tenth Edition, 2023, W.H Freeman and Co.
3. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons
5. Victor W. Rodwell, David Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil (2018). Harper's Illustrated Biochemistry, 31st Edition, McGraw Hill / Medical

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

NAME OF THE COURSE : BIO-ENTREPRENEURSHIP AND COMMERCIALIZATION
COURSE TYPE : MAJOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: This course provides an immersive exploration of biotechnology entrepreneurship. Students will gain insights into industry basics, financial skills, startup strategies, and funding insights.

Prerequisites

- Interest in entrepreneurship and innovation.
- Openness to experiential learning and field visits.

Course Objectives: By studying this course, the students will be able to

- Understand biotech industry pathways, entrepreneurship, accounting basics, valuation, exit strategies, intellectual property, clinical trials, corporate structures, funding processes.
- Apply Lean Launchpad, conduct surveys, evaluate valuations, develop exit strategies, classify intellectual property, design trials, manage ownership, prepare funding proposals.
- Foster innovation, proactive commercialization, strategic financial management, appreciation for IP, ethical clinical research, entrepreneurship, risk-taking, resilience in funding.

Course Outcomes (COs): On completion of this Course, students will be able to –

CO1: Understand the Biotechnology Industry and its Commercialization Pathways

LO 1.1: Analyze and compare the commercialization pathways for drug, medical device, and diagnostic companies within the biotechnology industry.

LO 1.2: Evaluate the role of entrepreneurship and intrapreneurship in biotechnology.

LO 1.3: Apply the Lean Launchpad (LLP) methodology to biotechnology ventures.

LO 1.4: Conduct a Commercialization Knowledge Survey (CKS) to assess understanding of commercialization strategies.

CO2: Apply Business Basics to Biotechnology Ventures

LO 2.1: Interpret financial statements and understand their significance in biotechnology ventures.

LO 2.2: Perform valuation of biotechnology companies and products.

LO2 .3: Evaluate different exit strategies and their implications for biotechnology startups.

CO3: Develop Skills for Starting a Biotechnology Startup

LO 3.1: Understand various corporate structures and their suitability for biotechnology startups.

LO 3.2: Explain concepts of ownership and vesting in the context of biotechnology startups.

LO 3.3: Implement customer development strategies as part of the LLP check-in process.

LO 3.4: Identify and access different funding sources for biotechnology startups, including crowdfunding.

CO4: Gain Practical Experience through Experiential Learning

LO 4.1: Participate in field visits to biotechnology startups to gain firsthand experience of the industry.

LO 4.2: Reflect on the experiential learning process and its impact on understanding biotechnology entrepreneurship.

LO 4.3: Create a mini-project on Biotechnology startup.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge		CO1				
Conceptual Knowledge				CO2		
Procedural Knowledge						CO3
Metacognitive Knowledge						CO4

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	-	2	1	1	-	3	1	1	2	1	1.5
CO2	1	2	1	1	1	3	1	1	2	1	1.4
CO3	1	2	1	1	1	3	1	1	2	1	1.4
CO4	1	1	1	1	3	1	2	1	1	1	1.3
Average	1.0	1.8	1.0	1.0	1.7	2.5	1.3	1.0	1.8	1.0	

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**BIO-ENTREPRENEURSHIP AND COMMERCIALIZATION**					
Category	**Major**	Year	3	Credits	4	Course code	**BTNC13**
		Semester	**VI**				
Instructional hours		Lecture		Tutorial		Practical	Total
		36		**9**		**30**	**75**

Course Outline

Unit 1: Introduction **Marks 15 L: 9, T: 3**

1.1 Introduction and Overview of the Biotechnology Industry
1.2 Translational biotechnology industry overview (include the commercialization pathways for drug, medical device, diagnostic companies)
1.3 Entrepreneurship/intrepreneurship,
1.4 Lean Launchpad (LLP) methodology
1.5 Commercialization Knowledge Survey (CKS)

Unit 2: Business Basics **Marks 18 L: 11, T: 3**

2.1 Accounting basics (financial statements)
2.2 Valuation (What's that company worth?)
2.3 Exit strategies (How do I get my ROI?)

Unit 3: How to start a Startup **Marks 15 L: 10, T: 3**

3.1 Corporate structure (LLC, LLP, C-Corp, S-Corp, etc.)
3.2 Ownership/vesting
3.3 LLP check in (customer development)
3.4 Funding: the funding process, funding sources, Crowd funding

Unit 4: Experiential Learning **Marks 12 L: 6, P: 30**

4.1 Case Study
4.2 Field visits to some of the Biotechnology related startups
4.3 Prepare a mini project on Biotechnology startup

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Field visit
   b) Group discussion
   c) Seminar/Presentation
3. Mini project on Biotechnological Startup **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

Suggested Readings

1. Steve Blank and Bob Dorf: The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company. K & S Ranch. ISBN-13: 978-0984999309

2. Craig Shimasaki, ed.: Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Elsevier Inc., 2014. ISBN: 978-0-12-404730-3. Reading list is noted within course schedule.

3. Lawton Robert Burns: The Business of Healthcare Innovation. Cambridge University Press, Cambridge UK, 2005

4. Burrill & Company Annual Biotechnology Industry Report

5. William B. Bygrave and Andrew Zacharakis, 2009. The Portable MBA in Entrepreneurship. Wiley & Sons, Hoboken, NJ.

6. Jeffrey A. Timmons, Andrew Zacharakis, Stephen Spinelli, 2004. Business Plans That Work: A Guide for Small Business. McGraw Hill.

NAME OF THE COURSE	**:**	**GENOMICS AND PROTEOMICS**
COURSE TYPE	**:**	**MAJOR**
TOTAL CREDIT	**:**	**4**
TOTAL MARKS	**:**	**60 (End Sem) + 40 (In Sem)**

Course Description: This course covers the fields of genomics and proteomics with a global OMICS approach. Genome sequences, protein structures, functions and relevant metabolic pathways are evaluated with computational data. Topics covered include introduction to various widely used bioinformatics databases, mapping and sequencing techniques. Students gain hands-on experience in comparison of different genomes. Current technologies covering different Next Generation Sequencing (NGS) platforms are studied. Transcriptomics is covered in parallel. Contemporary topics such as cancer genomics, epigenomics, pharmacogenomics, microbiome and genome editing are studied.

Pre requisite

- Knowledge of Basis Biochemistry
- Basic knowledge of cell biology

COURSE OBJECTIVES: The Objectives of this Course are to

- Knowledge on techniques of Genome and Proteome research.
- Understand the prokaryotic and eukaryotic genome constitution
- Underpin the contemporary genome analysis techniques
- Understand contemporary genome sequencing principle and working methodology.
- Understand the various regular, contemporary and high throughput proteomic and genomic tools, their underlying principles and varied applications.
- Understand the protein sequencing and identification techniques and explore its myriad scope and applications

COURSE OUTCOME (CO): The objectives of this Course are to

CO1: Examine of genomics and proteomics application in biological research can benefit in solving the complex biological and biochemical processes regardless of the type of organism which is the model for them.

LO 1.1: Defining prokaryotic and eukaryotic Nucleic Acid Extraction methods
LO 1.2: Demonstrate the Tools and Techniques in Genomics analysis
LO 1.3: Analyze the different mode and methods of DNA extraction.

CO2: Assessment of Protein identification and interaction technique.

LO 2.1: Defining the tools and techniques of Protein identification.
LO 2.2: Demonstrate the methods of Protein identification.
LO 2.3: Evaluation of protein and peptide sequence determination.

CO3: Assessment of Genome sequencing projects

LO 3.1: Defining the contemporary genome sequencing principles.
LO 3.2: Discuss the Principle and methodology of genome sequencing
LO 3.3: Evaluation of sequencing methods

CO4: Assessment of Scope, prospects and challenges of Proteomic and Genomics studies

LO 3.1: Defining the of Scope, prospects and challenges of Proteomic and Genomics studies
LO 3.2: Discuss the High Throughput protein functional analysis
LO 3.3: Evaluation of Application of Proteomic and Genomics in Gene Expression

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge						
Conceptual Knowledge				CO1	CO2	
Procedural Knowledge					CO3, CO4	
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	3	2	1	1	2	1	3	-	1	1	1.7
CO2	2	2	1	-	3	1	3	-	1	1	1.8
CO3	3	2	1	-	3	-	3	-	1	1	2.0
CO4	2	2	1	1	3	-	2	1	1	1	1.6
Average	2.5	2.0	1.0	1.0	2.8	1.0	2.8	1.0	1.0	1.0	

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**GENOMICS AND PROTEOMICS**					
Category	Major	Year	**3**	Credits	4	Course code	**BTNC14**
		Semester	**VI**				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		30		**15**		**30**	**75**

Course Outline

Marks: 15, L:8,T4,P:15

Unit 1: Structural organization of the Genome: Overview of Prokaryote genome and Eukaryotic nuclear genome, Extra-chromosomal DNA: bacterial plasmids, Eukaryotic organelles genomes (Mitochondria and Chloroplast).

Practical

a) Demonstration of Prokaryotic and Eukaryotic Nucleic acid extraction.

Marks: 15, L:7,T4,P:15

Unit 2: Protein identification and interaction: Peptide sequence determination; Protein identification: Tandem Mass-spectrometer, peptide mass fingerprinting, protein interaction: genetic test, yeast 2-hybrid system, co-immunoprecipitation , Affinity chromatography, FRET, SPR.

Practical

a) Demonstration of protein estimation and quantification

Marks: 15, L:7,T4

Unit 3: Genome Sequencing projects: Principle and methodology of genome sequencing, Genome Sequencing projects: in microbes, plants, and animals Human Genome Project

Marks: 15, L:7,T4

Unit 4: Scope, prospects and challenges of Proteomic and Genomics studies: High Throughput protein functional analysis; Target discovery, interaction proteomics, Chemical Proteomics

Application of Proteomic and Genomics: Application of Proteomic and Genomics in Gene Expression, Protein discovery, Biomarker discovery, therapeutic management of disease.

Where ***L: Lectures*** ***T: Tutorials*** ***P: Practical***

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS

1. Alberts, B., Bray, D., Levis, J., Raff, M., Roberts, K., Watson, J.D. (1994) Molecular Biology of the Cell, Garland Publishing, New York. 5 NCBI web page Kellner R., Lottspeich F, Meyer H.E. 1999
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
4. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.
6. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
7. Micro-characterization of Proteins, WILEY-VCH second edition
8. Schägger H. 2006 Tricine-SDS-PAGE, Nature Protocols Vol. 1. No.1 16-22 Wittig I., Braun H.-P.

9. Schägger H. 2006 Blue native PAGE, Nature Protocols Vol. 1. No.1 418-428. E. De Hoffman, V.
10. Stroobant, 2002 Mass Spectrometry Principle and Applications, Wiley, Chichester, 239- 275. A. J. R. Heck, R. H.H. van den Heuvel, 2004 Mass Spectrom
11. Bengt Nolting 2004 Methods in modern Biophysics. Springer-verlag

NAME OF THE COURSE	**:**	**FUNDAMENTALS OF PROGRAMMING**
COURSE TYPE	**:**	**MAJOR**
TOTAL CREDIT	**:**	**4**
TOTAL MARKS	**:**	**60 (End Sem) + 40 (In Sem)**

Course Description: This fundamental course in programming is designed for undergraduate students, providing an essential gateway to programming knowledge. It aims to develop a foundational understanding of the principles and concepts of programming languages. Students will gain basic proficiency in programming, learning fundamental concepts such as variables, data structures, loops, and functions. Additionally, the course will focus on developing skills in devising algorithms to solve problems specifically related to biological sciences. Through a combination of lectures, tutorials, and practical exercises, students will build a solid base in programming, enabling them to tackle computational challenges in their field.

Prerequisites

There are no formal prerequisites for this course. It is designed for undergraduate students with no prior experience in programming or computer science. The only requirements are an interest in biological sciences and a willingness to learn programming concepts. Basic mathematical skills and familiarity with high school-level biology will be beneficial but are not mandatory.

COURSE OBJECTIVES: The objectives of this Course are to -

- Develop a foundational understanding of the principles and concepts of programming languages.
- Gain basic proficiency in programming language, including fundamental programming concepts such as variables, data structures, loops, and functions.
- Develop skills in devising algorithm to solve problems related to biological sciences.

Course Outcomes (CO): On completion of this Course, students will be able to –

CO 1: Understand the fundamental concepts and principles of programming, including types of programming languages, applications of programming, and basic algorithms**.**

- LO 1.1: Comprehend the scope, significance, and applications of programming in various fields.
- LO 1.2: Identify and differentiate between various types of programming languages (e.g., procedural, object-oriented, functional) and understand their uses.
- LO 1.3: Understand the practical applications of programming in solving real-world problems.
- LO 1.4: Understand basic algorithms and write simple programs.

CO 2: Gain proficiency in C programming language, including the use of constants, variables, data types, operators, expressions, and control constructs**.**

- LO 2.1: Understand and use constants and variables in C programming.
- LO 2.2: Use and manipulate various data types in C.
- LO 2.3: Apply operators and expressions in C programs.
- LO 2.4: Manage input and output operations in C.
- LO 2.5: Implement decision-making constructs like if-else and switch-case in C.
- LO 2.6: Use looping constructs (for, while, do-while) in C programs.

CO 3: Develop skills in handling arrays and strings in C, enabling effective data manipulation and storage**.**

- LO 3.1: Declare, initialize, and manipulate character arrays and strings.
- LO 3.2: Use string handling functions in C programs.
- LO 3.3: Understand and implement single-dimensional and multi-dimensional arrays in C.

CO 4: Understand advanced programming concepts in C, including pointers, file handling, and the use of functions**.**

- LO 4.1: Understand and use pointers in C.
- LO 4.2: Perform file handling operations (open, close, read, write) in C.
- LO 4.3: Create and use functions with arrays and loops in C.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO1					
Conceptual Knowledge		CO2		CO4		
Procedural Knowledge			CO3			
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	**1**	**2**	**2**	**2**	**1**	**1**	**2**	**1**	**2**	**1**	**1.5**
CO2	**1**	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**1.3**
CO3	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1.1**
CO4	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1.1**
Average	**1**	**2**	**1.25**	**1.5**	**1**	**1**	**1.5**	**1**	**1.25**	**1**	**1.25**

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**FUNDAMENTALS OF PROGRAMMING**					
Category	Major	Year	**3**	Credits	4	Course code	**BTNC15**
		Semester	**VI**				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		37		**08**		**30**	**75**

Course Outline

Marks: 15, L:6, P:0

Unit 1: Introduction to Programming, Types of programming language, Application of Programming, Algorithm and programming

Marks: 15, L: 8, T: 5, P: 10

Unit 2: Constants and Variables, Data Types, Operators and Expression, Managing input and output operations, Decision making and branching, Decision Making and Looping

Practical: Introduction to C programming language (Defining the syntax of C , Installing the C- compiler), Programs to use if-else, nested if-else, switch-case constructs , Programs to test looping constructs for, while and do-while (sum of n numbers, max of n numbers, fibonacci series, amstrong number, prime number) , Programs to test nested loops(preferably number pyramids,); Program to test use arrays single dimensional, multi dimensional(3x3 matrix); Sum of series similar to X+X^2+X^3+...+x^n where x and n are given by user.

Marks: 15, L: 8, T: 5, P: 10

Unit 3: Character Array and Strings, Declaring and Initializing String Variables, String Handling Functions
Practical: Program in C to use string and array

Marks: 15, L: 8, T: 5, P:10

Unit 4: Pointers, File Handling and Functions
Practical: Program in C to use pointers, opening , closing and saving a file in C , Using functions with arrays and loop

Where L: Lectures T: Tutorials P: Practical

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. E.Balaguruswamy . Programming In ANSI C, 6th Edition 2012 Tata McGraw HilL
2. Byron Gottfried . PROGRAMMING WITH C, 3rd Edition 2010, Mcgraw Hill Education
3. Yaswant Karnetkar. Let Us C, 13th Edition 2012, BPB Publication
4. Yaswant Karnetkar. Data Structure Using C, 2nd Edition 2003 BPB Publications

NAME OF THE COURSE : BIOINFORMATICS TOOLS AND TECHNIQUES
COURSE TYPE : MINOR
TOTAL CREDIT : 4
TOTAL MARKS : 60 (End Sem) + 40 (In Sem)

Course Description: This course is tailored for undergraduate bioinformatics students, providing a comprehensive introduction to computer software and hardware. It aims to equip students with essential knowledge and skills in understanding and utilizing computer systems for bioinformatics applications. The course is structured into four units, covering fundamental concepts of computer hardware, operating systems, software applications, and practical computing skills. Through a combination of lectures, tutorials, and hands-on exercises, students will gain a solid foundation in computer technology relevant to their field.

Prerequisites

There are no formal prerequisites for this course. It is designed for undergraduate students with no prior experience in computer software and hardware. An interest in bioinformatics and a willingness to learn about computer technology are the only requirements. Basic mathematical skills and familiarity with high school-level biology will be beneficial but are not mandatory.

COURSE OBJECTIVES: The objectives of this Course are to -

- Recall and list the basic components of computer hardware and operating systems .
- Explain the functions and significance of computer hardware components and the essential processes of operating systems in the context of bioinformatics.
- Demonstrate the assembly and disassembly of computer hardware components and the installation/configuration of software applications necessary for bioinformatics tasks
- Differentiate between various types of computer architectures and operating systems, assessing their suitability and advantages for bioinformatics applications.

Course Outcomes (CO): On completion of this Course, students will be able to –

CO1: Understand the fundamentals of computer hardware.

- LO 1.1: Identify and describe the basic components of computer hardware.
- LO 1.2: Explain the function and importance of each hardware component.
- LO 1.3: Analyze the basic concepts of computer architecture and data processing.
- LO 1.4: Apply practical skills in assembling and disassembling computer parts.

CO2: Gain proficiency in operating systems and essential software applications for bioinformatics.

- LO 2.1: Describe different operating systems used in bioinformatics.
- LO 2.2: Explain the core functions and management processes of operating systems.
- LO 2.3: Install and configure essential software applications for bioinformatics tasks.
- LO 2.4: Utilize software applications like text editors, spreadsheets, and web browsers for bioinformatics purposes.

CO3: Develop proficiency in phylogenetic analysis for understanding evolutionary relationships.

- LO 1.1: Define phylogenetics and its significance in evolutionary biology.
- LO 1.2: Explain the principles behind phylogenetic trees and their representation of evolutionary relationships.
- LO 1.3: Compare and contrast different methods of phylogenetic analysis, including distance-based methods, maximum likelihood, and Bayesian inference.
- LO 1.4: Interpret phylogenetic trees and infer evolutionary patterns and relationships among species.

- LO 1.5: Install, configure, and utilize popular software packages for phylogenetic analysis, such as PHYLIP, RAxML, and MrBayes.
- LO 1.6: Apply phylogenetic analysis techniques to real biological data sets, constructing phylogenetic trees and analyzing their topology.
- LO 1.7: Critically evaluate the reliability of phylogenetic reconstructions and understand the limitations of phylogenetic analysis methods.
- LO 1.8: Participate in practical exercises to develop hands-on skills in phylogenetic analysis, collaborating with peers to solve analysis problems and interpret results.

CO4: Acquire practical computing skills for bioinformatics data management and analysis**.**

- LO 4.1: Implement data management and storage solutions for bioinformatics.
- LO 4.2: Explore bioinformatics tools and databases for data analysis.
- LO 4.3: Apply practical skills in data analysis and visualization for bioinformatics.
- LO 4.4: Engage in hands-on projects involving real bioinformatics data.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO1					
Conceptual Knowledge		CO2				
Procedural Knowledge			CO3	CO4		
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Average
CO1	-	-	-	-	**2**	-	**3**	**2**	-	-	**0.7**
CO2	**1**	-	-	**3**	**1**	-	**3**	**1**	-	-	**0.9**
CO3	-	-	-	**2**	**2**	-	-	**2**	-	-	**0.6**
CO4	-	-	-	-	**2**	-	**3**	**2**	-	-	**0.7**
Average	**0.25**	-	-	**1.25**	**1.75**	-	**2.25**	**1.75**	-	-	**0.72**

3 for highest correlation, 2 for medium correlation and 1 for lowest correlation

Biotechnology and Bioinformatics							*Dibrugarh University*
Title of the course		**BIOINFORMATICS TOOLS AND TECHNIQUES**					
Category	Minor	Year	**3**	Credits	4	Course code	**BTNM06**
		Semester	**VI**				
Instructional hours		Lecture		Tutorial		Lab Practical	Total
		37		**08**		**30**	**75**

Course Outline

Unit 1: Fundamentals of Computer Hardware **Marks: 15, L: 6, T: 2, P: 10**

i. Introduction to computer hardware components (CPU, memory, storage, I/O devices)
ii. Understanding the function and importance of each component, Basic concepts of computer architecture and data processing

Practical:

Assembling and disassembling computer parts

Unit 2: Operating Systems and Software Applications **Marks 15: L:6 T:2 P:10**

i. Overview of different operating systems (Windows, macOS, Linux)
ii. Functions and management of operating systems
iii. Introduction to essential software applications for bioinformatics

Unit 3: Introduction to Phylogenetics **Marks 15 L:8 T:2 P: 10**

i. Overview of phylogenetics and its importance in evolutionary biology.
ii. Understanding phylogenetic trees and their representation of evolutionary relationships.
iii. Concepts of common ancestry, speciation, and molecular evolution.
iv. Overview of genetic variation, mutation, and natural selection.
v. Introduction to different methods of phylogenetic analysis, including distance-based methods, maximum likelihood, and Bayesian inference.
vi. Understanding the principles and assumptions underlying each method.Overview of popular software packages used for phylogenetic analysis, such as PHYLIP, RAxML, and MrBayes.
vii. Hands-on experience with software installation and basic usage.

Practical:

a) Conducting phylogenetic analysis using software tools.
b) Building phylogenetic trees from molecular data.
c) Analyzing and interpreting phylogenetic trees to infer evolutionary relationships.

Unit 4: Practical Computing Skills for Bioinformatics **Marks 15 L:6 T: 2 P:10**

i. Data management and storage solutions
ii. Introduction to bioinformatics tools and databases
iii. Data analysis and visualization using Bioinformatics tool

Practical

a) Capstone project involving Bioinformatics data

Where ***L: Lectures*** ***T: Tutorials*** ***P: Practical***

Modes of In-Semester Assessment: **40 Marks**

1. One sessional test - **10 Marks**
2. Any one of the following activities listed below - **10 Marks**
   a) Assignment
   b) Group discussion
   c) Seminar/Presentation
   d) Multiple Choice Questions
3. Practical In semester Examination **20 Marks**

Attainment Strategies

- Feedback for each LO
- Activities

SUGGESTED READINGS:

1. Computer Organization and Design: The Hardware/Software Interface by David A. Patterson and John L. Hennessy, 5th Edition, Morgan Kaufmann - Comprehensive introduction to computer hardware and architecture.
2. Operating System Concepts by Abraham Silberschatz, Peter B. Galvin, and Greg Gagne, 10th Edition, Wiley - Thorough overview of operating systems, including their functions and management.
3. Bioinformatics: Sequence and Genome Analysis by David W. Mount, 2nd Edition, Cold Spring Harbor Laboratory Press - Covers essential bioinformatics tools and methods, including phylogenetic analysis.
4. Practical Computing for Biologists by Steven H.D. Haddock and Casey W. Dunn, 1st Edition, Sinauer Associates - Hands-on guide to programming, data management, and bioinformatics tools for biologists.
5. Phylogenetics: Theory and Practice of Phylogenetic Systematics by E.O. Wiley and Bruce S. Lieberman, 2nd Edition, Wiley-Blackwell - Detailed introduction to phylogenetics, including methods of analysis and practical applications.