SYLLABUS

DIBRUGARH UNIVERSITY

FYUGP

BIOTECHNOLOGY AND BIOINFORMATICS

PREAMBLE

Biotechnology and Bioinformatics are two fields of study that have revolutionized the way we approach and understand biological systems. Biotechnology is the application of scientific and engineering principles to the processing of materials by biological agents, to provide goods and services for human use. Bioinformatics, on the other hand, is the application of computational methods to the storage, analysis, and interpretation of biological data.

The integration of these two fields has resulted in significant advances in areas such as genetic engineering, drug discovery, and personalized medicine. Biotechnology and Bioinformatics have also played a crucial role in addressing global challenges, such as food and energy security, environmental sustainability, and the development of new diagnostic and therapeutic tools for diseases.

The Centre for Biotechnology and Bioinformatics, in accordance with the University Grants Commission's (UGC) recommendations and the proposed implementation by Dibrugarh University, is working towards incorporating the relevant elements of the New Education Policy (NEP) 2020 into the Four Year Under Graduate Program (FYUGP). When designing the fundamental structure of the Under Graduate (UG) program, the following factors were taken into consideration:

1. The ability to switch between different fields of study
2. The opportunity for learners to choose courses of interest across all disciplines
3. Flexible options for entry and exit with UG certificates, UG diplomas, or Bachelor's degrees depending on the credits earned
4. The possibility for students to transfer between institutions to participate in interdisciplinary learning
5. The ability to switch to alternative modes of learning
6. Providing the necessary knowledge and mindset for self-employment initiatives and entrepreneurship
7. Fostering the ability for complex critical thinking and solving real-life problems
8. Developing a capacity to comprehend global issues, cultural competency, and digital literacy
9. Equipping students with research skills, communication skills, community engagement, environmental awareness, responsibility, and accountability.

To ensure that the curriculum for Biotechnology and Bioinformatics at the undergraduate level remains relevant to contemporary society and modern practices, new components of learning have been integrated. The resulting Learning Outcome-based Curriculum Framework (LOCF) for Biotechnology and Bioinformatics, as well as the FYUGP, is expected to be

highly valuable to prospective graduates interested in Biotechnology, Bioinformatics, and Applied Biological Sciences as a whole.

The curriculum for Biotechnology and Bioinformatics aims to improve students' skills, making them more versatile and adaptable, which will in turn enhance their employability. Additionally, the discipline will aid in shaping students' personalities to enable them to confront the challenges of a competitive society, and in doing so, promote the development of bio-entrepreneurs and enhance capacity-building efforts. Moreover, the curriculum's incremental learning experiences will benefit students from a wide range of backgrounds, providing opportunities to develop individual potential and produce a pool of better-trained professionals each year.

INTRODUCTION

Higher Education is a vital component of India's development and growth strategy, as it is considered critical to the country's progress. As per the New Education Policy (NEP) 2020, the focus of Higher Education should be on identifying and nurturing each student's unique strengths by educating teachers and parents about the need to encourage holistic development in both curricular and co-curricular areas. The curriculum should be flexible enough to allow students to choose their own learning paths and programs based on their talents and interests, enabling them to make informed life choices. To promote unity and integrity of all knowledge in a pluralistic world, there should be an emphasis on multidisciplinary and comprehensive education in the sciences, social sciences, arts, humanities, and sports.

Biotechnology and Bioinformatics as a discipline encompasses various disciplines, including biology, computer science, mathematics, chemistry, and engineering, to tackle intricate biological issues. This interdisciplinary domain utilizes technology and computational approaches to examine the complicated biological processes of living organisms. Students pursuing this field need to have a comprehensive skill set that includes fundamental knowledge of molecular biology and the ability to analyze vast datasets using computational methods, statistics, programming, genetics, biochemistry, and more. The multidisciplinary aspect of Biotechnology and Bioinformatics allows students to acquire a holistic understanding of biological systems and their operations, which is crucial for solving practical challenges.

The Under Graduate (UG) syllabus of Biotechnology and Bioinformatics in light of New Education Policy (NEP), 2020 consists of Major (Core) disciplines, Minor disciplines, Multi-Disciplinary Generic Elective Courses (MDGEC), Ability Enhancement Courses (AEC), Value Added Courses (VAC), Skill Enhancement Courses (SEC), Environmental Education (EE), YOGA, Community Based Engagement (NCC/NSS/Adult Education/Student Mentoring/NGO/Govt. institutions, etc.), Digital and Technological Solutions/Digital Fluency

(DTS/DF), Internship, Project, Research Ethics and Methodology, Research Project (Development of Project/Research Proposal, Review of related literature), Dissertation (Collection of Data, Analysis and Preparation of Report) and Discipline Specific Electives (DSE).

The UG degree programme offers certificates, diplomas and degrees as follows:

UG Certificate: Students who opt to exit after completion of the first year (Two Semesters) and have secured 44 credits will be awarded a UG certificate. These students are allowed to re-enter within three years and complete the degree programme within the stipulated maximum period of seven years.

Certificate course consists of two Major disciplines, two Minor disciplines, two MDGEC, two AEC, two VAC, two SEC, YOGA and Environmental Education with emphasis on community-basedactivities.

UG Diploma: Students who opt to exit after completion of the second year (Four Semesters) and have secured 88 credits will be awarded the UG diploma. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.

Diploma course consists of six Major disciplines, four Minor disciplines, three MDGEC, three AEC, two VAC, three SEC, YOGA, Environmental Education with emphasis on community-based activities and Digital and Technological Solutions/Digital Fluency and Community engagement.

3-year UG Degree: Students who wish to undergo a 3-year (Six Semesters) UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 132 credits.

3-year UG degree course consists of fourteen Major disciplines, six Minor disciplines, three MDGEC, three AEC, two VAC, three SEC, YOGA, Environmental Education with emphasis on community based activities, Digital and Technological Solutions/Digital Fluency, Community engagement, Internship and Project.

4-year UG Degree (Honours with Research): Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year (Two Semesters). They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students who secure 176 credits, including 12 credits from a research project/dissertation, are awarded UG Degree (Honours with Research).

4-year UG degree course consists of twenty Major disciplines, eight Minor disciplines, three MDGEC, three AEC, two VAC, three SEC, YOGA, Environmental Education with emphasis on communitybased activities, Digital and Technological Solutions/Digital Fluency, Community engagement, Internship, Project, Research Ethics and Methodology, Research Project or one DSE and Dissertation or two DSE.

UG Degree Programmes with Single Major: A student has to secure a minimum of 50% credits from the major discipline for the 3-year/4-year UG degree to be awarded a single major.

UG Degree Programmes with Double Major: A student has to secure a minimum of 40% credits from the second major discipline for the 3-year/4-year UG degree to be awarded a double major

Interdisciplinary UG Programmes: The credits for core courses shall be distributed among the constituent disciplines/subjects so as to get core competence in the interdisciplinary programme.

Multidisciplinary UG Programmes: In the case of students pursuing a multidisciplinary programme of study, the credits to core courses will be distributed among the broad disciplines such as Life sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc..

The statutory bodies of the Universities and Colleges such as the Board of Studies and Academic Council will decide on the list of courses under major category and credit distribution for double major, interdisciplinary and multidisciplinary programmes.

AIMS OF FOUR YEAR UNDER-GRADUATE PROGRAMME (FYUGP) IN BIOTECHNOLOGY AND BIOINFORMATICS:

1. The Four Year Under-Graduate Programme (FYUGP) in Biotechnology and Bioinformatics has several aims that are designed to prepare students for a career in the field and develop their understanding of the principles and applications of Biotechnology and Bioinformatics, and Applied Biological Sciences as a whole. The program aims to provide students with a comprehensive understanding of the fundamental principles of Biotechnology and Bioinformatics, including the latest advancements in the field. It also focuses on enabling students to develop critical thinking and problem-solving skills, which are essential for a successful career in this field.
2. Another aim of the FYUGP is to prepare students for a career in the field of Biotechnology and Bioinformatics by providing them with practical experience and exposure to the latest industry trends and practices. The program also aims to foster students' research skills and promote innovation and entrepreneurship in the field. This will help to create a pool of skilled professionals who can contribute to the growth and development of the Biotechnology and Bioinformatics industry.
3. In addition to these, the program aims to promote ethical and social responsibility among students, ensuring that they are aware of the impact their work can have on society and the environment. The program also focuses on developing students' communication skills, multicultural competence, and digital literacy, which are increasingly important in today's globalized world.
4. Ultimately, the goal of the FYUGP in Biotechnology and Bioinformatics is to produce competent and skilled professionals who can contribute to the growth and development of the Biotechnology and Bioinformatics industry in India and globally. By providing students with a well-rounded education that includes practical experience, research skills, and exposure to the latest industry trends, the program aims to prepare them for a successful career in this field.

- **GRADUATE ATTRIBUTES OF THE FYUGP IN BIOTECHNOLOGY AND BIOINFORMATICS**

The Four Year Under-Graduate Programme (FYUGP) in Biotechnology and Bioinformatics aims to produce graduates with a range of attributes that will enable them to succeed in their professional and personal lives. Some of the comprehensive graduate attributes of the FYUGP in Biotechnology and Bioinformatics are:

Knowledge and skills: Graduates of the FYUGP in Biotechnology and Bioinformatics are expected to have a strong foundation of knowledge and skills in the areas of Biotechnology, Bioinformatics, and Applied Biological Sciences. They should be able to apply this knowledge to solve complex biological problems and make informed decisions in their professional lives.

Critical thinking and problem-solving: Graduates should be able to think critically and creatively to identify, analyze, and solve problems related to Biotechnology and Bioinformatics. They should be able to evaluate information, make sound judgments, and communicate their findings effectively.

Research skills: Graduates should be equipped with research skills that will enable them to conduct independent research in the field of Biotechnology and Bioinformatics. They should be able to design experiments, analyze data, and interpret findings.

Innovation and entrepreneurship: Graduates should be innovative and entrepreneurial, with the ability to identify new opportunities and develop novel solutions to problems in the field of Biotechnology and Bioinformatics. They should be able to work in interdisciplinary teams and collaborate with others to bring their ideas to fruition.

Ethical and social responsibility: Graduates should be aware of the ethical and social implications of their work in the field of Biotechnology and Bioinformatics. They should be able to integrate ethical considerations into their decision-making and be socially responsible in their actions.

Communication and interpersonal skills: Graduates should have strong communication and interpersonal skills, with the ability to work effectively in a team, present their findings to different audiences, and engage in constructive dialogue with colleagues and stakeholders.

Multicultural competence and digital literacy: Graduates should be able to work effectively in a multicultural environment and demonstrate proficiency in digital literacy. They should be able to adapt to new technologies and communicate using digital media.

Overall, the FYUGP in Biotechnology and Bioinformatics aims to produce graduates who are well-rounded, competent, and skilled professionals with a deep understanding of the principles and applications of Biotechnology and Bioinformatics, and who are prepared to make meaningful contributions to the growth and development of the industry in India and globally.

- **PROGRAMME LEARNING OUTCOMES**

The Objectives of the Undergraduate Programme in Biotechnology and Bioinformatics are listed in the following. After completing the programme an undergraduate student in biotechnology and bioinformatics will be able to-

PO1: Demonstrate familiarity with the major concepts, theoretical perspectives and latest trends in the field of biotechnology and bioinformatics.

PO2: Apply Biotechnology and Bioinformatics as a tool to solve problems of other disciplines viz., Natural Sciences, Commerce and Management, Humanities, Soft-computing etc.

PO3: Develop new techniques/methods for solving the unsolved problems in terms of global welfare.

PO4: Use scientific approach to address issues related to problems of learning

Teaching Learning Process

The programme allows to use varied pedagogical methods and techniques both within classroom and beyond.

- Lecture
- Tutorial
- Power point presentation
- Project Work/Dissertation
- Group Discussion and debate
- Seminars/workshops/conferences
- Field visits and Report/Excursions
- Mentor/Mentee

Teaching Leaning Tools

- Projector
- Smart Television for Documentary related topic
- LCD Monitor
- WLAN
- White/Green/Black Board

Assessment

- Home assignment
- Project Report
- Class Presentation: Oral/Poster/Power point
- Group Discussions
- In semester examinations
- End Semester examinations

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FYUGP Structure as per UGC Credit Framework of December, 2022

Year	Semester	Course	Title of the Course: B.Sc. in Biotechnology and Bioinformatics	Total Credit
Year 01	1st Semester	C - 1	Fundamentals of Biochemistry	4
		Minor 1	Biochemistry and Bio-instrumentation	4
		GEC - 1	IPR, Biosafety and Bioethics	3
		AEC 1	Modern Indian Language	4
		VAC 1	Understanding India	2
		VAC 2	Health and Wellness	2
		SEC 1	Good Lab Practices	3
				22
	2nd Semester	C - 2	Molecular Basis of Cell Biology	4
		Minor 2	Cell Biology and Microbiology	4
		GEC 2	Biological Database Design	3
		AEC 2	English Language and Communication Skills	4
		VAC 3	Environmental Science	2
		VAC 4	Yoga Education	2
		SEC 2	Vermicomposting	3
				22
The students on exit shall be awarded Undergraduate Certificate (in the Field of Study/Discipline) after securing the requisite 44 Credits in Semester 1 and 2 provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill based courses earned during 1st and 2nd Semester				
Year 02	3rd Semester	C - 3	Fundamentals of Microbiology	4
		C - 4	Molecular Biology	4
		Minor 3	Genetics and Biostatistics	4
		GEC – 3	Biotechnology and Human Welfare	3
		VAC 3	Digital and Technological Solutions / Digital Fluency	2
		AEC – 3	Communicative English / Mathematical Ability	2
		SEC – 3	Mushroom Cultivation	3
				22

Abbreviations Used:

- **C = Major**
- **GEC = Generic Elective Course / Multi Disciplinary Course**
- **AEC = Ability Enhancement Course**
- **SEC = Skill Enhancement Course**
- **VAC = Value Added Course**

B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**FUNDAMENTALS OF BIOCHEMISTRY**
Course Code	**:**	**BTNC1**
Nature of the Course	**:**	**Major**
Total Credits	**:**	**04 = 3 (Theory)+ 1(Practical)**
Distribution of Marks	**:**	**80 (End Sem) + 20 (In-Sem)**
		End Sem: 60(Theory) + 20 (Practical)

COURSE OBJECTIVES:

- To identify the basic the structure and function of biomolecules, their chemical and physical properties and catalysis.
- To explain the biological catalysts, their mechanisms of action, kinetics and provides an overview of the major metabolic pathways.
- To analyze the role of enzymes in the various metabolism in-vivo.

UNITS	CONTENTS	L	T	P	Total Hours
1 (12 Marks)	**FUNDAMENTALS OF BIOCHEMISTRY:** 1.1 Physical, chemical, 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.	07	1	-	08
2 (15 Marks)	**INTRODUCTION TO BIOMOLECULES:** **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, cerebrocides, steroids, bile acids, prostaglandins, lipoproteins, proteolipids, phosphatidopeptides, lipopolysaccharides	09	01	-	10
3 (18 Marks)	**INTRODUCTION TO ENZYMES:** **3.1** General characteristics, nomenclature, IUB enzyme classification, biological roles, measurement and expression of enzyme activity, enzyme assay. Definitions of IU, Katal, enzyme turnover and specific activity. Allosterism & Allosteric enzymes, Isoenzymes with	13	1	-	14

	special reference to lactate dehydrogenase, 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.				
4 (15 Marks)	**METABOLISM:** **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	12	1	-	13

5 (20 Marks)	**PRACTICAL** **5.1.** Numerical problems based on the preparation of standard solutions of different molarity, normality, strength and percentage. **5.2.** Isolation and purification of enzyme from microbial/ plant/ animal source **5.3.** Assay of enzyme activity: Time dependence of enzyme catalysed reaction. **5.4.** Effect of pH and temperature and substrate concentration on the rate of enzymatic reaction. **5.5.** Inhibition of enzyme activity and Determination of Ki. **5.6.** Estimation of proteins by Lowry and Bradford assays. **5.7.** Estimation of total carbohydrates by Anthrone method. **5.8.** Quantification of reducing sugars by Dinitrosalicylic acid method. **5.9.** Estimation of DNA by diphenylamine method. **5.10.** Quantification of RNA by orcinol method.	-	-	30	30
	Total	**41**	**04**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Comprehend the role and significance of biomolecules and is anticipated to develop an understanding of working of enzyme.
- In addition, the student is expected to develop an understanding of biochemical pathways and theirsignificance in the sustenance of life.

SUGGESTED READINGS:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition, W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman andCompany, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

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B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**BIOCHEMISTRY AND BIOINSTRUMENTATION**
Course Code	**:**	**MINBTN1**
Nature of the Course	**:**	**Minor Course**
Total Credits	**:**	**04 = 3 (Theory)+ 1(Practical)**
Distribution of Marks	**:**	**80(End Sem) + 20 (In-Sem)**
		End Sem: 60(Theory) + 20 (Practical)

COURSE OBJECTIVES:

1. The course is designed to provide an insight into the structure and function of biomolecules, their chemical andphysical properties and catalysis.
2. The course introduces the students to working principles of various instruments used in biological analytical purposes.

UNITS	CONTENTS	L	T	P	Total Hours
1 (18 Marks)	**1.1** Structure of atoms, molecules and chemical bonds. **1.2** Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). **1.3** Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). **1.4** Fundamentals of thermodynamic principles applicable to biological processes. **1.5** Significance of water in biochemistry; acid-base concept, buffers, pH and pK. **1.6** Hydrogen bonding, hydrophobic, electrostatic and Van der Waals interactions. **1.7** Energy rich compounds- sources and utilization.	11	01	-	12
2 (12 Marks)	**2.1** Introduction to enzymes: nomenclature, classification, mechanisms and biological roles. **2.2** Carbohydrate metabolism	09	01	-	10
3 (15 Marks)	**3.1 Biophysical Method:** 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.	12	01	-	13
4 (15 Marks)	**4.1 Separation technique:** Chromatography: Principle, types and applications of different chromatographic methods. Partition and Adsorption chromatography, Ion-exchange chromatography, Size exclusion and affinity chromatography. **4.2 Electrophoresis:** Theory, instrumentation and applications. Native PAGE, SDS PAGE, Agarose gel electrophoresis. Centrifugation: Working principle, types and applications	09	01	-	10
5 (20 Marks)	**PRACTICALS** **5.1** Numerical problems based on the preparation of standard solutions of different molarity, normality, strength and percentage.	-	-	30	30

	5.2 Estimation of proteins by Lowry and Bradford assays. **5.3** Estimation of total carbohydrates by Anthrone method. **5.4** Quantification of reducing sugars by Dinitrosalicylic acid method. **5.5** Estimation of DNA by diphenylamine method. **5.6** Quantification of RNA by orcinol method				
	Total	**41**	**04**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

LEARNING OUTCOMES:

- Students will be able to understand the structure and function of biomolecules, their chemical andphysical properties and catalysis.
- Students will be able to understand the working principles of various instruments used in biological analytical purposes.

SUGGESTED READINGS:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition, W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman andCompany, New York, USA.

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B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**IPR, BIOSAFETY AND BIOETHICS**
]Course Code	**:**	**GECBTN1**
Nature of the Course	**:**	**Generic Elective Course**
Total Credits	**:**	**03**
Distribution of Marks	**:**	**80(End Sem) + 20 (In-Sem)**

COURSE OBJECTIVES:

1. This subject aims to introduce students to Intellectual Property Rights and apprise them of ethical issues in the biological sciences and the laws pertaining to these in both the global and national context.
2. This course would help students to adhere to the ethical practices appropriate to the various scientific disciplines at all times and to adopt safe working practices relevant to the different biotech industries & fields of research.

UNITS	CONTENTS	L	T	P	Total Hours
1 (16 Marks)	**Concept of Property** 1.1 Tangible and Intangible Property, 1.2 Classification of Intellectual Property-Patents, Copyright, Trademark, Industrial Design, Geographical Indications, sui-generis rights (Protection of Plant Varieties and Traditional Knowledge), 1.3 Relevance of Intellectual Property Rights for Science and Technology	08	01	-	09
2 (16 Marks)	**International Conventions relating to Intellectual Property** 2.1 General Agreement on Trade and Tariff (GATT); 2.2 Trade Related Aspects of Intellectual Property Rights (TRIPS); 2.3 Establishment of WIPO – Mission and Activities; 2.4 Indian IPR legislations	08	01	-	09
3 (16 Marks)	**Nature, Origin and Scope of Patents;** 3.1 Essentials of Patents- Patentability Criterion-Discovery and Invention 3.2 Patentability of Biotechnology Inventions; 3.3 Patent Laws in Indian and International Perspective; 3.4 Patent Case study: Basmati Case, Neem Controversy, Turmeric Case	08	01	-	09
4 (16 Marks)	**Biosafety:** **4.1** Definition and requirement; **4.2** International Legal Instruments on Biosafety-Cartagena Protocol on Biosafety, **4.3** Nagoya Protocol **4.4** Laws relating to Biosafety in India: The Biological Diversity Act, 2002, **4.5** Biosafety procedures, rules and guidelines under Environment (Protection) Act 1986 and Rules 1989; **4.6** Biosafety Regulation: Principles and Practices in Microbial and Biomedical Labs	08	01	-	09

5 (16 Marks)	**Basic Principles of Bioethics;** **5.1** Bioethics in Plants, Animals and Microbial Genetic Engineering; **5.2** Ethical issues in Healthcare; **5.3** Biopiracy and Bioethics	08	01	-	09
	Total	**40**	**05**	**00**	**45**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

LEARNING OUTCOMES:

At the end of the course, the student would be able to

- adhere to the ethical practices appropriate to the various scientific disciplines at all times
- adopt safe working practices relevant to the different biotech industries & fields of research..

SUGGESTED READINGS:

1. Cornish, W. R., Intellectual Property (Latest Edition)
2. Intellectual Property Rights by Paul Goldstein
3. Intellectual Property Rights by K. R. G. Nair, Ashok Kumar, K. R. G. Nair
4. Kilner, John, et.al, eds., Cutting-Edge Bioethics. Eerdmans 2002.
5. B.L. Wadera, Patents, Trademarks, Copyright, Designs and Geographical Indications
6. S. Ignacimuthu, Bioethics, Alpha Science International, Limited (2009)
7. Matthew Rimmer, Intellectual Property and Biotechnology: Biological Inventions (2008)
8. Arthur L. Caplan, Robert Arp, Contemporary Issues in Bioethics (2014)
9. Kshitij Kumar Singh, Biotechnology and Intellectual Property Rights: Legal and Social Implications Springer (India) (2014) (in press)
10. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York

B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**GOOD LAB PRACTICES**
Course Code	**:**	**SEC101**
Nature of the Course	**:**	**SKILL ENHANCEMENT COURSES**
Total Credits	**:**	**03 = 2 (Theory)+ 1(Practical)**
Distribution of Marks	**:**	**80(End Sem) + 20 (In-Sem)**
		End Sem: 60(Theory) + 20 (Practical)

COURSE OBJECTIVES:

- Prepare students for practical study in science laboratories.
- Students able to handle safely every laboratory facility and know troubleshoot measures during laboratory processes.
- Student able to keep, analyse laboratory data with accuracy.
- Objective in minimization of Errors related with handling of laboratory material and work, becomes more accurate and precise.

UNITS	CONTENTS	L	T	P	Total Hours
1 (15 Marks)	**INTRODUCTION TO GLP** **1.1** History, Scope, Fundamental points of GLP (Resources Characterization, Rules, Results) **1.2** General Rules/Protocols for Lab Safety measures, Precaution and Safety in handling of chemicals, Laboratory tools, Glassware and instruments. **1.3**Internal and External Audit.	6	1	-	7
2 (15 Marks)	**2.1** Levels of Laboratories, Log Book Maintenance, **2.2** Basic SOPs for instrument handling and Maintenance. **2.3** Keeping data records, its analysis by using statistical and mathematical tools. **2.4** Result analysis and its interpretation	7	1	-	8
3 (15 Marks)	**3.1** Biosafety: Definition and requirement; International Legal Instruments on Biosafety-Cartagena Protocol on Biosafety, Nagoya Protocol **3.2** Laws relating to Biosafety in India: The Biological Diversity Act, 2002, Biosafety procedures, rules and guidelines under Environment (Protection) Act 1986 and Rules 1989; **3.3** Biosafety Regulation: Principles and Practices in Microbial and Biomedical Labs for Infectious agents	7	1	-	8
4 (15 Marks)	**4.1** Good Manufacturing Practices. **4.2** Quality Control and Quality Assurance. **4.3** Concept, Function and Advantages OECD Guidelines	6	1	-	7

5 (20 Marks)	**PRACTICALS:** **5.1** Standard Operating Procedures **5.2** Demonstration of Laboratory Safety Wear **5.3** Demo and Maintenance of Internal and 5.4 External Audit **5.4** Calibration of Basic Instruments such as PH meter, water bath, Distillation assembly, Burette, Pipette etc. **5.5** Use of Microsoft word, Excel. (For Data entry, calculation and graphical representation)	-	-	30	30
	Total	**26**	**04**	**30**	**60**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

LEARNING OUTCOMES:

- Students will be able to safely practice basic laboratory procedures and protocols in future lab situations.
- Maintain laboratory records compliant with current industry standards.

SUGGESTED READINGS:

1. Handbook Good Laboratory Practices-World health organization (WHO)
2. Life science protocol manual (2018)-DBT star college scheme
3. Guidelines for good laboratory practices-Indian council of medical research, New Delhi (2008)

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B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**MOLECULAR BASIS OF CELL BIOLOGY**
Course Code	**:**	**BTNC2**
Nature of the Course	**:**	**Major**
Total Credits	**:**	**04 = 3 (Theory)+ 1(Practical)**
Distribution of Marks	**:**	**80 (End Sem) + 20 (In-Sem)**
		End Sem: 60(Theory) + 20 (Practical)

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.

UNITS	CONTENTS	L	T	P	Total Hours
1 (18 Marks)	**MEMBRANE STRUCTURE AND FUNCTION**: 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.	11	01	-	12
2 (12 Marks)	**CELLULAR INTERACTION** **2.1** Interaction between Cells and their environment- extra-cellular space and components of extracellular matrix, **2.2** Interaction of cells with ECM, Plant Cell walls, **2.3** Cellular Junctions, Cell adhesion.	09	01	-	10
3 (15 Marks)	**CELL COMMUNICATIONS AND SIGNAL TRANSDUCTION** **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.	11	01	-	12

4 (15 Marks)	**CELL CYCLE** 4.1 Cell division-Mitosis and meiosis 4.2 Steps in cell cycle, Their regulation 4.3 Molecular basis of cell cycle- 4.4 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	10	01	-	11
5 (20 Marks)	**PRACTICAL** **5.1** Study of mitosis in onion root tips **5.2** Study of mitosis in tadpole tail. **5.3** Study of meiosis in flower bud. **5.4** Study of meiosis in grasshopper/rabbit testes. **5.5** Study of polytene chromosome in *Drosophila* larvae. **5.6** Study of polytene chromosome in *Chironomous* larvae. **5.7** Study of barr body in the epithelial buccal cell. **5.8** Staining of mitochondria in human cheek epithelial cells.	-	-	30	30
	Total	**41**	**04**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

EXPECTED LEARNING OUTCOME:

The students will have

- strong underpinning of fundamentals of cell structure and function.
- lucid understanding of the cellular processes of signaling and transport
- a comprehensive understanding of the cellular changes that lead to malignancy
- strong underpinning of fundamentals of the different developmental pathways that lead to both morphogenesis and organogenesis in both animals and plants

RECOMMENDED READINGS:

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., 1998
5.Cell and Molecular Biology: Concepts and Experiments, Gerald Karp, 8th edition, Wiley

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B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**CELL BIOLOGY AND MICROBIOLOGY**
Course Code	**:**	**MINBTN2**
Nature of the Course	**:**	**Minor Course**
Total Credits	**:**	**04**
Distribution of Marks	**:**	**80(End Sem) + 20 (In-Sem)** **End Sem: 60(Theory) + 20 (Practical)**

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 and 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.

UNITS	CONTENTS	L	T	P	Total Hours
1 (18 Marks)	**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).	13	1	-	14
2 (12 Marks)	**2.1 Cell division and cell cycle** (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).	07	01	-	08
3 (15 Marks)	**3.1 Structure of bacteria;** nutrition, growth medium. **3.2 Methods of sterilization:** pure culture, isolation, selective method of isolation, cultivation, preservation.	11	01	-	12
4 (15 Marks)	**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.	10	01	-	11

5 (20 Marks)	**PRACTICALS** **5.1** Study of mitosis in onion root tips/ tadpole tail. **5.2** Study of meiosis in flower bud/ grasshopper testes. **5.3** Study of polytene chromosome in *Drosophila*/ *Chironomous* larvae. **5.4** Study of barr body in the epithelial buccal cell. **5.5** Microbial sub-culturing and preservation techniques. **5.6** Various Staining techniques. **5.7** IMViC test. **5.8** Starch hydrolysis test. **5.9** Catalase test **5.10** Fermentation of carbohydrates.	-	-	30	30
	Total	**41**	**04**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

LEARNING OUTCOMES:

The students will have

- strong underpinning of fundamentals of cell structure and function.
- lucid understanding of the cellular processes of signaling and transport
- 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.

SUGGESTED READINGS:

1. Schaum's Outline of Molecular and Cell Biology, William Stansfield, Jaime S. Colomé, Raúl J. Cano, McGraw Hill Professional, 22-Sep-1996
2. Essential Cell Biology. Bruce Alberts. Garland Pub., 1998
3. Cell and Molecular Biology: Concepts and Experiments, Gerald Karp, 8th edition, Wiley
4. Microbiology: A Text Book of Microorganisms,General and Applied,Charles Edward marshall,F.TBioletti Published P. P.Blakiston's son &co.
5. Microbiology , M.J Pelczer and R.D Reid.
6. General Microbiology- by R. Y. Stanier .et.al

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B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**BIOLOGICAL DATABASE DESIGN**
Course Code	**:**	**GECBTN2**
Nature of the Course	**:**	**Generic Elective Course**
Total Credits	**:**	**03 = 2 (Theory)+ 1(Practical)**
Distribution of Marks	**:**	**80(End Sem) + 20 (In-Sem)** **End Sem: 60(Theory) + 20 (Practical)**

COURSE OBJECTIVES:

The objective of the course is

1. To enable learners to understand basics of database and design design process
2. To enable learners to design databases with MySQL and to enable them to issue queries
3. To enable learners to design front end with HTML/PHP
4. To enable learners to design basic web based applications in the field of biological science with PHP and MySQL

UNITS	CONTENTS	L	T	P	Total Hours
1 (15 Marks)	Concepts of Database and DBMS: 1.1 History of Database System, 1.2 File System Vs DBMS, 1.3 Advantages of DBMS, 1.4 Structure of DBMS	0	01	-	08
2 (15 Marks)	2.1 Introduction to Database Design: Entities, Attributes and Relationship,ER Model 2.2 Development of Database : Mapping ER Model to Relational Model 2.3 Understanding Modeling of Biological Databases	06	01	-	07
3 (15 Marks)	3.1 Structured Query Language (MySQL), 3.2 Development of Database with MySQL with Biological Case Studies	07	01	-	08
4 (15 Marks)	4.1 Basics of HTML/PHP 4.2 Development of Front End with HTML/PHP 4.3 PHP-MySQL Connectivity: Connect, Create DB/Table, Select/Insert/Update/Delete Data	06	01	-	07
5 (20 Marks)	**PRACTICALS** **5.1** Design Entity-Relationship Model on Biological Cases 5.2. Mapping of ER Diagram to Relational Model 5.3. Execute Basic SQL Queries 5.4 Design PHP-MySQL Web Application for various Biological Cases	-	-	30	30
	Total	**26**	**04**	**30**	**60**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

LEARNING OUTCOMES:

After successful completion of course learner will be able to

- design database using My-SQL
- develop web application using PHP-MYSQL.
- develop simple web application for biological sciences.

SUGGESTED READINGS:

1. Database Management Systems, Ramakrishnan, Gehrke, International Edition, McGRAW-HILL
2. Powell Thomas. HTML & CSS: The Complete Reference, Fifth Edition. Mcgraw Hill
3. Steven Holzner. PHP: The Complete Reference 2017 McGraw Hill Education
4. Luke WellingLaura Thomson. PHP and MySQL Web Development. Pearson 5th Edition 2016
5. Vikram Vaswani, How to do everything with PHP and MySQL, McGrawHill 2005

B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**VERMICOMPOSTING**
Course Code	**:**	**SEC201**
Nature of the Course	**:**	**SKILL ENHANCEMENT COURSES**
Total Credits	**:**	**03 = 2 (Theory)+ 1(Practical)**
Distribution of Marks	**:**	**80(End Sem) + 20 (In-Sem)**
		End Sem: 60(Theory) + 20 (Practical)

COURSE OBJECTIVES:

1. To have a basic understanding of vermicomposting
2. To develop skills, through lab experiments and exercises, in specific methodologies used in the contemporary vermicomposting.
3. To elucidate the impact of different vermicomposting practices and its economic importance.
4. To understand the scope, prospect and challenges in vermi-technology and its application.

UNITS	CONTENTS	L	T	P	Total Hours
1 (15 Marks)	**1.1** Importance of Vermicompost in Agri-horticultural practices. **1.2** Vermicomposting for Organic Farming - an Eco-Friendly approach Vermicomposting for Rural Development	06	01	-	07
2 (15 Marks)	**2.1** Waste materials: Classification, disposal techniques & their impact on environment. **2.2** Earthworms: Type, identification & usefulness. **2.3** Anaerobic (Pit) & Aerobic (Heap) composting: techniques & their comparison	07	01	-	08
3 (15 Marks)	**3.1** Vermiculturing: Techniques & importance. **3.2** Vermicomposting techniques, standard composition of Vermicompost. **3.3** Vermi-wash production techniques, standard. composition of vermiwash.	07	01	-	08
4 (15 Marks)	**4.1** Economics on Vermiculture and Vermicomposting. **4.2** Problems & prospects of Vermicomposting in India	06	01	-	07
5 (20 Marks)	**PRACTICALS:** **5.1 Preparation of Vermicompost pit** a) Collection of wastes & their segregation & processing b) Bed preparation for Anaerobic & Aerobic composting. Fortnightly mixing of beds c) Bed preparation for Vermicomposting. Four-chambered tank/pit system, etc. d) Earthworm collection & application on beds. Inspection of beds & watering	-	-	30	30

	5.2 Vermicompost and vermin-wash collection. a) Vermicompost collection, Earthworms Separation, Air drying of vermicompost, Sieving & storing b) Vermi-wash collection & processing				
	Total	**30**	**-**	**30**	**60**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

LEARNING OUTCOMES:

The students will

- have a basic understanding of vermicomposting
- develop skills in specific methodologies used in the contemporary vermicomposting.
- have a comprehensive understanding of the impact of different vermicomposting practices and its economic importance.
- have strong underpinning of fundamentals of the scope, prospect and challenges associated with vermi-technology, along with its application.

SUGGESTED READINGS:

Text Book:

1. Verms & Vermitechnology, Arvind Kumar (2005) APH Publishing (New Delhi).

Reference Books:

1. Vermitechnology, A. Mary Violet Christy (2014) MJP Publisher (India).
2. Vermitechnology, M. Seetha Lekshmy and R. Santhi Saras (2012) Publication (New Delhi)

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B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**FUNDAMENTALS OF MICROBIOLOGY**
Course Code	**:**	**BTNC3**
Nature of the Course	**:**	**Major**
Total Credits	**:**	**04 = 3 (Theory)+ 1(Practical)**
Distribution of Marks	**:**	**80 (End Sem) + 20 (In-Sem)**
		End Sem: 60(Theory) + 20 (Practical)

COURSE OBJECTIVES:

- To identify the diversity of microorganisms and a comprehensive understanding of the basic techniques employed for their isolation, characterization and culture.
- 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.

UNITS	CONTENTS	L	T	P	Total Hours
1 (20 Marks)	**BASICS OF MICROBIOLOGY:** **1.1** Structure of bacteria: Nutrition, growth medium. **1.2** Methods of sterilization; pure culture, isolation, selective method of isolation, cultivation, preservation.	07	01	-	08
2 (10 Marks)	**DIVERSITY** **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).	08	01	-	09
3 (15 Marks)	**BACTERIAL KINGDOM:** **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. **ARCHEON:** **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.	13	01	-	14

4 (15 Marks)	**VIRUSES AND OTHER INFECTIOUS AGENTS:** **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, Pramecium.	13	01	-	14
5 (20 Marks)	**PRACTICAL** **5.1** Cleaning and sterilization of glass wares. **5.2** Preparation of liquid and solid media for growth of microorganism and pure culture technique. **5.3** Isolation and enumeration microorganisms from mixed population. **5.4** Microbial colony characterization in different media. **5.5** Microbial sub-culturing and preservation techniques. **5.6** Various Staining techniques. **5.7** IMViC test. **5.8** Starch hydrolysis test. **5.9** Catalase test **5.10** Fermentation of carbohydrates. **5.11** Hydrogen sulphide production test. **5.12** Urease test. **5.13** Oxidase test. **5.14** Gelatin hydrolysis test.	-	-	30	30
	Total	**41**	**04**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

EXPECTED LEARNING OUTCOME:

The students will have

- Thorough knowledge and understanding of the core concepts in the discipline of Microbiology.
- Knowledge on how microorganisms are used as model systems to study basic biology, genetics, metabolism and ecology.

RECOMMENDED READINGS:

1. Microbiology: A Text Book of Microorganisms,General and Applied,Charles Edward marshall,F.TBioletti Published P. P.Blakiston's son &co.
2. Microbiology , M.J Pelczer and R.D Reid.
3. General Microbiology- by R. Y. Stanier .et.al
4. Soil Microbiology- by S. A. Walman
5. Microbiology, by Prescott, Tata MacGrawHill

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B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**MOLECULAR BIOLOGY**
Course Code	**:**	**BTNC4**
Nature of the Course	**:**	**Major**
Total Credits	**:**	**04**
Distribution of Marks	**:**	**80 (End Sem) + 20 (In-Sem)** **End Sem: 60(Theory) + 20 (Practical)**

COURSE OBJECTIVES:

- To identify the concepts of biomolecules viz DNA and RNA, its maintenance and processing inside a cell.
- To explain in-depth knowledge about the different mechanism involved in replication of DNA in prokaryotes and eukaryotes.
- To explain transcription of DNA to RNA in prokaryotes and eukaryotes and translation of protein from RNA in prokaryotes and eukaryotes.
- To analyze and conceptualize the fundamental principles behind the expression of gene.

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UNITS	CONTENTS	L	T	P	Total Hours
1 (112 Marks)	**GENETIC MATERIAL AND ITS PACKAGING**: **1.3** Nucleic acid as genetic material, Genome organization in prokaryotes and eukaryotes **1.4** Chromatin structure and function. Heterochromatin, euchromatin. **1.5** Histones and non-histone proteins, general properties of histone, nucleosomes, solenoid structure, packaging of DNA, satellite DNA.	07	01	-	08
2 (15 Marks)	**REPLICATION:** **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.	10	01	-	11
3 (18 Marks)	**TRANSCRIPTION:** **3.1** Prokaryotic transcription; promoters, properties of bacterial RNA polymerase. Steps: initiation, elongation and termination **3.2** Properties of RNA polymerase I, II and III. **3.3** RNA processing and RNA editing. Inhibitors of transcription. **TRANSLATION:** **3.4** Ribosomes structure and function, genetic code, aminoacyl tRNA synthases. **3.5** Direction of protein synthesis (Dintzis experiment).Formation of translation initiation complex, chain elongation, translocation & termination and the role of respective factors involved therein. **3.6** Post-translational modifications- Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulfide bond formation. Inhibitors of translation.	13	01	-	14

4 (15 Marks)	**REGULATION OF TRANSCRIPTION AND TRANSLATION:** **4.4** Positive and negative control. Repressor & Inducer. **4.5** Concept of operon- lac-/ ara-/ trp operons. Attenuation and catabolite repression. **4.6** Nucleases and restriction enzymes, Denaturation of DNA and Reassociation Kinetics. C-value paradox.	11	01	-	12
5 (20 Marks)	**PRACTICAL** **5.1** Extraction of DNA/ RNA **5.2** Quantification of DNA/RNA **5.3** Quality assessment of DNA **5.4** Restriction Digestion **5.5** Hyperchromic effect	-	-	30	30
	Total	**41**	**04**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

EXPECTED LEARNING OUTCOME:

The students will be able to develop

- An understanding of the concepts of replication, transcription, translation and other concepts of molecular biology.
- Practical knowledge on isolation, screening and visualization of biomolecules viz DNA, RNA and Protein.

RECOMMENDED 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

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B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**GENETICS AND BIOSTATISTICS**
Course Code	**:**	**MINBTN3**
Nature of the Course	**:**	**MINOR COURSE**
Total Credits	**:**	**04 = 3 (Theory)+ 1(Practical)**
Distribution of Marks	**:**	**80(End Sem) + 20 (In-Sem)**
		End Sem: 60(Theory) + 20 (Practical)

COURSE OBJECTIVES:

- 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.

UNITS	CONTENTS	L	T	P	Total Hours
1 (18 Marks)	**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.	12	01	-	13
2 (12 Marks)	**Mutations and Chromosomal aberration** **2.1** Molecular basis of mutation—types, spontaneous mutation, induced mutations **2.2** Radiation and chemical mutagens.	08	01	-	09
3 (15 Marks)	**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	11	01	-	12
4 (15 Marks)	**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	10	01	-	11
5 (20 Marks)	**PRACTICALS** **5.1** Solving Problems related to Mendelian Genetics **5.2** Solving Problems related to deviation Mendelian Genetics **5.3** Solving Problems related to linkage analysis and chromosome mapping **5.4** Solving Problems related to population genetics **5.5** Solving Problems related to quantitative genetics **5.6** Solving of statistical problem using Excel **5.7** Solving of statistical problem using SPSS	-	-	30	30
	Total	**41**	**04**	**30**	**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

LEARNING OUTCOMES:

The students will have:

1. an in-depth knowledge about the fundamentals of genetics.
2. a basic understanding of mendelian principles
3. Concept of mutation and chromosomal disorder
4. an in-depth knowledge about use of statistics in biological analysis.

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.

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B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**BIOTECHNOLOGY AND HUMAN WELFARE**
Course Code	**:**	**GECBTN3**
Nature of the Course	**:**	**Generic Elective Course**
Total Credits	**:**	**03 = 2 (Theory)+ 1(Practical)**
Distribution of Marks	**:**	**80(End Sem) + 20 (In-Sem)** **End Sem: 60(Theory) + 20 (Practical)**

COURSE OBJECTIVES:

3. This course is an introduction to the students on the ethical aspects of conducting research and safety aspects to be adhered in a research setting.
4. This course also introduces the students to effective management of available resources and footprint of research activities.

UNITS	CONTENTS	L	T	P	Total Hours
1 (15 Marks)	**Industrial Biotechnology:** **1.1** Protein engineering. **1.2** Enzyme and polysaccharide synthesis **1.3** Activity and secretion of enzyme **1.4** Alcohol and antibiotic formation.	07	01	-	08
2 (15 Marks)	**Agriculture Biotechnology:** **2.1** N2 fixation **2.2** Transfer of pest resistance genes to plants **2.3** Interaction between plants and microbes **2.4** Qualitative improvement of livestock.	06	01	-	07
3 (15 Marks)	**Environments:** **3.1** Chlorinated and non-chlorinated organ pollutant degradation **3.2** Degradation of hydrocarbons and agricultural wastes **3.3** Wastes management **3.4** Development of biodegradable polymers such as PHB.	07	01	-	08
4 (15 Marks)	**Health:** **4.1** Development of non-toxic therapeutic agents **4.2** Recombinant live vaccines, **4.3** Gene therapy, **4.4** Diagnostics, **4.5** Monoclonal antibodies production **4.6** Human genome project.	06	01	-	07
5 (20 Marks)	**PRACTICALS** **5.1** Perform of ethanolic fermentaion using Baker's yeast **5.2** Study of a plant part infected with a microbe **5.3** To perform quantitative estimation of residual chlorine in water samples **5.4** Isolation and analysis of DNA from minimal	-	-	30	30

	available biological samples **5.5** Case studies on Bioethics				
	Total	**26**	**04**	**30**	**60**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

LEARNING OUTCOMES:

- At the end of the course, the student would have gained sufficient knowledge to act as a responsible scientist and environmentally conscious.

SUGGESTED READINGS:

1. Microbiological Examination of Water and Wastewater By Maria Csuros; CRC Publishing House
2. Textbook of Environmental Microbiology By Pradipta K. Mohapatra; I. K. International Pvt Ltd.
3. Environmental Microbiology (Second Edition) Edited by: Ian L. Pepper, Charles P. Gerba, Terry Gentry and Raina M. Maier; Elsevier LLC.
4. Agricultural Microbiology by Rangaswami G; MT Publishers.
5. Atlas RM (1997). Principles of Microbiology. McGraw Hill.

B.Sc. IN BIOTECHNOLOGY AND BIOINFORMATICS (NEP)
DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**MUSHROOM CULTIVATION**
Course Code	**:**	**SEC301**
Nature of the Course	**:**	**SKILL ENHANCEMENT COURSES**
Total Credits	**:**	**03 = 2 (Theory)+ 1(Practical)**
Distribution of Marks	**:**	**80(End Sem) + 20 (In-Sem)**
		End Sem: 60(Theory) + 20 (Practical)

COURSE OBJECTIVES:

1. To identify and differentiate edible mushrooms from poisonous one.
2. To explain the impact of different practices in cultivation of mushroom.
3. To explain the impact of different practices in cultivation of mushroom
4. To analyze and develop the develop skills, through lab experiments and exercises, in specific methodologies identification of edible mushroom.

UNITS	CONTENTS	L	T	P	Total Hours
1 (15 Marks)	**INTRODUCTION TO EDIBLE MUSHROOM** **1.1** Edible Mushroom: Different parts of a typical mushroom & variations in mushroom morphology. **1.2** Key to differentiate Edible from Poisonous mushrooms.	06	01	-	07
2 (15 Marks)	**NUTRIENT PROFILE OF MUSHROOM:** **2.1** Protein, **2.2** Amino acids, **2.3** Calorific values, **2.4** Carbohydrates, **2.5** Fats, **2.6** Vitamins & minerals.	07	01	-	08
3 (15 Marks)	**HEALTH BENEFITS OF MUSHROOM:** **3.1** Antiviral value, **3.2** Antibacterial effect, **3.3** Antifungal effect, **3.4** Anti-tumour effect, **3.5** Haematological value **3.6** Cardiovascular & renal effect, **3.7** Therapeutic diets for adolescence, aged persons & diabetes mellitus.	07	01	-	08
4 (15 Marks)	**Cultivation of Button, Oyster and Straw Mushrooms:** **4.1** Collection of raw materials, compost & composting, spawn & spawning, casing & case run, cropping & crop management, picking & packing. **4.2 Economic Importance of Mushroom and Their Uses**	06	01	-	07
5 (20 Marks)	**PRACTICALS:** **1. Cultivation of Mushroom (Oyster Mushroom/Button Mushroom and other locally available edible mushroom).** a) Mushroom bed preparation b) Spawning and Spawn maintenance c) Harvesting of Mushroom	-	-	30	30

	2. Nutrients content analysis in mushroom. a) Protein and amino acid analysis in mushroom b) Lipid analysis in mushroom				
	Total	**26**	**04**	**30**	**60**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Group Discussion
  - Seminar presentation on any of the relevant topics
  - Debate
  - Quiz

LEARNING OUTCOMES:

The students will

- have a basic understanding and identifying edible mushroom
- be able to identify and differentiate edible mushroom from poisonous mushroom
- be able to cultivate edible mushroom and understand its nutritive and economic importance

SUGGESTED READINGS:

Text Book:

1. Mushroom Cultivation, Tripathi, D.P.(2005) Oxford & IBH Publishing Co. PVT.LTD, New Delhi.

Reference Books:

1. Mushroom Production and Processing Technology, Pathak Yadav Gour (2010) Published by Agrobios (India).
2. A hand book of edible mushroom, S.Kannaiyan& K.Ramasamy (1980). Today & Tomorrows printers & publishers, New Delhi
3. Handbook on Mushrooms, Nita Bahl, oxford & IBH Publishing Co.

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