



B.Sc. (Hons./Hons. with Research) Biotechnology As per NEP2020

[Prepared as per Curriculum and Credit
Framework for Undergraduate Programs
(CCFUP) given by UGC, 2022]

Effective from 2025-26

(Applies to batches from 2023)



Mahayogi Gorakhnath University, Gorakhpur
Faculty of Health and Life Sciences
Department of Biotechnology

B.Sc. Biotechnology (Hons./Hons. With Research)
Study Evaluation Scheme (Choice-Based Credit System)
Effective from the session 2025-26

I Year: I Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT101	Cell Biology and Genetics	4	0	0	25	75	100	4	Major	Own faculty
2	BBT102	Fundamental of Biochemistry	4	0	0	25	75	100	4	Major	Own faculty
3	BBT103	Fundamentals of Plant Physiology	4	0	0	25	75	100	4	MD	Own faculty
4	BBT121SE	Comprehension & Communication Skills in English	3	1	0	25	75	100	4	AEC	Own faculty
5	BBT132	First Aid and Health	2	0	0	25	75	100	2	SEC	Any faculty
Practical											
6	BBT151	Cell Biology and Genetics Lab	0	0	2	25	75	100	1	Major	Own faculty
7	BBT 152	Plant Physiology Lab	0	0	2	25	75	100	1	MD	Own faculty
8	BT153	Biochemistry Lab	0	0	2	25	75	100	1	Major	Own faculty
Total			17	1	3	200			21		

Evaluation Scheme, promotion scheme, grading system, and CGPA calculation adopted from CCFUP, by UGC 2022.

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AEC	Ability Enhancement Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective
MD	Multidisciplinary
VAC	Value-Added Courses common for all UG

MOOCS/NPTEL/SWYAM/Other University/College	
BBT103 Fundamentals of Biochemistry	https://nptel.ac.in/courses/102105034 BioChemistry I, IIT Kharagpur Prof. S. Dasgupta
BBT101 Cell Biology and Genetics	https://onlinecourses.nptel.ac.in/noc23_bt32/preview ell Biology By Prof. Shikha Laloraya IISc Bangalore

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I Year: II Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT201	Molecular Biology	4	0	0	25	75	100	4	Major	Own faculty
2	BBT203	Mammalian Physiology	4	0	0	25	75	100	4	MD	Any faculty
3	BBT204	Biotechnology and Human Welfare	4	0	0	25	75	100	4	Major	Own faculty
4	BBT205	Enzyme Technology	3	0	0	25	75	100	3	Major	Own faculty
5	BBT2201	Bioethics and Biosafety	3	0	0	25	75	100	3	Major	Own faculty
6	BBT232	Food, Nutrition and Hygiene	2	0	0	25	75	100	2	VAC	Any faculty
Practical											
7	BBT251	Molecular Biology Lab	0	0	2	25	75	100	1	Major	Own faculty
8	BBT253	Mammalian Physiology Lab	0	0	2	25	75	100	1	MD	Own faculty
Total			20		2	200	600	800	22		

Certificate Course in Tools and Techniques of Cell and Molecular Biology*

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MOOCS/NPTEL/SWYAM/Other University/College	
BBT205 Enzyme Technology	https://onlinecourses.nptel.ac.in/noc23_bt05/preview Enzyme Sciences and Technology By Prof. Vishal Trivedi, IIT Guwahati

*** UG Certificate:** Students who opt to exit after completion of the first year and have secured 40 credits will be awarded a UG certificate if, in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree program within three years and complete the degree program within the stipulated maximum period of seven years.

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II Year: III Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT302	Environmental Biotechnology	4	0	0	25	75	100	4	Minor	Own faculty
2	BBT304	Developmental Biology	4	0	0	25	75	100	4	Minor	Own faculty
3	BBT305	Genetic Engineering	4	0	0	25	75	100	4	Major	Own faculty
4	-----	Discipline Specific Elective-1	3	0	0	25	75	100	3	SEC	Own faculty
5	BBT331	Physical Education and Yoga	1	0	2	25	75	100	2	VAC	Any faculty
Practical											
6	BBT353	Genetic Engineering Lab	0	0	2	25	75	100	1	Major	Own faculty
7	BBT354	Environmental Biotechnology Lab	0	0	2	25	75	100	1	Major	Own faculty
8	BBT353IV	Industrial Visit-1	0	0	4	25	75	100	2	SEC	Own faculty
Total			16		5	200	600	800	21		

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Discipline Specific Elective-1	
Course Code	Course Name
BBT3201VO	Molecular Diagnostics
BBT3202VO	Quality Control in Biopharmaceutical Lab

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II Year: IV Semester

Diploma in Tools and Techniques of Biotechnology*

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT401	Microbiology and Immunology	4	0	0	25	75	100	4	Major	Own faculty
2	BBT402	Medicinal Chemistry	3	0	0	25	75	100	3	MD	Own faculty
3	BBT403	Industrial Fermentation	4	0	0	25	75	100	4	Major	Any faculty
4	-----	Minor Elective-1	3	0	0	25	75	100	3	Minor	Any Faculty
5	-----	Interdisciplinary Elective-1	3	0	0	25	75	100	3	Minor	Any faculty
6	BBT431	Human Values and Environmental Studies	2	0	0	25	75	100	2	VAC	Any faculty
Practical											
7	BBT451	Microbiology and Immunology Lab	0	0	2	25	75	100	1	Major	Own faculty
8	BBT452	Medicinal Chemistry Lab	0	0	2	25	75	100	1	Major	Own faculty
Total			19		2	200	600	800	21		

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Interdisciplinary Elective-1	
Course Code	Course Name
BBT4202VO	Basics of Forensic Science
BBT4203VO	Diagnostic Biochemistry and Laboratory Management

Minor Elective-1	
Course Code	Course Name
BBT4201	Ecology and Environmental Management
BBT4202	Plant Science

*** UG Diploma:** Students who opt to exit after completion of the second year and have secured 80 credits will be awarded the UG diploma if, in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. 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.

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III Year: V Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT502	Animal and Plant Biotechnology	4	0	0	25	75	100	4	Major	Own faculty
2	BBT504	Biostatistics	3	0	0	25	75	100	3	Minor	Own faculty
3	BBT505	Bioprocess Technology	4	0	0	25	75	100	4	Major	
4		Interdisciplinary Elective-2	4	0	0	25	75	100	4	Minor	Own faculty
5	BBT531	Communication Skills and Personality Development	2	0	0	25	75	100	2	AEC	Any faculty
6	BBT533	Understanding India	2	0	0	25	75	100	2	VAC	
Practical											
5	BBT556	Bioprocess Technology Lab	0	0	2	25	75	100	1	Major	Own faculty
6	BBT554	Animal and Plant Biotechnology lab	0	0	2	25	75	100	1	Major	Own faculty
7	BBT553IS	Industrial Training/Internship	0	0	4	25	75	100	2	SI	Own faculty
Total			17	0	4	175	525	700	23		

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SI	Summer Internship

Interdisciplinary Elective-2	
Course Code	Course Name
BBT5102	Food Microbiology
BBT5103	Medical Microbiology

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III Year: VI Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT603	Genomics and Proteomics	4	0	0	25	75	100	4	Major	Own faculty
2	BBT607	Bioanalytical Tool	4	0	0	25	75	100	4	Major	Own faculty
3	----	Minor Elective 2	3	0	0	25	75	100	3	Minor	Own faculty
4		Vocational Elective-I	3	0	0	25	75	100	3	Minor	Own faculty
5	BBT631	Analytical Ability and Digital Awareness	2	0	0	25	75	100	2	AEC	Own faculty
6	BBT632	Artificial Intelligence in Biological Sciences	2	0	0	25	75	100	2	VAC	Outsourced
Practical											
6	BBT651	Bioanalytical Tool Lab	0	0	2	25	75	100	1	Major	Own faculty
7	BBT653	Genomics and Proteomics Lab	0	0	2	25	75	100	1	Major	Own faculty
8	BBT653SM	Seminar	0	0	4	25	75	100	2	SEC	Own faculty
Total			17	0	4	200	600	800	22		

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Minor Elective 2	
Course Code	Course Name
BBT6110	Industrial Biotechnology
BBT6111	Animal Cell Culture
BBT6112	Medical Biotechnology
BBT6113	Scientific Writing and Communication

Vocational Elective	
Course Code	Course Name
BBT6210	Food Processing and Preservation
BBT6211	Mushroom Culture https://onlinecourses.swayam2.ac.in/nos20_ge07/preview
BBT6213	Api Culture https://onlinecourses.swayam2.ac.in/nos19_as10/preview

***3-year UG Degree:** Students who wish to undergo a 3-year UG program will be awarded UG Degree in the Major discipline after successful completion of three years, securing 120 credits and satisfying the minimum credit requirement as given in table 2.

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IV Year: VII Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT702	Intellectual Property Right	4	0	0	25	75	100	4	Major	Own faculty
2	BBT704	Computational and Structural Biology	4	0	0	25	75	100	4	Major	Own faculty
3		Interdisciplinary Elective-3	3	0	0	25	75	100	3	Minor	Own faculty
4	BBT705	Agricultural Biotechnology	4	0	0	25	75	100	4	MD	Own faculty
5	BBT706	Plant Tissue Culture	3	0	0	25	75	100	3	Major	Own faculty
6	BBT707	Biofuels and Bioenergy	3	0	0	25	75	100	3	Minor	Own faculty
Practical											
7	BBT752	Computational and Structural Biology Lab	0	0	2	25	75	100	1	Major	Own faculty
8	BBT753	Agricultural Biotechnology Lab	0	0	2	25	75	100	1	Major	Own faculty
Total			21	0	2	200	600	800	23		

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Interdisciplinary Elective -3	
Course Code	Course Name
BBT7101	Nanobiotechnology
BBT7104	Introduction to Biosensors

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IV Year: VIII Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT801	Research Methodology	4	0	0	25	75	100	4	Major	Own faculty
2	BBT802	Research Publication Ethics	2	0	0	25	75	100	2	Minor	Own faculty
3	BBT804	Entrepreneurial Biotechnology	4	0	0	25	75	100	4	Major	Own faculty
Practical											
4	BBT852SI	Entrepreneurial Biotechnology Seminar	0	0	4	25	75	100	2	Major	Own faculty
5		Total	10	0	2	100	300	400	12		
OR											
1	BBT853PJ	Research Project/ Dissertation	0	0	24			400	12	Major	

B.Sc. (Honours)/ B.Sc. (Honours with Research) in Biotechnology*

Evaluation Scheme, promotion scheme, grading system, and CGPA calculation adopted from CCFUP, by UGC 2022.

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MD	Multidisciplinary
VAC	Value-added courses common for all UG

***4-year UG Degree (Honours):** A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree program with 160 credits and have satisfied the credit requirements as given in table 2 in Section 5.

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. 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 160 credits, including 12 credits from a research project/dissertation, are awarded UG Degree (Honours with Research).

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S.NO.	Broad Category of Course	Minimum Credit Requirement			
		3-year UG		4-year UG	
		As per UGC	MGUG Biotechnology	As per UGC	MGUG Biotechnology
1	Major (Core)	60	61	80*	84*
2	Minor Stream	24	24	32	35
3	Multidisciplinary	09	13	09	17
4	Ability Enhancement Courses (AEC)	08	08	08	8
5	Skill Enhancement Courses (SEC)	09	9	09	9
6	Value Added Courses common for all UG (VAC)	06 - 08	10	06 - 08	10
7	Summer Internship	02 - 04	3	02 - 04	2
8	Research Project / Dissertation	*For those who undergo 4 years of honors without research (Course credit included)		Only for Honors with Research	
				12	12
	Total	120	128	160	165

Table 1: Minimum Credit Requirements to Award Degree under 3-year and UG and 4-year UG Programs

Curriculum and Credit Frame Work for Undergraduate										
Category of course (Minimum credits by UGC)	I Semester (21)	II Semester (22)	III Semester (21)	IV Semester (21)	V Semester (21)	VI Semester (22)	3 Year UG (127)	VII Semester (23)	VIII Semester (12)	Total (165)
Major (60-80)	10	15	6	10	10	10	61	13	10*	84
Minor(24-32)	0	0	8	6	7	6	28	6	2*	35
MD (9)	5	5	0	3	0	0	13	4	0	17
AEC (8)	4	0	0	0	2	2	8	0	0	8
SEC (9)	2	0	5	0	0	2	9	0	0	9
VAC (6-8)	0	2	2	2	2	2	6	0	0	10
SI (2-4)	0	0	0	0	2	0	2	0	0	2
Research (12)	0	0	0	0	0	0	0	0	12**	12

*For those who undergo 4 years honors without research (Course credit included).

**For those who opt for honors with research

Table 2: Semester Wise distribution of minimum credits required for B. Sc. (Honours)/ B.Sc. (Honours with Research) in Biotechnology

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Letter Grades and Grade Points:

Letter Grade	Grade Point
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above Average)	6
C (Average)	5
P (Pass)	4
F (Fail)	0
Ab (Absent)	0

Computation of SGPA and CGPA

The following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.

$$\text{SGPA (Si)} = \sum(C_i \times G_i) / \sum C_i$$

Where C_i is the number of credits of the i th course and G_i is the grade point scored by the student in the course.

Example for Computation of SGPA

Semester	Course	Credit	Letter Grade	Grade point	(Credit x Grade)
1	Course 1	3	A	8	3 x 8 = 24
1	Course 1	4	B +	7	4 x 7 = 28
1	Course 1	3	B	6	3 x 6 = 18
1	Course 1	3	O	10	3 x 10 = 30
1	Course 1	3	C	5	3 x 5 = 15
1	Course 1	4	B	6	4 x 6 = 24
		20			139
SGPA					139/20=6.95

The Cumulative Grade Point Average (CGPA) is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

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$$CGPA = \frac{\sum(C_i \times S_i)}{\sum C_i}$$

where S_i is the SGPA of the semester and C_i is the total number of credits in that semester.

Example for Computation of CGPA

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
Credit:21	Credit: 22	Credit :25	Credit: 26	Credit: 26	Credit: 26
SGPA: 6.9	SGPA :7.8	SGPA: 5.6	SGPA: 6.0	SGPA:6.3	SGPA:8.0
CGPA=6.73 $(21 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 26 \times 8.0) / 145$					

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.



B. Sc. (Honours)/ B.Sc. (Honours with Research)

Subject Prerequisite

The candidate should have passed (10+2) examination in science stream with PCB (Physics, Chemistry, Biology and/or Biotechnology) or PCM (Physics, Chemistry and Math's) or any other science subject.

Program Outcomes (PO):

After completion of the B. Sc. Biotechnology programme, the candidate should be able to:

1. Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology research, Biotechnology Industry, Pharma industry, Medical or hospital related organizations, and Academia.
2. Demonstrate skills to use modern analytical tools/ software/ equipment and analyze and solve problems in various courses of biotechnology.
3. Execute their professional roles in society as biotechnology professionals, employers and employees in various industries, researchers and educators.
4. Design, perform experiments, analyze and interpret data for investigating complex problems in biotechnology and related fields.
5. Demonstrate learning skills to work as a team in a multidisciplinary environment.
6. Design and develop sustainable solutions to major biological problems by applying appropriate biotechnology tools.
7. Develop skills, attitude and values required for self-directed, lifelong learning and professional development.
8. Acquire knowledge and understanding of norms and ethics in the field of biotechnology.



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B. Sc. (Honours)/ B.Sc. (Honours with Research) Programme Specific Outcome (PSO)

FIRST YEAR: CERTIFICATE COURSE IN TOOLS AND TECHNIQUES OF CELL AND MOLECULAR BIOLOGY

This course introduces the knowledge of cell biology, genetics, molecular biology and genetic engineering. After completion of this certificate course, students will be able to –

PSO1: Demonstrate and apply their knowledge of cell biology, genetics, molecular biology and genetic engineering to solve the problems related to the field of biotechnology

PSO2: Gain knowledge about the application of various types of microscope, karyotyping, banding techniques, chromosome painting and FACS.

PSO3: Understand the basic concepts of genetics and molecular biology such as inheritance pattern, DNA replication, transcription and translation

PSO4: Understand and perform various recent molecular and recombinant DNA technology techniques in early diagnosis and prognosis of human diseases.

PSO5: Perform experiments of DNA isolation, agarose gel electrophoresis, gene cloning, transformations, protein expression, and purification. This experience would enable them to begin a career in an industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

PSO6: Apply at technical positions in different research laboratories, diagnostic centres and industries.

SECOND YEAR: DIPLOMA IN TOOL AND TECHNIQUES IN BIOTECHNOLOGY

After completion of diploma course, students will be able to-

PSO1: Familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.

PSO2: Understand the significance of Biochemistry and basics of enzymes.

PSO3: Learn the chemistry, structure and functions of major bio-molecules and metabolism of carbohydrate, protein etc.

PSO4: Understand different biochemical tools and techniques such as chromatography, electrophoresis, X-ray diffraction, NMR and mass spectrometry.

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PSO5: Perform different experiments based on the techniques such as chromatography, electrophoresis, centrifugation etc.

PSO6: Understand the different methods of sterilization

PSO7: Understand and also able to perform different immunological techniques like agglutination reaction, ABO typing and ELISA.

THIRD YEAR: DEGREE IN BACHELOR OF SCIENCE

After completing the three-year degree course in Biotechnology, the students will be able to –

PSO1: Demonstrate the concepts in computational Biology. Understand the interrelationship between Biology and Computer

PSO2: Acquire knowledge in different domains of biotechnology enabling their application in industry, research and academia.

PSO3: Perform and analyse the results of experiments using basic laboratory techniques of cell biology, molecular biology, genetic engineering, biochemistry, immunology, microbiology, bioinformatics, biostatistics, animal and plant biotechnology and Food biotechnology.

PSO4: Recognize the foundations of modern biotechnology and explain the principles that form the basis for recombinant technology.

PSO5: Develop an ability to properly understand the technical aspects of existing technologies that help in addressing the biological and medical challenges faced by humankind.

PSO6: Exhibit ability to do research independently as well as in collaboration.

PSO7: Recognize the importance of Bioethics, IPR, and entrepreneurship.

FORTH YEAR: DEGREE IN BACHELOR OF SCIENCE(HONOURS)OR HONOURS WITH RESEARCH

After completing the fourth years course in Biotechnology, the students will be able to –

PSO1: Understand the basic knowledge of research ethics

PSO2: Understand the experimental model for design of fermentation systems



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PSO3:Create research plans/ideas with the help of relevant literature and execute and achieve it in the limited time frame

PSO4:Analyzing the research data



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I Year: I Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT101	Cell Biology and Genetics	4	0	0	25	75	100	4	Major	Own faculty
2	BBT102	Fundamental of Biochemistry	4	0	0	25	75	100	4	Major	Own faculty
3	BBT103	Fundamentals of Plant Physiology	4	0	0	25	75	100	4	MD	Own faculty
4	BBT121SE	Comprehension & Communication Skills in English	3	1	0	25	75	100	4	AEC	Own faculty
5	BBT132	First Aid and Health	2	0	0	25	75	100	2	SEC	Any faculty
Practical											
6	BBT151	Cell Biology and Genetics Lab	0	0	2	25	75	100	1	Major	Own faculty
7	BBT 152	Plant Physiology Lab	0	0	2	25	75	100	1	MD	Own faculty
8	BT153	Biochemistry Lab	0	0	2	25	75	100	1	Major	Own faculty
Total			17	1	3	200			21		

Evaluation Scheme, promotion scheme, grading system, and CGPA calculation adopted from CCFUP, by UGC 2022.

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AEC	Ability Enhancement Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective
MD	Multidisciplinary
VAC	Value-Added Courses common for all UG

MOOCS/NPTEL/SWYAM/Other University/College	
BBT103 Fundamentals of Biochemistry	https://nptel.ac.in/courses/102105034 BioChemistry I, IIT Kharagpur Prof. S. Dasgupta
BBT101 Cell Biology and Genetics	https://onlinecourses.nptel.ac.in/noc23_bt32/preview Cell Biology By Prof. Shikha Laloraya IISc Bangalore



Mahayogi Gorakhnath University, Gorakhpur
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Department of Biotechnology

I Year: I Semester (THEORY)

Cell Biology and Genetics

Code: BBT101

L	T	P	C
4	0	0	4

Course Objective:

1. The course gives the life activities at cellular and molecular level and basic functions of the various cellular compartments and organelles.
2. It also gives the structural, functional and biochemical details of all cellular activities, cell cycles and signaling and cancerous cells.
3. It explains the basic structure of genetic materials and basic principles of Mendelian, population genetics and heredity and gives an overview on the classical genetics- Linkage & Crossing over.

UNIT I: Introduction of cell

Introduction and history of Biotechnological science with special reference to contribution of Indian scholars in biological sciences. Structure of animal, plant and bacterial cells, Diversity of cell size and shape, Cell theory. Cell Membrane: Chemical components of biological membranes, organization and Fluid Mosaic Model and membrane transport

UNIT II: Structure and functions of cellular organelles and chromosome

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion, Structure and functions: Lysosomes:(Vacuoles and microbodies), Ribosomes, Mitochondria, Chloroplasts, Nucleus, Chromosomes. (Structural and numerical changes in human chromosomes and ploidy in plants). Mutations: Types of mutations and mutagens.

UNIT III: Cell cycle, Cancer and Cell Signalling

Cell Cycle: G₁, S, G₂, and M phases, Mitosis and Meiosis: Control points in cell-cycle Cell senescence and programmed cell death. Cancer –chromosomal disorders, Oncogenes, tumor suppressor genes. Introduction to cell–cell interaction.

UNIT IV: Mendelian and non-Mendelian genetics:

Historical developments in the field of genetics. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and trihybrid crosses, Law of segregation & Principle of independent assortment. Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, codominance,. Sex determination and sex

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linkage: Mechanisms of sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory.

UNIT V: Linkage, crossing over, and population Genetics and Cytological Techniques:

Linkage: Definition, Types, and Significance, Crossing-over Definition, Types, and Significance. Introduction to Cytological Techniques like Microscopy and staining techniques, Microtomy, Karyotyping, Chromosome banding, *in situ* hybridization and FISH, chromosome painting, Fluorescence Activated Cell Sorting, etc.

Suggested Reading:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6thEd.). New York: Garland Science.
2. Cooper, G. M., and Hausman, R. E. (2013). The Cell: A Molecular Approach (6th Ed.). Washington: ASM; Sunderland.
3. Karp, G. Cell and Molecular Biology. Concepts and experiments. John Harris, D., Wiley & sons, New York.
4. Iwasa J., Marshal W. Karp's Cell Biology (2018) (8th edition) Wiley & Sons, NY
5. Iwasa J., Marshal W. Karp's Cell and Molecular Biology. Concepts and experiments. (2015) (8th edition) Wiley & sons, New York
6. Watson, J. D. Baker TA, Bell, SP Gann, A. Levine, M. Losick R. (2008). Molecular Biology of the Gene (5thed.). Pearson.
7. Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.
8. Gupta P.K. Cell and Molecular Biology 2018. 5th edition Rastogi Publication India
9. Hartl, D. L., & Jones, E. W. (1998). Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett.
10. Pierce, B. A. (2005). Genetics: A Conceptual Approach. New York: W.H. Freeman.
11. Tamarin, R. H., & Leavitt, R. W. (1991). Principles of Genetics. Dubuque, IA: Wm.C. Brown.
12. Smith, J. M. (1998). Evolutionary Genetics. Oxford: Oxford University Press Genetics: Principles and Analysis – Hartl and Jones.
13. Gardner EJ, Simmons MJ, Sunstad DP. Principles of Genetics. 8th Edition. John Wiley and Sons.
14. Snustand DP, Simmons MJ. Principles of Genetics. (2016) 7th Edition. John Wiley and Sons.
15. Verma PS, Agarwal VK. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. (2004). S Chand and Company Ltd.
16. Satyanarayana U (2020). Biotechnology. Books and Allied (P) Ltd.
17. Singh BD. (2015). Biotechnology: Expanding Horizons (4th edition). Kalyani Publishers
18. Dubey RC. (2014) A Textbook of Biotechnology (5th edition) S Chand and Company Ltd.
19. सिंहबी. डी. (2017) बायोटेक्नोलॉजी Kalyani Publishers
20. पीकेगुप्ता, कोशिका विज्ञान और आनुवंशिकी, 2015 2nd edition Rastogi Publications
21. सिंहबी. डी. आनुवंशिकी के आधार. (2017) Kalyani Publishers
22. सोनीके. सी. स्वरंकार गायत्री. आधुनिक कोशिका विज्ञान, 2018 CBC

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Course Learning Outcome (CLO) This course introduces the principles of cell biology and genetics. After completion of this course, students will be able to-

1. Learn different areas of cell biology including the structure and functions of cell, its organelles such as mitochondria, nucleus etc.
2. Understand how genetic information is transmitted in organism
3. Understand the role of cytoskeleton and its remodeling including the diseases associate with improper remodeling.
4. Learn how the synthesized proteins are transported to different organelles.
5. Understand the regulation of cell cycle, programmed cell death and Cancer.
6. Learn different cell biology techniques like karyotyping, chromosome banding, FISH, FACS, centrifugation and microscopy.

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Mahayogi Gorakhnath University, Gorakhpur
Faculty of Health and Life Sciences
Department of Biotechnology

Year I: I Semester (THEORY)

Fundamental of Biochemistry

Code: BBT102

L	T	P	C
4	0	0	4

Course objectives:

1. The overall objective of the course is for the student to gain a basic working knowledge of biochemical concepts and techniques which will be necessary for future scientific endeavors.
2. To understand the basic knowledge of carbohydrates, lipids, amino acids and nucleic acid.
3. This course gives an idea on different biological molecules, their origin, biological role, with the structures, function and their key properties.
4. The interrelation of each of these metabolic pathways and their contribution in various metabolic disorders are also explained in detail.
5. The application of the knowledge generated in the practical aspects of Biotechnology.

UNIT I: Basics of Biochemistry

History of biochemistry with special reference to the contribution of Indian biochemists. General idea about normality, molarity, molality, percentage solutions, mole fraction. W/v and v/v solutions. Concept of pH determinations using indicators, buffer solutions, and their biological importance. Water as universal solvent.

UNIT II: Carbohydrates

Monosaccharides: structures of aldoses and ketoses, Ring structure of sugars, Fisher Projection, conformations of sugars, mutarotation, anomers, epimers, and enantiomers. Structure of biologically important sugar derivatives, oxidation, and reduction of sugars. Formation of disaccharides, reducing and non-reducing, Polysaccharides, homo and hetero-polysaccharides, structure and storage of polysaccharides.

UNIT III: Nucleic acids structure and functions

Nucleoside, Nucleotides - structure and properties. Nucleic acid structure –Watson - Crick Model of DNA Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides.

UNIT IV: Amino acids and vitamins

Chemical properties of amino acids (Zwitter ion, Isoelectric point etc), Structural features and classification, Physical properties, optical properties (Stereoisomerism), uncommon amino acids and their function. Classification of protein, structural organization as primary, secondary, tertiary and quaternary structure of protein and characteristics of the peptide bond.

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Structure and active forms of water soluble and fat-soluble vitamins, sources, deficiency diseases and symptoms.

Unit V: Lipids

Introduction to lipid micelles, monolayers & bilayers, Introduction to storage and structural lipids, various types of lipids – Oils and fats, Triglycerides- structure and function, Phospholipids- structure, classification and functions, biological significance of various types of Phospholipids, Glycolipids and lipoproteins, serum lipids and its significance, Cholesterol and its derivatives.

Suggested Readings:

1. Lehninger, Albert, Cox, Michael M. Nelson, David L. (2017) Lehninger principles of biochemistry New York: W. H. Freeman.
2. Voet, D., & Voet, J. G. (2011). Biochemistry. New York: J. Wiley & Sons.
3. Biochemistry –Lubertstryer Freeman International Edition.
4. Biochemistry –Keshav Trehan Wiley Eastern Publications
5. Fundamentals of Biochemistry- J. L. Jain S. Chand and Company
6. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
7. Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott:
8. Biochemistry and Molecular Biology: Oxford University Press
9. Taiz, L., Zeiger, E.,. Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
10. Hopkins, W.G., Huner, N.P.,. Introduction to Plant Physiology. John Wiley & Sons,
11. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
12. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.

Course learning outcome (CLO): At the end of the course the student will:

1. Understand the structure of biomolecules (proteins, carbohydrates, lipids, nucleic acid) and their different roles in biological systems
2. Understand the function vitamins
3. Develop an understanding of structure and function of enzymes
4. Understand the coordinated regulation of carbohydrate metabolic pathway.

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Mahayogi Gorakhnath University, Gorakhpur
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I Year: I Semester (THEORY)

Fundamentals of Plant Physiology

Code: BBT103

L	T	P	C
4	0	0	4

Course Objective: The objectives of the course will be as follows.

1. To provide detailed information about the basic principles of plant function.
2. To teach the plant-water relationships.
3. To teach principles of plant cell physiology, growth, and development.
4. To teach carbon and nitrogen metabolism.
5. To provide information about plant secondary metabolites and their role in plant stress physiology.

UNIT I: Plant water relations and micro and macro nutrients

Plant water relation, Importance of water, water potential and its components; Transpiration and translocation in phloem: Transpiration and its significance; Factors affecting transpiration, girdling experiment; Pressure flow model, Composition of phloem sap. Transport of ions across cell membrane, active and passive transport, Root pressure and guttation. Mineral Nutrition, Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops,

UNIT II: Carbon Oxidation

Glycolysis, fate of pyruvate- aerobic and anaerobic respiration and fermentation, regulation of glycolysis, oxidative decarboxylation of pyruvate, Krebs cycle, oxidative pentose phosphate pathway, regulation of Krebs cycle, mitochondrial electron transport, oxidative phosphorylation, ATP-Synthetase, Chemiosmotic mechanism, P/O ratio, cyanide-resistant respiration, factors affecting respiration.

UNIT III: Nitrogen Metabolism

Physiology and biochemistry of nitrogen fixation, Nitrate assimilation, biological nitrogen fixation (in leguminous and non-leguminous plants), Ammonia assimilation (GS/GOGAT cycle), reductive and transamination, amino acid synthesis.

UNIT IV: Lipid Metabolism & Photosynthesis

Lipid Metabolism: Synthesis and breakdown of triglycerides, glyoxylate cycle, gluconeogenesis and its role in the mobilization of lipids during seed germination, Photosynthesis: Pigments, Action spectra, and Enhancement effect, Electron transport system and Photophosphorylation, C3 and C4 photosynthesis, CAM- Reaction and Significance.

UNIT V: Plant Development, Movements, Dormancy & Responses

Developmental roles of Phytohormones (auxins, gibberellins, Cytokinins, ABA, ethylene), autonomic and paratonic movements, control and coordination in plants, Photoperiodism (SDP, LDP, Day-neutral plants), Phytochrome (discovery and structure), red and far red-light responses on photomorphogenesis, seed physiology and dormancy, Vernalization and senescence.

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Suggested Reading:

1. Sunil D Purohit, K. Ahmed & Gotam K Kukda. Plant Physiology and Biochemistry ISBN #:81-301-0035-5 Edition: 2013 Pages: 368 + VIII Text Book (Hindi).
2. Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.
3. Pathmanabhan G, Vanangamudi M, Chandrasekaran CN, Sathyamoorthi K, Babu CR, Babu RC, Boopathi. A Handbook On Mineral Nutrition and Diagnostic Techniques for Nutritional Disorders of Crops (pb) ISBN: 9788177543377 Edition: 01 Year: 2011 PN Publisher: Agrobios (India)
4. Jain, V.K. Fundamental of Plant Physiology (7th ed.) 2004. S. Chand and Company.
5. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.
6. Panday, S.N. & Sinha, B.K. Plant Physiology (4th ed.), 2006, Vikas Publishing House Pvt. Ltd.
7. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
8. Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pthways 2008, New Central Book. Agencies.
9. Voet, D. and Voet, J.G., Bio-Chemistry (3rd ed.), 2005, John Wiley & Sons.
10. Mathews, C.K., Van Holder, K.E. & Ahren, K.G. Bio-Chemistry (3rd ed.), 2000, Pearson Education.
11. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.
12. Srivastava, HN. 2006. Pradeep's Botany Vol. V. Pradeep Publications, Jalandhar.
13. Verma, SK. Plant Physiology and Biochemistry. S. Chand & Sons, New Delhi.
14. Buchanan, Gruissen and Jones. Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, 2000, I.K. International.

Course Learning Outcome (CLO): Upon successful completion of this course the student should be able to understand:

1. Understand the basics of plant physiology and physiological mechanisms governing plant growth and development
2. Learn the basics of transport in plants and movement of solutes and water
3. Remember the basics of photosynthesis, respiration and hormonal signalling as it impacts plant growth and development
4. Comprehend and increase the awareness and appreciation for plants in environment, as well as to understand their diverse physiological functions.



Mahayogi Gorakhnath University, Gorakhpur
Faculty of Health and Life Sciences
Department of Biotechnology

I Year: I Semester (Theory)

Comprehension & Communication Skills in English

Course code: BSB121SE

L	T	P	C
3	1	0	4

Course objective: The objectives of the course are as follows:

1. To enable the students to acquire the communication skills of listening, speaking, reading and writing through a learning-centered curriculum comprising skills of intensive reading, extensive reading, written communication and oral communication.
2. To provide task-centered teaching-learning materials for students of diverse entry levels so that they eventually attain almost the same level of target behavior.
3. To enable the learner to communicate effectively and appropriately in real life situation.

UNIT I: Comprehension and Textual Analysis

Textual Comprehension: R.K. Narayan: "Toasted English" – Reading comprehension and vocabulary enhancement, Francis Bacon: "Of Studies" – Interpretation, vocabulary, and summarization.

Summarization: Techniques of summarizing a given text or passage

UNIT II: Functional Language Skills

Grammar and Sentence Correction: Identification and correction of incorrect sentences, Functional grammar in context, Core Language Skills: Understanding and application of LSRW (Listening, Speaking, Reading, Writing) + Grammar, Text Analysis: Martin Luther King Jr.: "I Have a Dream" – Textual summarization and critical understanding, Grammar: Degrees of Comparison

UNIT III: Writing Skills

Letter Writing: Format and mechanics of personal and official letters, Effective correspondence techniques, Practical Writing Tasks: Application writing, Welcome speeches and vote of thanks, Paragraph and essay writing, Story writing and review writing, Abstract writing, and journal writing
Creative and Academic Composition: Exposure to various forms of written expression

UNIT IV: Productive Communication Skills

Professional Communication: Preparation of Curriculum Vitae (CV) and job applications, Types, settings, and purposes of interviews, Roles of interviewer and interviewee, Communication Theory: Definition, process, and components of communication, Oral Presentation Skills: Structure, delivery techniques, and audience engagement

UNIT V: Applied Grammar and Usage

Basic Grammar: Use of articles and parts of speech, sentence punctuation and correction
Vocabulary: Synonyms and Antonyms, One-word substitutions, Idioms and phrases, Pair of words (commonly confused/misused), Sound and Speech Elements: Vowel and consonant sounds, Homonyms and homophones, Stylistic Devices: Figures of speech and their usage in context

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Suggested Readings:

1. Essential Communication Skills: A Multi-Course for English Communication. MacMillan Publishers India Pvt. Limited.
2. English Grammar & Composition by S.C. Gupta
3. Nurture English Grammar and Composition Books by Target Publications.
4. Toasted English Essay's Books by R.K Narayan.
5. BOOK: I Have a Dream – Martin Luther King.
6. Leech, Cruickshank, And Ivanic's An A-Z of English Grammar & Usage
7. Of Studies books by Francis Bacon.,

Course Learning Outcome (CLO)

At the end of the course the student will be able to:

1. Make good resume and prepare effectively for interview.
2. Perform effectively in group discussions.
3. Explore communication beyond language.
4. Acquire good communication skills and develop confidence.

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Mahayogi Gorakhnath University, Gorakhpur
Faculty of Health and Life Sciences
Department of Biotechnology

I Year: I Semester (THEORY)

First Aid and Health
Code (BBT132)

L	T	P	C
2	0	0	2

Course Objectives: The objectives of the course are as follows:

1. To give immediate care.
2. To protect the casualty from further harm.
3. To relieve pain.
4. To promote recovery
5. The recovery is promoted as the heart rate goes down, which in turn prevents blood loss from the victim's body.

UNIT I- Basic First Aid and Technique

Aims of first aid & First aid and the law, Dealing with an emergency, Resuscitation (basic CPR), Recovery position, Initial top to toe assessment, Hand washing and Hygiene, Types and content of a first aid kit, Dressings and Bandages, Fast evacuation techniques (single rescuer), Transport techniques

UNIT II: First aid related with the respiratory system, Heart, Blood and Circulation and Wounds and Injuries

Basics of respiration, No breathing or difficult breathing, Drowning, Choking, Strangulation and hanging, Swelling within the throat, Suffocation by smoke or gases and Asthma, Basics of The heart and the blood circulation, Chest discomfort, bleeding, Type of wounds, Small cuts and abrasions, Head, Chest, Abdominal injuries, Amputation, Crush injuries, Shock.

UNIT III: First aid related with; Nervous system and Unconsciousness, Gastrointestinal Tract, Skin, Burns

Basics of the nervous system, Unconsciousness, Stroke, Fits – convulsions – seizures, Epilepsy, Basics of the gastrointestinal system, Diarrhea, Food poisoning, Basics of the skin, Burn wounds, Dry burns and scalds (burns from fire, heat and steam), Electrical and Chemical burns, Sun burns, heat exhaustion and heatstroke, Frost bites (cold burns), Prevention of burns, Fever and Hypothermia, Animal bites, Road and traffic accidents.

UNIT IV: Basic Sex Education

Overview, ground rules, and a pre-test, Basics of Urinary system and Reproductive system, Male puberty — physical and emotional changes, Female puberty — physical and emotional changes, Male-female similarities and differences, Sexual intercourse, pregnancy, and childbirth, Facts, attitudes, and myths about LGBTQ+ issues and identities, Birth control and abortion, sexual harassment, sexual abuse, and rape, Prevention of sexually transmitted diseases.

UNIT V: Mental Health and Psychological First Aid

Mental Health First Aid, Mental Health Problems in India, The Mental Health First Aid Action Plan, Understanding Depression and Anxiety Disorders, Crisis First Aid for Suicidal Behaviour & Depressive symptoms, Non-Suicidal Self-Injury, Non-crisis First Aid for Depression and Anxiety, Crisis First Aid for Panic Attacks, Traumatic events, Understanding Disorders in Which Psychosis may Occur, Crisis First Aid for Acute Psychosis, Understanding Substance Use Disorder, Crisis First Aid for Overdose, Withdrawal, Using Mental Health First Aid

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Department of Biotechnology

SUGGESTED READING

1. Dr. Gauri Goyal, Dr. Kumkum Rajput & Dr. Manjul Mungali. 2020. First Aid and Health, ISBN 978-93-92208-19-5
2. Indian First Aid Manual-<https://www.indianredcross.org/publications/FA-manual.pdf>
3. Red Cross First Aid/CPR/AED Instructor Manual

Course Learning Outcome (CLO): Upon successful completion of this course the student should be able to:

1. Learn the skill needed to assess the ill or injured person and to provide CPR to infants, children and adults.
2. Learn the Basic sex education help young people navigate thorny questions responsibly and with confidence.
3. Learn the Basic sex education help youth to understand Sex is normal. It's a deep, powerful instinct at the core of our survival as a species. Sexual desire is a healthy drive.
4. Learn the skill to identify Mental Health status and Psychological First Aid

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Mahayogi Gorakhnath University, Gorakhpur
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I Year: I Semester (PRACTICAL)

Cell Biology and Genetics Lab

Code: BBT151

L	T	P	C
0	0	2	1

Course objective: The objectives of the lab course are as follows:

1. To give practical experience to learn safety measures in Laboratories
2. To understanding of different cell structure, its organelles and multiplication
3. To learn the laws of heredity with practical emphasis on inheritance
4. To gain hand on training to test Ames test for mutagenesis

PRACTICAL

1. Introduction to safety measures in Laboratories
2. Study of structure of any Prokaryotic and Eukaryotic cell.
3. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, esophagus, stomach, pancreas, intestine, kidney etc.
4. Cell division in onion root tip/ insect (grasshopper) gonads.
5. Vital Staining of Mitochondria with Janus green B.
6. Demonstration of Sex chromatin in buccal smear.
7. Karyotype preparation.
8. Preparation of polytene chromosomes from the salivary gland of Chironomus larvae.
9. Genetics problems based on: (i) Mendel's law (ii) Gene mapping and (iii) Transposable elements.
10. Ames test for mutagenesis

Course Learning Outcome (CLO):After successful completion of this lab course, the student:

1. Would be able to identify and outline the structure of an eukaryotic cell at different magnifications, and measure the cell length and breadth using micrometry.
2. Understand different stages of Mitosis and meiosis, to isolate chloroplasts and estimate chlorophyll content in plant samples.
3. Would be able to understand (i) Mendel's law (ii) Gene mapping and (iii) Transposable elements.

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Mahayogi Gorakhnath University, Gorakhpur
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I Year: I Semester (PRACTICAL)

Plant Physiology Lab
Code: BBT152

L	T	P	C
0	0	2	1

Course objective: The objectives of the lab course are as follows:

1. To introduce concepts about plant physiology.
2. To give practical experience to understand the Separation of photosynthetic pigments by chromatography
3. To experience an advanced level to enable a practical understanding of the cardinal importance of plant metabolism in the biosphere
4. To introduce physiology of plants like aerobic respiration in germinating seeds, photosynthesis in aquatic plant etc.

PRACTICAL

1. Demonstration of plasmolysis in *Tradescantia* leaves
2. Determination of water potential of plant tissue
3. Study stomatal distribution on leaf surfaces and calculation of stomatal index
4. Study of ascent of sap in plants
5. Study aerobic respiration in germinating seeds
6. Separation of photosynthetic pigments by paper chromatography
7. Chlorophyll and carotenoid quantification via spectrophotometric analysis
8. Demonstration of photosynthesis in aquatic plant
9. Determine the presence of starch and sucrose in plants
10. Determination of transpiration from foliar surface

Course Learning Outcome (CLO): After successful completion of this lab course, student:

1. Would be able to understand basic of plant physiology and biochemistry.
2. To understand the distribution of stomata on leaf and their photosynthesis.
3. Understand the function of chlorophyll and aerobic respiration.
4. Would be able to determine the presence of starch and sucrose in plants.

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I Year: I Semester (PRACTICAL)

Biochemistry Lab

Code: BBT153

L	T	P	C
0	0	2	1

Course objective: The objective of this practical course is as:

1. To acquire the skill for preparation buffers and their validation.
2. To estimate protein concentrations by plotting standard graphs by Beer-Lambert law.
3. To teach titration of amino acids and separation of different compounds by TLC.
4. To teach purification and quantification of different enzymes/ proteins.
5. To teach different spectroscopy techniques and determine the mass of proteins.

PRACTICAL

1. Qualitative tests for Carbohydrates, lipids and proteins.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. To study activity of any enzyme under optimum conditions
9. Testing of Blood Sugar (3 Periods)
10. Testing of Liver Function Test (Bilirubin, SGOT, SGPT, Alkaline Phosphatase, Albumin, Globulin, Total Protein) (8 Periods)

Course Learning Outcome (CLO):

1. Students will heighten their awareness of correct usage of English grammar in writing and speaking.

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2. Students learn to improve their speaking ability in English both in terms of fluency and comprehensibility.
3. Students will be able to present oral presentations and receive feedback on their performance.
4. Students will develop to improve their reading speed with fluency skills and comprehension of academic articles.
5. Students will enlarge their vocabulary and ability to write academic papers, essays and summaries using the process approach.

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B.Sc. Biotechnology (Hons./Hons. With Research)
Study Evaluation Scheme (Choice-Based Credit System)
Effective from the session 2025-26

I Year: II Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT201	Molecular Biology	4	0	0	25	75	100	4	Major	Own faculty
2	BBT203	Mammalian Physiology	4	0	0	25	75	100	4	MD	Any faculty
3	BBT204	Biotechnology and Human Welfare	4	0	0	25	75	100	4	Major	Own faculty
4	BBT205	Enzyme Technology	3	0	0	25	75	100	3	Major	Own faculty
5	BBT2201	Bioethics and Biosafety	3	0	0	25	75	100	3	Major	Own faculty
6	BBT232	Food, Nutrition, and Hygiene	2	0	0	25	75	100	2	VAC	Any faculty
Practical											
7	BBT251	Molecular Biology Lab	0	0	2	25	75	100	1	Major	Own faculty
8	BBT253	Mammalian Physiology Lab	0	0	2	25	75	100	1	MD	Own faculty
Total			20		2	200	600	800	22		

Certificate Course in Tools and Techniques of Cell and Molecular Biology*

Evaluation Scheme, promotion scheme, grading system, and CGPA calculation adopted from CCFUP, by UGC 2022.

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AEC	Ability Enhancement Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective
MD	Multidisciplinary
VAC	Value-Added Courses common for all UG

MOOCS/NPTEL/SWYAM/Other University/College	
BBT205 Enzyme Technology	https://onlinecourses.nptel.ac.in/noc23_bt05/preview Enzyme Sciences and Technology By Prof. Vishal Trivedi, IIT Guwahati

*** UG Certificate:** Students who opt to exit after completion of the first year and have secured 40 credits will be awarded a UG certificate if, in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree program within three years and complete the degree program within the stipulated maximum period of seven years.

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I Year: II Semester (THEORY)

Molecular Biology

Code: BBT201

L	T	P	C
4	0	0	4

Course objectives: Molecular biology has witnessed a paradigm shift after the discovery of the double helical structure of DNA. This course on molecular biology aims to teach the fundamental role of DNA molecules as a blueprint of life. The specific objectives of the course are as follows:

1. To familiarize students with the structure and function of biological systems at the molecular level.
2. To impart knowledge about the key components participating in the replication of genetic material.
3. To teach the processes and pathways that replicate, transcribe, and translate DNA.
4. To make students understand the different methods of DNA damage, repair, and recombination.

Unit I: DNA structure and replication

Central dogma of life, DNA as genetic material, Structure, types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, **Enzymes and Proteins involved in replication**. The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

Unit II: DNA damage, repair and homologous recombination

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

Unit III: Transcription and RNA processing

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation. Processing of pre mRNA: 5' cap formation, polyadenylation, concept of introns and exons, RNA splicing.

Unit IV: Translation:

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Genetic code and its characteristics, **Wobble Hypothesis**, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation., Post-translational modifications of proteins.

Unit V: Regulation of gene expression and translation

Regulation of gene expression in prokaryotes and eukaryotes: Operon concept (inducible and repressible system): lac and trp operons. Basics of RNA interference, Antisense Technology, CRISPR Cas9

SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication.
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco.
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
7. Gardner EJ, Simmons MJ, Snustard DP (2008). Principles of Genetics. 8th Ed. Wiley-India.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Understand the structure and function of biological system at the molecular level.
2. Understand molecular mechanisms.
3. Learn different kinds of gene expression regulation.
4. Understand the fundamentals of DNA molecule as a blueprint of life.



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I Year: II Semester (THEORY)

Mammalian Physiology

Code: BBT203

L	T	P	C
4	0	0	4

Course objective: The objectives of the course are as follows:

1. To examine basic concepts of mammalian physiology
2. To understand the mechanisms of digestion and respiration system
3. To know the mechanisms of circulation and endocrine function
4. To explore the physico-chemical basis and operation of each organ system.

UNIT I: Digestion and Respiration

Digestion: Mechanism of digestion and absorption of carbohydrates, proteins, lipids and nucleic acids. Composition of bile, saliva, pancreatic, gastric and intestinal juice Respiration: Exchange of gases, Transport of O₂ and CO₂, Oxygen dissociation curve, Chloride shift.

UNIT II: Circulation

Composition of blood, plasma proteins and their role, blood cells, hemopoiesis, mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, origin and conduction of heartbeat.

UNIT III: Muscle physiology and osmoregulation

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

UNIT IV: Nervous coordination

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

UNIT V: Endocrine coordination and **Reproduction**

Different endocrine glands: Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo and hyper-secretions. **Introduction to Reproductive Physiology, Male and female Reproductive System, Reproductive Disorders**

SUGGESTED READING

1. Guyton, AC, and Hall, JE. 2006. Textbook of Medical Physiology. 11th ed. Hecourt Asia PTE Ltd. /W.B. Saunders Company.

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2. Agarwal, RA, Srivastava, AK, and Kumar, K. 1986. Animal Physiology and Biochemistry. S Chand Publications. ISBN 9788121904476

Course learning outcomes (CLO): At the end of course the student will be able to:

1. Understand the working of digestive and respiratory systems of mammals.
2. Learn about the functioning and components of the circulatory system.
3. Comprehend the role of nervous system in coordinating the muscular and sensory functions of the mammalian body.
4. Remember the role of endocrine system in regulating the body's growth, metabolism, and sexual development.

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I Year: II Semester (THEORY)

Biotechnology and Human Welfare

Code: BBT204

L	T	P	C
4	0	0	4

Course Objective: The course introduces students to the fundamentals of biotechnology, current trends and careers in biotechnology, regulatory, and ethical aspects of biotechnology. The knowledge and skills gained in this course will provide students with a broad understanding of biotechnology and its impact on society.

UNIT I-Industry

Protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation, **Role in food processing and probiotics.**

UNIT II-Agriculture

N₂ fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III-Environment

Chlorinated and non-chlorinated organic pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, and development of biodegradable polymers such as PHB. **Bioremediation: strategies and examples (oil spills, heavy metal detox), Biosensors for environmental monitoring, Waste management using microbes.**

UNIT IV- Forensic Science

Solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V- Health

Development of non-toxic therapeutic agents, **Stem cells and regenerative medicine.** recombinant live vaccines, gene therapy, diagnostics, monoclonal Antibodies , human genome project.

Suggested Readings:

1. Sateesh, MK 2010. Bioethics and Biosafety. IK International Pvt Ltd.
2. Dubey, RC 2010. A Textbook of Biotechnology. S Chand Publications.
3. Singh, BD 2013. Expanding Horizons in Biotechnology. Kalyani Publication.
4. Shri Krishna, V 2007. Bioethics and Biosafety in Biotechnology. New age international publishers.

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Course Learning Outcome (CLO): Upon successful completion of this course, the student will:

1. Recognize the importance of various molecular techniques used in biotechnological industry and the importance of modern agriculture and its application.
2. Understand the importance of biotechnology in relation to environment and pollution.
3. Learn about various applications-based techniques in biotechnology like forensic science and the related activities currently going on and that will lay the foundations for the future work in relation to crime.
4. Comprehend the application of biotechnology in therapeutic drug and vaccine development, gene therapy and diagnostics

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I Year: II Semester (THEORY)

Enzyme Technology

Code: BBT205

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are as follows:

1. To provide an understanding of the biochemical nature of enzyme and other associated biomolecules and their role.
2. To provide a basic understanding of the enzyme kinetics and application of enzymes in industries.
3. To understand the current applications and future potential of enzymes and their activity.
4. To understand the role of enzyme immobilization and its microbial production.

UNIT I: Introduction to enzymes technology

Historical aspects, Scope of enzyme, Nomenclature and their classification, Coenzyme, Cofactor, Properties of enzymes, enzyme assay, enzyme units, turnover number.

UNIT II: Mechanisms and kinetics

Mechanisms of enzyme action, Concept of the active site and energetics of enzyme-substrate complex formation, Specificity of enzyme action, Kinetics of single substrate reactions, Estimation of Michaelis-Menten parameters, Transformation of Michaelis-Menten equation (Lineweaver-Burk equation). Enzymes inhibition

UNIT III: Enzyme immobilization

Physical and chemical techniques for enzyme immobilization, Adsorption, Matrix entrapment, Encapsulation, Cross-linking, Covalent binding, Advantages and disadvantages of different immobilization techniques.

UNIT IV: Enzyme engineering

Strategies to alter catalytic efficiency; structure prediction & modeling proteins; Dynamics & mechanics; Random and site-directed mutagenesis.

UNIT V: Production of enzymes

Cost-effective production, optimization of microbial enzyme production, enzyme-based bioreactor and enzyme base biosensor, downstream processing of enzyme, **Isoation and Purification of enzymes.**
Different methods of enzyme characterization- SDS-PAGE, 2-D

SUGGESTED READING

1. Nelson D.L., Lehninger A.L. and Cox M.M. 2008. Lehninger principles of biochemistry. Macmillan.
2. Palmer T and Bonner P. 2007 (Reprint). Enzymes: Biochemistry Biotechnology, Clinical chemistry, 2nd Edition Woodhead Publishing.

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3. Nicholas C. P. and Lewis S. 1989(Reprint). Fundamentals of Enzymology 1st Edition. Oxford University Press.
4. Voet D. and Voet J. G. 2011(Reprint). Biochemistry, 4th Edition, Wiley.

Course Learning Outcome (CLO): Upon successful completion of this course the student should be able to:

1. To understanding of biochemical nature of enzyme
2. To explain basic understanding of the enzyme kinetics and their application in industries.
3. To understand future potential of enzymes and their activity.
4. To explain the role of enzyme immobilization and its microbial production.

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I Year: II Semester (THEORY)

Bioethics and Biosafety

Code: BBT2201

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are as follows:

1. To understand importance of bioethics and biosafety.
2. To understand legal social and economic impacts of biotechnology.
3. To understand regulatory guidelines and their importance.
4. To understand importance of patent and procedure for patent filling.
5. To understand procedure of assessment of biosafety for biotech foods.
6. To understand ethical implications of biotechnology.

UNIT I: Introduction to Bioethics and Biosafety

Bioethics-Necessity of bioethics, different paradigms of bioethics- National and international ethical issues against molecular technologies. Institutional, social, Cultural, Business and Consumer issues.

UNIT II: Biosafety regulation guidelines

Biosafety-Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and good laboratory practices (GLP) and good manufacturing practices (GMP). Implications of biotechnological products and techniques: Bioterrorism, transgenic science, GM crops.

UNIT III: Biosafety Regulation

GMO/LMO and their release in the environment. Experimental protocol approvals, Laboratory associated infections and other hazards, Risk groups and assessment and levels of biosafety. Pesticides preharvest residue management

UNIT IV: Bioethics towards Biodiversity protection and conservation

Convention on biodiversity, Indian Biodiversity act, Legal implications, Biodiversity and farmers' rights. Human genome project and stem cells research: Introduction, Ethical, legal and social implications of HGP. Stem Cell Research- biosafety and its ethical issues

UNIT V: Food and pharma safety

The GM-food debate and biosafety assessment procedures for biotech foods and related products, including transgenic food crops, Environmental aspects of biotech applications. FlavrSavr Tomato as model case, Biosafety assessment of biotech pharmaceutical products.

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1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers
3. The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
4. Intellectual property rights – Ganguli – Tat McGraw-Hill
5. Biotechnology-B. D. Singh- Kalyani Publications

Course Learning Outcome (CLO): Upon successful completion of this course the student should be able to:

1. Understand the scope and aspects of Bioethics and biosafety
2. Learn the ethical implications of biotechnology and need for biosafety, GLP and GMP, concerns related to GMO's and their regulation.
3. Analyze the safer use of Biotechnology in agriculture, animal husbandry, pharmaceuticals, and environment by implanting biosafety regulations.
4. Comprehend the ability to understand biosafety assessment procedure for biotech food, pharmaceuticals and other products.

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I Year: II Semester (THEORY)

Food, Nutrition and Hygiene

Code: BBT232

L	T	P	C
2	0	0	2

Course objective: The objectives of the course are as follows:

1. To learn the basic concept of Food and Nutrition
2. To study the nutritive requirement during special conditions like pregnancy and lactation
3. To learn meal planning
4. To learn 100 days Nutrition Concept

UNIT I: Concept of Food and Nutrition

Concept of Food and Nutrition (a) Definition of Food, Nutrients, Nutrition, Health, balanced Diet (b) Types of Nutrition- Optimum Nutrition, under Nutrition, Over Nutrition (c) Meal planning- Concept and factors affecting Meal Planning (d) Food groups and functions of food.

UNIT II: Nutrients: Macro and Micro

Nutrients: Macro and Micro RDA, Sources, Functions, Deficiency and excess of (a) Carbohydrate (b) Fats (c) Protein (d) Minerals Major: Calcium, Phosphorus, Sodium, Potassium Trace: Iron, Iodine, Fluorine, Zinc (e) Vitamins Water soluble vitamins: Vitamin B, C Fat soluble vitamins: Vitamin A, D, E, K (f) Water (g) Dietary Fiber.

UNIT III: 1000 days Nutrition

1000 days Nutrition (a) Concept, Requirement, Factors affecting the growth of child (b) Prenatal Nutrition (0 - 280 days): Additional Nutrients' Requirement and risk factors during pregnancy (c) Breast / Formula Feeding (Birth – 6 months of age) Complementary and Early Diet (6 months – 2 years of age)

UNIT IV: Community Health Concept

Community Health Concept (a) Causes of common diseases prevalent in the society and Nutrition requirements in the following: Diabetes Hypertension (High Blood Pressure) Obesity Constipation Diarrhoea, Typhoid (b) National and International Program and Policies for improving Dietary Nutrition (c) Immunity Boosting Food.

Suggested Readings

1. Singh, Anita, "Food and Nutrition", Star Publication, Agra, India, 2018.
2. 1000Days-Nutrition_Brief_Brain-Think_Babies_FINAL.pdf
3. <https://pediatrics.aappublications.org/content/141/2/e20173716>
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5750909/>
5. SheelSharma, Nutrition and Diet Therapy, Peepee Publishers Delhi, 2014, First Edition.

Course Learning Outcome (CLO): Upon successful completion of this course, the student will:

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1. Understanding the basic concept of the Food, Nutrition and hygiene
2. To explain nutritive requirement during pregnancy and lactation etc.
3. To prepare meal planning
4. To understand and explain 100 days Nutrition Concept



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I Year: II Semester (PRACTICAL)

Molecular Biology Lab
Code: BBT251

L	T	P	C
0	0	2	1

Course objective: The objective of this laboratory course is to provide the students practical skills in basic molecular biology and Genetic Engineering

1. Students will learn different techniques of molecular biology
2. Demonstrate practical skills in different laboratory equipment and their handling like colorimeter, spectrophotometer, Electrophoresis etc.

PRACTICAL

1. Study of different types of DNA and RNA using micrographs and model/schematic representations.
2. Study of semi-conservative replication of DNA through micrographs / schematic representations.
3. Isolation of genomic DNA from *E. coli*.
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) and UV spectrophotometer (A260 measurement).
5. Estimation of RNA using colorimeter (orcinol reagent) and UV spectrophotometer (A260 measurement).
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

Course Learning Outcome (CLO): After completion of the course, the student shall be able to -

1. prepare different bacterial growth media,
2. Understand principals and methods of competent cell preparation, restriction digestion, gene ligation, gene cloning, and transformation i. e gene manipulation.
3. Understand the method of agarose electrophoresis for plasmid and genomic DNA separation
4. Understand the method of blotting and PCR

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I Year: II Semester(PRACTICAL)

Mammalian Physiology Lab

Code: BBT253

L	T	P	C
0	0	2	1

Course objective: The objective of this laboratory course is to provide the students with practical skills in Mammalian Physiology

1. The course practical has been designed to make students understand the functioning of organs/ systems of Mammals so that students can further appreciate the knowledge.
2. to provide a course of study in mammalian, principally human, systems physiology, building on knowledge of basic physiological principles
3. to expand on some areas touched on in mammalian Physiology to introduce new and more complex physiological functions like blood cells
4. to develop further practical biological skills introduced in Physiology of Organisms

PRACTICAL

1. Preparation of a temporary slide of a mammalian tissue sample
2. Estimation of bleeding time and clotting time of the human being
3. Identification of blood cells by differential staining
4. Perform differential leukocyte count (DLC) in the blood sample
5. Study the formation of hemin crystals in the human blood
6. Estimation of blood glucose level by glucometer
7. Identification of blood group in humans
8. Analyze the action of catalase enzyme
9. Separation of plasma and serum from the whole blood
10. Study pulmonary function test via online video tutorial

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Course Learning Outcome (CLO): After successful completion of this lab course, students will be able to understand:

1. The course has been designed to provide students with sufficient information about Mammalian Physiology which forms the basis for undertaking mammalogy studies by the students subsequently.
2. Students will learn the general structure of mammalian tissue.
3. Understanding of blood cells by differential staining.
4. Understanding of pulmonary function



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B.Sc. Biotechnology (Hons./Hons. With Research)
Study Evaluation Scheme (Choice-Based Credit System)
Effective from the session 2025-26

II Year: III Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT302	Environmental Biotechnology	4	0	0	25	75	100	4	Minor	Own faculty
2	BBT304	Developmental Biology	4	0	0	25	75	100	4	Minor	Own faculty
3	BBT305	Genetic Engineering	4	0	0	25	75	100	4	Major	Own faculty
4	-----	Discipline Specific Elective-1	3	0	0	25	75	100	3	SEC	Own faculty
5	BBT331	Physical Education and Yoga	1	0	2	25	75	100	2	VAC	Any faculty
Practical											
6	BBT353	Genetic Engineering Lab	0	0	2	25	75	100	1	Major	Own faculty
7	BBT354	Environmental Biotechnology Lab	0	0	2	25	75	100	1	Major	Own faculty
8	BBT353IV	Industrial Visit-1	0	0	4	25	75	100	2	SEC	Own faculty
Total			16		5	200	600	800	21		

Evaluation Scheme, promotion scheme, grading system, and CGPA calculation adopted from CCFUP, by UGC 2022.

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AEC	Ability Enhancement Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective
MD	Multidisciplinary
VAC	Value-added courses common for all UG

Discipline Specific Elective-1	
Course Code	Course Name
BBT3201VO	Molecular Diagnostics
BBT3202VO	Quality Control in Biopharmaceutical Lab

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II Year: III Semester (THEORY)

Environmental Biotechnology

Code: BBT-302

L	T	P	C
4	0	0	4

Course objectives: The course is aimed to introduce the basics of environmental biotechnology and focuses on the utilization of different biotechnological methods to protect the environment. The course is designed to meet the following specific objectives:

1. To impart the basic knowledge about environmental biotechnology.
2. To introduce the concepts and applications of biofuels and bioremediation.
3. To introduce the process of formation of biofertilizers and learn its applications.
4. To give students an overview of various applications of biotechnology in pollution control and biotransformation of pollutants.

UNIT I: Basics of environmental biotechnology

Introduction to environmental biotechnology; importance of biotechnology in environmental protection; population diversity; environmental hazards; energy flow in ecological systems, energy efficiencies.

UNIT II: Biofuels

Conventional fuels and their environmental impact: firewood, coal, and gas; biofuels methanogenic bacteria, microbial hydrogen production, biogas, biodiesel, bio ether, bioethanol, microbe-based fuel cells.

UNIT III: Bioremediation

Bioremediation of soil and water contaminated with oil spills; heavy metals, detergents, and pesticides; phytoremediation; degradation of lignin, cellulose, pesticides, petroleum products, and other toxic chemicals by micro-organisms; treatment of municipal waste.

UNIT IV: Bio-fertilizers

Role of symbiotic and symbiotic nitrogen-fixing bacteria in the enrichment of soil; algal and fungal biofertilizers; microphos biofertilizers; composting.

UNIT V: Application of biotechnology in pollution control

Biotechnological methods of pollution detection: bioassay, biosensors, and biological indicators; environmental genetics: degradative plasmids, environmental significance of genetically modified microbes, plants, and animals.

SUGGESTED READING

1. Wainwright, M 1999. An Introduction to Environmental Biotechnology, 1st ed. Springer, USA.
2. Singh, RL 2017. Principles and Applications of Environmental Biotechnology for a Sustainable Future, 1st ed. Springer Singapore

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3. Kumar, R, Sharma, AK and Ahluwalia, SS 2017. Advances in Environmental Biotechnology, 1st ed. Springer Singapore
4. Vallero, DA 2015. Environmental Biotechnology: A Biosystems Approach, 2nd ed. Academic Press.

Course Learning Outcome (CLO): After successful completion of the course, student will be able to:

1. Understand the problems in isolation, strain improvement and growth of
2. Microorganisms in industrial processes.
3. Learn to Isolate and improve the industrially important microorganisms.
4. Understand design and types of fermenters and operation of fermenters.
5. Learn fundamentals of Environmental Biotechnology
6. Understand the importance of clean (pollution free) environment
7. Understand biotechnological solutions to address environmental issues including
8. Pollution, mineral resource winning, renewable energy and water recycling.

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II Year: III Semester (THEORY)

Developmental Biology

Code: BBT304

L	T	P	C
4	0	0	4

Course objectives: The course aims to teach the principles and molecular biology of eukaryotic development, from zygote to embryo development and differentiation. The specific objectives of the course are:

1. To understand the history and basic concepts of embryology
2. To become familiar with the process of fertilization, spermatogenesis, and oogenesis
3. To understand the process of organogenesis.
4. To understand the molecular basis of development.

UNIT I: Gametogenesis and fertilization

Definition, scope and historical perspective of development biology; gametogenesis: spermatogenesis and oogenesis; fertilization: mechanism and types of fertilization; *in-vivo* and IVF different types of eggs on the basis of yolk.

UNIT II: Early embryonic development

Embryo cleavage types, patterns and mechanism; process, types and mechanism of blastulation; gastrulation; cell movements: epiboly, emboly, extension, invagination, convergence, de-lamination; formation and differentiation of primary germ layers; fate maps in early embryos.

UNIT III: Embryonic differentiation

Differentiation; cell commitment and determination; the epigenetic landscape: a model of determination and differentiation; control of differentiation at the level of genome, transcriptional and post-translational levels; concept of embryonic induction: primary, secondary and tertiary embryonic induction; neural induction and induction of vertebrate lens.

UNIT IV: Organogenesis

Neurulation, notogenesis, development of vertebrate eye; the fate of different primary germ layers; development of behavior: constancy and plasticity; extra embryonic membranes; placenta in mammals.

UNIT V: Molecular biology of development

Role of homeotic genes (*Hox* gene) and maternal effect genes (*bicoid* and *nanos*) in *Drosophila* development; axis specification in amphibians: concept of primary organizer; role of β -*catenin* gene and the origin of *Nieuwkoop* centre; vulval induction in *C. elegans*; role of *TBX* 4, *TBX* 5 and *Sonic hedgehog* genes in the development of tetrapod limb in vertebrates

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1. Balinsky, BI 2012. An introduction to Embryology, 5th ed. Cengage Learning India.
2. Gilbert, SF 2006. Developmental Biology, 8th ed. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
3. Kalthoff, 2000. Analysis of Biological Development, 2nd revised ed., McGraw-Hill Publishing Co.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Understand the differences between the structure of male and female gametes
2. Learn the process of early and late embryonic development including the process of cleavage, blastulation and gastrulation in animals.
3. Understand the role and importance of Hox, bicoid, sonic hedgehog, etc genes in development.

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II Year: III Semester (THEORY)

Genetic Engineering

Code: BBT 305

L	T	P	C
4	0	0	4

Course Objective:

1. To gain knowledge on gene manipulation using genetic engineering methods and its importance in plant, animal and environmental biotechnology.
2. To introduce the role of different enzymes in genetic engineering
3. To introduce vectors used in recombinant DNA technology.
4. To know the applications of genetic engineering for making transgenic organisms

UNIT I: Enzymes and vectors used in DNA manipulating

Enzymes used in cloning; restriction endonucleases, ligases, Polymerases, Kinases, Alkaline phosphatases, Reverse Transcriptase, phosphatases, and topoisomerases. Vectors used in cloning and expression- Cloning vectors (plasmids, cosmids, bacterial artificial chromosomes and yeast artificial chromosomes), shuttle vectors, and expression vectors.

UNIT II: Transformation and related techniques

Competent cell preparation methods, Transformation methods for bacteria, plant and animal cells. Screening of transformants- selection markers (antibiotic resistance and genes of essential metabolism), alpha complementation for recombinant selection, reporter genes (GUS assay, luciferase), strategies for heterologous expression of genes and guiding principles.

UNIT III: PCR and related techniques

Polymerase chain reaction: Thermal profile and reaction components: Optimization (touch down/ hotstart and gradient PCR) Types of PCR and their applications, Real Time-PCR. PCR-based cloning: T/A cloning, TOPO cloning, and gateway cloning.

UNIT IV: Construction of libraries, screening and sequencing

Preparation and comparison of genomic and cDNA library, DNA sequencing methods: Conventional and Next Generation sequencing approaches. Maxam Gilbert chemical degradation method, Sanger's dideoxy chain termination method, Nanopore sequencing, pyrosequencing, Ion torrent method.

UNIT V: Applications of genetic engineering

Gene downregulation using antisense RNA, dsRNA, and cosuppression, CRISPR-CAS-9. Site-directed mutagenesis (PCR based methods) Assessment of gene functional boundary, transgenic animals (knockout mice) and plants: Bt crops.

Q. 2



SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pasternik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
5. Wiley JM, Sherwood LM and Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 8th edition, McGraw Hill Higher Education.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Understand the use of enzymes in genetic engineering.
2. Explain gene cloning, transformation techniques used in genetic engineering
3. Explain to gene cloning and application of genetic engineering
4. Understand the application of PCR and related techniques

Q. 2



II Year: III Semester (THEORY)

Discipline Specific Elective-1

Molecular Diagnostics

Code: BBT3201VO

L	T	P	C
3	0	0	3

Course objectives: The course is designed to give an overview and applications of different molecular biology techniques used in disease diagnosis. The specific objectives of the course are:

1. To teach students different molecular techniques used for disease diagnosis.
2. To make students understand the utilization of these techniques in disease diagnosis.
3. To teach the use of different enzyme immunoassay-based diagnostic methods.
4. To impart knowledge about the molecular diagnostic of different human diseases.

UNIT I: Enzyme immunoassays

Basics of Enzyme Immunoassays and their types, Comparison of enzymes for enzyme immunoassays; conjugation of enzymes; homogeneous and heterogeneous enzyme immunoassays; immunoblotting; polyclonal or monoclonal antibodies; immunoassays in diagnostic microbiology.

UNIT II: Molecular methods in clinical microbiology

Applications of PCR, RFLP, nuclear hybridization methods; single nucleotide polymorphism and plasmid fingerprinting in clinical microbiology; micro-dilution and macro-dilution broth procedures; diffusion test procedures. **Antibiotic resistance gene detection (e.g., MRSA, MDR-TB)**

UNIT III: Advanced methods of microbial diagnosis

Automation in microbial diagnosis; rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies; concepts and methods in idiotypes; anti idiotypes and molecular mimicry and receptors; epitope design and applications.

UNIT IV: Techniques used in molecular diagnostics

Immunodiagnostic tests; immunofluorescence; radioimmunoassay; GLC, HPLC; electron microscopy; flow cytometry and cell sorting, **Lab-on-a-chip technologies, Artificial Intelligence and Machine Learning in diagnostics**

UNIT V: Molecular biology-based diagnostics

Molecular diagnostics for infectious diseases; molecular testing for Neisseria; molecular diagnosis for HIV-1; genetic counseling and molecular diagnosis; genetic testing: need and uses.

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Suggested Reading:

1. Bruns, DE, Ashwood, ER and Burtis, CAF 2007. Fundamentals of Molecular Diagnostics, 1st ed. Elsevier.
2. Tokas, J 2015. Immunology and Molecular Diagnostics. 1st ed. University Science Press.
3. Wilson, K and Walker, J Editors, S 2010. Principles and Techniques of Biochemistry and Molecular Biology, 7th ed. Cambridge University Press.
4. Patrinos, GP, Danielson, PB and Ansorge, W 2009. Molecular Diagnostics, 3rd ed. McMillan.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Gain an understanding of the principles governing molecular diagnostics.
2. Be able to apply the knowledge and skills gained in the course in developing new molecular diagnostic kits.

Q. 2



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II Year: III Semester (THEORY)
Departmental Elective-1(DE-1)

Quality Control in Biopharmaceuticals Lab

Code: BBT3202VO

L	T	P	C
3	0	0	3

Course objective (CO)

1. To understand the concept of quality control in the laboratory.
2. To understand the factors, influence quality control in the laboratory.
3. To understand the role of Institutional ethic committee.
4. To get exposure to laboratory biosafety and lab equipment's.

Unit I: Introduction of Quality control laboratory

Quality control of product, chemical reagents, good reliable and authentic report, total quality management framework of laboratory. Essential elements in quality assurance programmed, internal quality control, control of preanalytical variable, laboratory precision, accuracy and sensitivity validation method. Quality control chart, Cullum chart

Unit II: Internal and External Quality Control

Analysis of raw materials, finished products, packaging materials, in process quality control (IPQC), Developing specification (ICH Q6 and Q3) Purchase specifications and maintenance of stores for raw materials. tablets, capsules, ointments, suppositories, creams, parenterals, ophthalmic and surgical products (How to refer pharmacopoeias), Quality control test for containers, closures and secondary packing materials.

Unit III: Institutional Ethical Committee

Institutional ethical committee and its role. Laboratory ethics of Bio-Safety. Code of good and safe laboratory practice for support staff and responsibilities of the workers regarding Biosafety, ISO rules for laboratory.

Unit IV: Laboratory biosafety

Laboratory Biosafety Level Criteria (BSL-1, 2, 3 and 4). Handling, transfer, and shipment of specimens. Decontamination and disposal. Treatment and disposal technologies for healthcare waste. Chemical, electrical, fire, and radiation safety. Safety organization. Laboratory first-aid measures and kit. Safety equipment and safety signs.

Unit V: Introduction to Quality Assurance

Introduction of Pharmaceutical QA, Concepts & Definition of QA, Quality Management System (QMS), Total Quality Management (TQM), Format of Standard Operating Procedure (SOP), Validation & Maintenance of Records, Pharmaceutical Regulations

Suggested Readings-

1. Total Quality Management Key Concepts and Case Studies, by D.R. Kiran.

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2. Fundamentals of quality control and improvement by Amitava Mitra.
3. Quality Control by Dale, H Biesterfield.

Course Learning Outcome (CLO)

At the end of the course the student will be able to:

1. Understand the concept of quality control in the laboratory.
2. Understand the factors, influence quality control in the laboratory.
3. Understand the role of Institutional ethic committee.
4. Explain the laboratory biosafety and lab equipment's.



Mahayogi Gorakhnath University, Gorakhpur
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II Year: III Semester n(THEORY)

Physical Education and Yoga

Code: BBT331

L	T	P	C
1	0	2	2

Course objective: The objectives of the course are as follows:

1. Students will learn the introduction of Physical Education, the concept of fitness and wellness, Weight management, and the lifestyle of an individual.
2. The student will also learn about the relationship of Yoga with mental health and value education.
3. In this course students will also learn about the aspects of the traditional games of India.
- 4.

UNIT I: Physical Education

Meaning, Definition, Aim and Objective, Misconception About Physical Education, Need, Importance and Scope of Physical Education in the Modern Society, Physical Education Relationship with General Education, Physical Education in India before Independence, Physical Education in India after Independence.

UNIT II: Concept of Fitness and Wellness

Meaning, Definition and Importance of Fitness and Wellness, Components of Fitness, Factor Affecting Fitness and Wellness

UNIT III: Weight Management and Lifestyle

Meaning and Definition of Obesity, Causes of Obesity, Management of Obesity, Health problems due to Obesity, Meaning, Definition, Importance of Lifestyle, Factor affecting Lifestyle, Role of Physical Activity in the maintenance of Healthy Lifestyle.

UNIT IV: Yoga and Meditation

Historical aspect of yoga, Definition, types scopes & importance of yoga, Yoga relation with mental health and value education, Yoga relation with Physical Education and sports, Definition of Asana, differences between asana and physical exercise, Definition and classification of pranayama, Difference between pranayama and deep breathing, *Practical:* Asana, Surya-Namaskar, Bhujang Asana, Naukasana, Halasana, Vajrasana, Padmasana, Shavasana, Makrasana, Dhanurasana, Tad Asana. Pranayam: Anulom, Vilom.

UNIT V: Traditional Games of India and Recreation in Physical Education

Types of Traditional Games- Gilli- Danda, Kanche, Stapu, Gutte, etc, Importance/ Benefits of Traditional Games, How to Design Traditional Games, Recreation in Physical Education; Meaning, Definition of Recreation, Scope and Importance of Recreation, General Principles of Recreation, Types of Recreational Activities, Aerobics and Zumba.(Fit India Movement).

Suggested Reading:

1. Singh, Ajmer, Physical Education and Olympic Abhiyan, "Kalayani Publishers", New Delhi, Revised Addition, 2006
2. Patel, Shri krishna, Physical Education, "Agrawal Publishers", Agra, 2014-15

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3. Panday, Preeti, SharirikShikshaSankalan, “ KhelSanskritiPrakashan, Kanpur
4. Kamlesh M.L., “Physical Education, Facts and foundations”, Faridabad P.B. Publications.
5. B.K.S. Yengar, "Light and Yog. Yoga Deepika", George Allen of Unwin Ltd., London,1981.
6. BrajBilari Nigam, Yoga Power "TheKpath of Personal achievement" Domen and Publishers, New Delhi, 2001.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

5. Understand basic knowledge of Physical Education Concept of fitness and wellness,
6. To explain weight management and lifestyle of an individual.
7. Also understand about the relation of Yoga with mental health and value education.
8. To explain about the aspects of the traditional games of India.

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II Year: III Semester (PRACTICAL)

L	T	P	C
0	0	2	1

Genetic Engineering Lab

Code: BBT353

Course objective: The objective of this laboratory course is to provide the students practical skills in basic molecular biology and Genetic Engineering

1. Students will learn different techniques of molecular biology
2. Demonstrate practical skills in different laboratory equipment and their handling like colorimeter, spectrophotometer, Electrophoresis etc.

PRACTICAL

1. Study of different types of DNA and RNA using micrographs and model/schematic representations.
2. Study of semi-conservative replication of DNA through micrographs / schematic representations.
3. Isolation of genomic DNA from *E. coli*.
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) and UV spectrophotometer (A260 measurement).
5. Estimation of Nucleic acids by V spectrophotometer (A260 measurement).
6. Performance of Restriction digestion
7. Minipreparation of plasmid DNA.
8. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
9. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).
10. Preparation of Competent Cell.
11. Demonstration of Ligation, Cloning, heat shock method of transformation and Blue white Screening of Clones.
12. Demonstration of PCR.

Course Learning Outcome (CLO): After completion of the course, the student shall be able to -

1. prepare different bacterial growth media,
2. Understand principals and methods of competent cell preparation, restriction digestion, gene ligation, gene cloning, and transformation i. e gene manipulation.

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3. Understand the method of agarose electrophoresis for plasmid and genomic DNA separation
4. Understand the method of blotting and PCR



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II Year: III Semester (PRACTICAL)

Environmental Biotechnology Lab

Code: BBT354

L	T	P	C
0	0	2	1

Course objective: The course is an introduction to environmental biotechnology and focuses on the utilization of microbial processes in waste and water treatment, and bioremediation. Topics included are microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology, approaches for studying microbial communities, and basic principles in bioremediation and biological water and waste treatment.

1. Calculation of bacterial growth curve.
2. Calculation thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.
7. Calculation of Total Dissolved Solids (TDS) of water sample.
8. Calculation of BOD of water sample.
9. Calculation of COD of water sample.
10. Bacterial Examination of Water by MPN Method

Course Learning Outcome (CLO): After completion of this course , students will be able to-

1. understand various methods of screening of industrially important microorganisms from different sources.
2. understand the working of small scale fermenter and also determine the aeration efficiency of the fermenter
3. understand the technique of immobilization of cells like yeast and *E.coli*.

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II Year: III Semester (PRACTICAL)

Industrial Visit-1

Code: BBT353IV

L	T	P	C
0	0	4	2

Course Objectives: The overall objective of the industrial visit is to expose the student to the work environment in the field of biotechnology. In particular, the industrial visit program will:

1. Enable the students to gain valuable practical experience, and test the students' career interests.
2. Provide the students with in depth knowledge about career fields.
3. Develop the students' job-related skills.
4. Enhance the students' biotechnology knowledge acquired in class through lab experience.
5. Teach the students on how to deal with the society outside the university.
6. Provide the training organizations with a better assessment of the quality of future human resources, and suggest improvements.

Industrial Visit

Industrial visits are an essential part of the academic curriculum. It is a part of interactive learning, industrial visits bridge the widen gap between theoretical learning and practical exposure by giving students the first-hand exposure to identify the inputs and outputs for different Industrial operations and processes performed at the workplace.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to

1. Analyzed different career prospects available in biotechnology-related establishments
2. Understand the technology implemented in the manufacturing of products in real-world scenario
3. Understand the entrepreneurial skills required to establish biotechnology-related manufacturing units
4. Understand the cost-cutting strategies adopted by manufacturing units

②.2



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B.Sc. Biotechnology (Hons./Hons. With Research)
Study Evaluation Scheme (Choice-Based Credit System)
Effective from the session 2025-26

II Year: IV Semester

Diploma in Tools and Techniques of Biotechnology*

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT401	Microbiology and Immunology	4	0	0	25	75	100	4	Major	Own faculty
2	BBT402	Medicinal Chemistry	3	0	0	25	75	100	3	MD	Own faculty
3	BBT403	Industrial Fermentation	4	0	0	25	75	100	4	Major	Any faculty
4	-----	Minor Elective-1	3	0	0	25	75	100	3	Minor	Any Faculty
5	-----	Interdisciplinary Elective-1	3	0	0	25	75	100	3	Minor	Any faculty
6	BBT431	Human Values and Environmental Studies	2	0	0	25	75	100	2	VAC	Any faculty
Practical											
7	BBT451	Microbiology and Immunology Lab	0	0	2	25	75	100	1	Major	Own faculty
8	BBT452	Medicinal Chemistry Lab	0	0	2	25	75	100	1	Major	Own faculty
Total			19		2	200	600	800	21		

Evaluation Scheme, promotion scheme, grading system, and CGPA calculation adopted from CCFUP, by UGC 2022.

L	Lecture
	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AEC	Ability Enhancement Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective
MD	Multidisciplinary
VAC	Value-added courses common for all UG

Interdisciplinary Elective-1	
Course Code	Course Name
BBT4202VO	Basics of Forensic Science
BBT4203VO	Diagnostic Biochemistry and Laboratory Management

Minor Elective-2	
Course Code	Course Name
BBT4201	Ecology and Environmental Management
BBT4202	Plant Science

*** UG Diploma:** Students who opt to exit after completion of the second year and have secured 80 credits will be awarded the UG diploma if, in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. 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.

②.2



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II Year: IV Semester (THEORY)

Microbiology and Immunology

Code: BBT401

L	T	P	C
4	0	0	4

Course objectives: The specific objectives of the course are as follows:

1. To teach students basic knowledge of Microbiology and types of microorganisms.
2. To make students understand sterilization, inoculation, etc.
3. To familiarize students with the structure and function of the immune system.
4. To impart knowledge about the key components participating in fighting the disease.
5. To make students understand immunodiagnostic methods like RIA and ELISA.
6. To teach students about vaccines and modes of vaccination.

Unit I: History of Microbiology

History of the development of microbiology as a discipline, Spontaneous generation versus biogenesis, contributions of Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Richard Petri, Charles Chamberland, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei Winogradsky, Alexander Fleming, Elie Metchnikoff and Emil von Behring.

Unit II: Diversity of Microbial world and Microbial Cell organization:

Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Archaea, Algae, Fungi, and Protozoa) with emphasis on distribution, occurrence and morphology. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, mechanism of Gram's staining. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.

Unit III: Microbial Nutrition and Growth:

Nutritional types of microorganisms, growth factors, culture media- synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; the influence of environmental factors on the growth of microbes: effect of pH, temperature, solute, oxygen concentration, pressure and radiations. Sterilization, disinfection, and antiseptics. Use of physical methods (heat, low-temperature, filtration, radiation) and chemical agents (phenolics, halogens, heavy metals, sterilizing gases) in microbial control.

Unit IV: History and basic concepts of Immunology:

Historical perspective and overview of Immune system, Cells and Organs of Immune system, . Concept of non-specific (innate immunity) and specific immunity (adaptive immunity). Concept of Pathogen recognition receptor and Molecular Patterns (PAMP), Antigens, Haptens, epitopes, Immune Response - An overview, of components of the mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T- lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements

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during B-lymphocyte differentiation, Antibody affinity maturation, class switching, Basics of complement system.

UNIT V MHC and Vaccines

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defence strategies, Hypersensitivity reaction, Autoimmune diseases, Immunodeficiency-AIDS. Vaccines & Vaccination

Suggested Reading:

1. Kuby Immunology by J. Punt, S. Stranford, P. Jones and J. Owen. 8 th edition. W.H. Freeman and Company, USA. 2018.
2. Cellular and Molecular Immunology by A.K. Abbas, A.H. Lichtman and S. Pillai. 9th edition. Elsevier, USA. 2017.
3. Roitt's Essential Immunology by P. Delves, S. Martin, D. Burton and I.M. Roitt. 13th edition. Wiley- Blackwell Scientific Publication, UK. 2017.
4. Immunobiology: A short course by R. Coico and G. Sunshine. 7th edition. Wiley- Blackwell Scientific Publication, UK. 2015.
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5. Basic and Clinical Immunology by M. Peakman and D. Vergani. 2nd edition. Churchill Livingstone, UK. 2009.
6. Immunology by C. Richard and S. Geoffrey. 6th edition. Wiley- Blackwell Scientific Publication, UK. 2009.
7. Janeway's Immunobiology by K. Murphy, P. Travers and M. Walport. 7th edition. Garland Science Publishers, USA. 2007.

Course learning Outcome (CLO): Upon successful completion of this course the student will:

1. To understand basic of microbiology and types of microorganism
2. Explain microbiological techniques
3. Understand the role of immune cells.
2. Learn about the most fundamental of antigens, antibodies and their functional role.
3. Understand immunodiagnostic methods like RIA and ELISA

Q. 2



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II Year: IV Semester (THEORY)

Medicinal Chemistry

Code: BBT402

L	T	P	C
3	0	0	3

Course objectives: The objectives of the course are as follows:

1. To understand the basic concept of medicinal chemistry
2. To make students understand the fundamental concepts of drug metabolism.
3. To teach students about different kinds of drugs
4. To know the drug's action on the nervous system, cholinergic neurotransmitters, etc.

UNIT I: Introduction to medicinal chemistry

History and development of medicinal chemistry; physicochemical properties in relation to biological action: ionization, solubility, partition coefficient, hydrogen bonding, protein binding, chelation, bioisosterism; optical and geometrical isomerism.

UNIT II: Drug metabolism

Drug metabolism principles: Phase I and Phase II; factors affecting drug metabolism including stereochemical aspects; causes for drug resistance; genetic principles of drug resistance.

UNIT III: Drugs acting on autonomic nervous system

Adrenergic neurotransmitters: biosynthesis and catabolism of catecholamine; adrenergic receptors (Alpha and Beta) and their distribution.

UNIT IV: Sympathomimetic agents: SAR of sympathomimetic agents

Direct acting: Norepinephrine, Epinephrine, Phenylephrine, Dopamine; indirect acting agents: hydroxy amphetamine; pseudoephedrine; propylhexedrine; agents with mixed mechanism: ephedrine, metaraminol.

UNIT V: Cholinergic neurotransmitters

Biosynthesis and catabolism of acetylcholine; cholinergic receptors (muscarinic and nicotinic) and their distribution; parasympathomimetic agents: SAR of parasympathomimetic agents; direct acting agents: Acetylcholine, Carbachol; indirect acting/cholinesterase inhibitors (Reversible and Irreversible).

Suggested Reading:

1. Lemke, TL, Williams, DA, Roche, VF and Zito, SW 2012. Foye's Principles of Medicinal Chemistry, 7th ed. Lippincott Williams and Wilkins, Philadelphia.
2. Singh, H and Kapoor, VK 1996. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan Publishers, Delhi.
3. Patrick, GL 2017. An Introduction to Medicinal Chemistry, 6th ed. Oxford University Press, New York.

②.2



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Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Understand the concepts of drugs and their actions.
2. Learn about the fundamentals of various receptors and signaling processes.



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II Year: IV Semester (THEORY)

Industrial Fermentation

Code: BBT403

L	T	P	C
4	0	0	4

Course objectives: The specific objectives of the course are as follows:

1. To familiarize students with the production of industrial chemicals.
2. To impart knowledge about metabolic engineering of secondary metabolism.
3. To teach students about the enzyme and cell immobilization techniques relevant to industrial processing.
4. To make students understand the different methods of experimental model for design of fermentation systems.

UNIT I: Introduction to fermentation

Historical overview of fermentation; definition and role of fermentation; yeast fermentation; production of valuable biological compounds such as lactic acid, butyric acid; biofuels: Biogas, ethanol, butanol, hydrogen, biodiesel, microbial electricity; microbial insecticides.

UNIT II: Secondary metabolites

Microbial products of pharmacological interest; steroid fermentations and transformations; overproduction of microbial metabolite; secondary metabolism, its significance and products; metabolic engineering of secondary metabolism for highest productivity.

UNIT III: Enzyme immobilization

Enzyme and cell immobilization techniques in industrial processing; enzymes in organic synthesis; proteolytic enzymes and hydrolytic enzymes; enzymes in food technology and organic synthesis.

UNIT IV: Protein characterization

Purification and characterization of proteins; upstream and downstream processing; distribution of microbial cells; centrifugation, filtration of fermentation broth; liquid extraction; ion-exchange recovery of biological products.

UNIT V: Kinetics of bioprocess

Growth kinetics of batch and continuous culture operations; mass transfer in aerobic fermentation; fundamentals of bioreactor design; scale-up, mass transfer factors depending on scale-up principle; metabolic engineering of antibiotic biosynthetic pathways.

SUGGESTED READING

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

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3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology, Second Edition, Butterworth-Heinemann, Elsevier Science Ltd.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Understand about biological and biochemical technology, with a focus on biological products, the design and operation of industrial practices.
2. Learn about fermentation Technology, history, types of fermentation.
3. Know about the diverse applications of fermentation technology in fermentation industry.

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II Year: IV Semester (THEORY)

Minor Elective-1

Ecology and Environmental Management

Code: BBT4201

L	T	P	C
3	0	0	3

Course objectives: The specific objectives of the course are as follows:

1. To impart basic knowledge about the environment and its allied problems.
2. To teach students about different types of ecosystems.
3. To make students understand the flow of energy in an ecosystem.
4. To increase awareness amongst students about different environmental challenges.

UNIT I: Environment and concept of ecosystem

Our environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere; scope of ecology; principles and concepts of ecosystem; structure of ecosystem; strata of an ecosystem; development and evolution of ecosystems.

UNIT II: Different types of ecosystems and their habitat

Forest ecosystems; tropical evergreen forest, tropical deciduous forest, temperate evergreen forest, temperate deciduous forest, tundra, and taiga; desert ecosystem; freshwater and marine ecosystems; cybernetics and homeostasis; biological control of the chemical environment.

UNIT III: Energy transformation and bio-geochemical cycles

Energy transfer in an ecosystem; energy budget; production and decomposition in a system; ecological efficiencies; trophic structure and energy pyramids; ecological energetics; principles pertaining to limiting factors; biogeochemical cycles.

UNIT IV: Environmental issues

Pollution and environmental health; detection of environmental pollutants; indicators and detection systems; bio-transformation; plastic, aromatics, hazardous wastes; environmental cleanup: Case studies.

UNIT V: Biotechnological control of environmental problems

Environmental biotechnology; biotechnology in protection and preservation of the environment; bioremediation; waste disposal.

SUGGESTED READING

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing

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4. Joseph, B., Environmental studies, Tata Mc Graw Hill.
5. Michael Allabay, Basics of environmental science, Routledge Press.
6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5th edition) Books/Cole, Thompson Learning, Inc.
7. Mohapatra Textbook of environmental biotechnology IK publication.

Course learning Outcome (CLO): Upon successful completion of this course the student will:

1. Understand the differences between atmosphere, hydrosphere, and lithosphere.
2. Learn about forest, desert, freshwater, and marine ecosystems.
3. Understand the flow of energy in an ecosystem.
4. Know about the role of biotechnology in addressing environmental challenges.



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II Year: IV Semester (THEORY)

Minor Elective-1

Plant science
Code: BBT4202

L	T	P	C
3	0	0	3

Course objectives: The specific objectives of the course are as follows:

Course objectives (CO)

1. To get familiarize with the classification, and morphology of lower plants
2. To study the reproduction and economic importance of various groups of. Plants
3. To get familiarize with economic importance of plants
4. To understand the the basic knowledge for the employment of these plants to study plant biotechnology.

Unit I:Algae and Lichen: General characters of algae, Various habitats, Cell structure in algae (special reference flagella, stigma, Neuromotor apparatus, and pigments), Classification of algae (F. E. Fritsch), Economic importance of algae, Life cycle of Polysiphonia, General character, thallus structure and reproduction in Lichen.

Unit II: Bryophytes: General character, taxonomy and economic importance of bryophytes, life cycle of few bryophytes such as Marchantia.

Unit III: Pteridophytes: General character and taxonomy of pteridophytes, heterospory and seed habit in pteridophytes, stellar system in pteridophytes and life cycle of Marsilea.

Unit IV: Gymnosperm: General character and taxonomy of gymnosperms, life cycle of Pinus, the economic importance of pteridophytes and gymnosperms.

Unit V: General character and taxonomy of angiosperms:, Description of Lamiaceae, Malvaceae, Euphorbiaceae, Poaceae, Cucurbitaceae and Rutaceae. Economically important plants for cereals,fibre, oil, timber and medicinal value.

Suggested Readings:

1. Gangulee, H. C and Kar, A. K. (1989). College Botany, Vol-II, 5th Ed. Books & Allied Pvt. Ltd., Calcutta.
2. Singh, V. (2010). A text book of Botany. 4th Ed. Rastogi Publications.
3. Chapman, V. J.,•& Chapman, D. J. (1973). The algae (Vol. 2, pp. XIV-XIV). 2nd Ed. London: Macmillan.
4. Kumar, H. D. (1990). Introductory Phycology. 2nd Ed. Affiliated East West.●

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5. Kumar, H. D.,•& Singh, H. N. (1995). A Textbook of Algae Ed. 4th. Ed. East–West Press Pvt. Ltd. New Delhi. Parihar, N. S. (1961).
6. Bryophyta (Vol. 1). 4th Ed. Central Book Depot.
7. Parihar, N. S. (1965). Pteridophytes. 4th Ed. Central Book Depot



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II Year: IV Semester (THEORY)

Interdisciplinary Elective-1

Basics of Forensic Science

Code: BBT4202VO

L	T	P	C
3	0	0	3

Course objectives: This is an introductory course on forensic sciences with the following objectives:

1. To familiarize students with the fundamental principles of forensic sciences.
2. To impart knowledge about the injuries and deaths and how they are assessed.
3. To make students understand the process of documentation of crime scenes.
4. To impart the knowledge about the importance of cyber security in forensic sciences.

UNIT I: Principles of Forensic Sciences

Introduction and principles of forensic science; forensic science laboratory and its organization; tools and techniques in forensic science; branches of forensic science; causes of crime; role of *modus operandi* in criminal investigation.

UNIT II: Injuries and deaths

Classification of injuries and their medico-legal aspects; method of assessing various types of deaths; general and individual characteristics of handwriting; examination and comparison of handwriting and analysis of ink from various samples.

UNIT III: Explosives and ballistics

Classification of firearms and explosives; introduction to internal, external and terminal ballistics; chemical evidence for explosives; process of documentation of crime scene by photography, sketching, and field notes.

UNIT IV: Fingerprints, DNA fingerprinting and toxicology

Fundamental principles of fingerprinting; classification of fingerprints; development of fingerprints as science for identification; principle of DNA fingerprinting; application of DNA profiling in forensics; role of the toxicologist; significance of toxicological findings in forensics.

UNIT V: Forensic biology

Nature and importance of biological evidence; significance of hair, semen, and blood as biological evidences; types and identification of microbial organisms of forensic significance; identification of wood, leaves, pollens, diatoms, and insects as forensic evidence. Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

SUGGESTED READING

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1. Bhasin, MK and Nath, S 2002. Role of Forensic Science in the New Millennium, University of Delhi, Delhi.
2. James, SH and Nordby, JJ 2005. Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd ed. CRC Press, Boca Raton.
3. Nanda, BB and Tiwari, RK 2001. Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi.
4. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
7. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Apply the Laboratory skills to participate in the career needs of Forensic community.
2. Become trained in the laboratory skills of different division of Forensic Science.
3. Be able to work with different R&D organizations

②.2



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Department of Biotechnology

II Year: IV Semester (THEORY)

Interdisciplinary Elective-1

Diagnostic Biochemistry and Laboratory Management

Code: BBT4203VO

L	T	P	C
3	0	0	3

Course objectives (CO)

1. To get familiarize with the organization of clinical laboratory.
2. To know the different biochemical specimens, used in disease diagnosis.
3. To get familiarize with tumor markers.
4. To understand the concept of quality control
5. To acquire knowledge about different organ function test.

Unit-I Organization of a clinical laboratory

Basic requirement in hematology, pathology, microbiology, serology, and biochemistry lab.

Unit-II Biochemical specimens

Specimen collection, transport, preservation, and storage Scientific practice of handling specimens. Laboratory management and planning, Receiving and recording of specimens, indexing and maintaining records. Disposal of wastes. Diagnostic importance of CSF, pleural fluid, seminal fluid, amniotic fluid, saliva and sweat in clinical biochemistry.

Unit-III Tumor markers

Classification, their importance in differential diagnosis – Bence-Jones proteins, AFP, serotonin, PSA, TPA, MCA, CA, CEA, beta HCG, VMA.

Unit-IV Quality Control

Precision, accuracy, sensitivity, specificity, standard deviation Pre analytical and analytical variables, Quality control charts, control serum, Quality control programme a) Internal quality control and b) external quality control. Establishment and use of reference values, analytical and statistical procedures used in establishing reference values, Use of biochemical investigations in diagnosis and prognosis of diseases, and Interpretation of results.

Unit-V Organ Function Tests

Liver function tests, Renal function tests, Gastric function tests, Cardiac function tests, Thyroid function tests, Pancreatic function tests

Suggested Readings:

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1. Interpreting Clinical Diagnostic Tests, by Dr.Remapai (Author), published by Medvision Publishers.
2. Clinical Biochemistry in Diagnosis and Management 2020 by A.S Saini, published by CBS.

Course Learning Outcome (CLO)

At the end of the course, the student should be able to-

1. Explain the organization of clinical laboratory.
2. Know the different biochemical specimens, used in disease diagnosis.
3. Familiarize with tumor markers.
4. Understand the concept of quality control
5. Discuss different organ function test.



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II Year: IV Semester(THEORY)

Human Values and Environmental Studies

Code: BBT431

L	T	P	C
2	0	0	2

Course objectives:

1. To create awareness, conviction & commitment to values for improving the quality of life through education, and for advancing social and human well-being.
2. To develop the ability to distinguish between what is of value and what is superficial in life.
3. To develop the ability to face difficult situations in life boldly and resolve them confidently.
4. Understand and evaluate the global scale of environmental problems; and. Reflect critically on their roles, responsibilities

UNIT I: Human Values

Introduction- Values, Characteristics, Types, Developing Value system in Indian Organization, Values in Business Management, value-based Organisation, Trans –cultural Human values in Management. Swami Vivekananda's philosophy of Character Building, Gandhi's concept of Seven Sins, APJ Abdul Kalam's view on the role of parents and Teachers. Human Values and Present Practices – Issues: Corruption and Bribe, Privacy Policy in Web and social media, Cyber threats, Online Shopping, etc. Remedies UK Bribery Act, Introduction to sustainable policies and practices in Indian Economy.

UNIT II: Principles of Ethics

Secular and Spiritual Values in Management- Introduction- Secular and Spiritual values, features, Levels of value Implementation. Features of spiritual Values, Corporate Social Responsibility- Nature, Levels, Phases and Models of CSR, Corporate Governance. CSR and Modern Business Tycoons Ratan Tata, Azim Premji and Bill Gates.

UNIT III: Holistic Approach in Decision making

Decision making, the decision making process, The Bhagavad Gita: Techniques in Management, Dharma and Holistic Management. Discussion through Dilemmas – Dilemmas in Marketing and Pharma Organisations, moving from Public to Private – monopoly context, Dilemma of privatisation, Dilemma on liberalization, Dilemma on social media and cyber security, Dilemma on Organic food , Dilemma on standardization ,Dilemma on Quality standards. Case Studies

UNIT IV: Ecosystem

Concept, structure & functions of ecosystem : producer, consumer, decomposer, foodweb, food chain, energy flow, Ecological pyramids Conservation of Biodiversity- *In-situ* & *Ex-situ* conservation of biodiversity Role of individual in Pollution control Human Population & Environment Sustainable Development India and UN Sustainable Development Goals Concept of circular economy and entrepreneurship

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UNIT V: Environmental Laws

International Advancements in Environmental Conservation, Role of National Green Tribunal, Air Quality Index, Importance of Indian Traditional knowledge on environment, Bio assessment of Environmental Quality Environmental Management System, Environmental Impact Assessment and Environmental Audit.

SUGGESTED READING

1. A foundation course in Human Values and Professional Ethics by RR. Gaur, R. Sangal et.al
2. JUSTICE: What's the Right Thing to Do? Michael J. Sandel.
3. Human Values by A. N. Tripathi New Age International
4. Environmental Management by N.K. Uberoi

Course Learning Outcome (CLO): The mission of the course on Human Values and Environmental Studies is to create morally articulate solutions to be truthful and just and to become responsible towards humanity. The course seeks to establish a continuous interest in the learners to improve their thought process with intent to develop a new generation of responsible citizens capable of addressing complex challenges faced by the society due to disruptions in human interactions effecting human values. This course works toward

1. Building fundamental knowledge of the interplay of markets, ethics, and law,
2. Look at various challenges faced by individual to counter unethical issues
3. Look at core concepts for business ethics
4. Look at core concepts of anti-corruption
5. Look at core concepts for a morally articulate solution evolver to management issues in general,
6. Issues of sustainable development for a better environment.
7. To know how environmental degradation has taken place.
8. Be aware of negotiations and international efforts to save environment.
9. How to develop sustainably?
10. Efforts taken up by UN in Sustainable Development.
11. Efforts taken by India in Sustainable Development.

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II Year: IV Semester(PRACTICAL)

Microbiology and Immunology Lab

Code: BBT451

L	T	P	C
0	0	2	1

Course objective: The objective of this laboratory course is to provide the students with practical skills in basic Microbiology and Immunology techniques.

1. To introduce basic knowledge of Microbiology like growth curve, culture transfer techniques etc.
2. To introduce microbiological techniques like sterilization, inoculation etc.
3. To familiarize students with the Microbiological and immunological techniques.
4. To introduce immunodiagnostic methods like ELISA.

1. To prepare and sterilize the culture media for the growth of microorganisms.
2. To perform various culture transfer techniques: Solid to solid (streaking), liquid to solid (spreading), liquid to liquid, solid to liquid and determine CFU/ml.
3. To stain bacteria using methylene blue.
4. To perform Gram staining.
5. To prepare a temporary mount of algae (spirogyra)/fungi (penicillium).
6. To study the growth curve of E.coli.
7. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs.
8. Differential leucocytes count.
9. Total leucocytes count
10. Total RBC count
11. Hemagglutination assay
12. Separation of serum from blood
13. Double immunodiffusion test using specific antibody and antigen.
14. Enzyme linked immunosorbent assay (ELISA).

Course Learning Outcome (CLO): After completion of this course students will be able to:

1. Understand methods of cleaning and sterilization of plastic wares and glassware.
2. Understand and perform pure culture techniques which include, pour plate and spread plate.
3. Understand the preparation and use of differential, selective, and special media.
4. Understand and identify the morphology of cells of the immune system.
5. Understand the basic concepts of blood grouping.

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6. Understand antigen-antibody interactions and thus quantitate the presence of antigen and or antibodies in biological samples.



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II Year: IV Semester(PRACTICAL)

Medicinal Chemistry Lab

Code: BBT452

L	T	P	C
0	0	2	1

Course objective: The objectives of the Medicinal Chemistry practical course are as follows:

1. General Assay and determination of vitamins, aspirin, ibuprofen etc.
2. Relevant chemical reactions for Synthesis of selected drugs
3. Structural influences on pharmacologic/toxicological/therapeutic profiles.
4. The gained practical knowledge of Medicinal Chemistry

PRACTICAL

1. Assay of thiamine in vitamin B complex tablets.
2. Determination of vitamin C content of commercial tablets.
3. Determination of molarity of acetic acid in vinegar.
4. Isolation of citric acid from lemon.
5. Color spot tests for detection of alkaloids.
6. Synthesis of paracetamol from p-aminophenol.
7. Determination of dissociation constant of benzoic acid
8. Determination of percentage purity of aspirin.
9. Determination of percentage purity of ibuprofen.
10. Determination of percentage purity of sulphamethoxazole.

Course Learning Outcome (CLO): After completion of this course students will be able to:

1. Understand the assay and determination of drugs and their actions.
2. Understand the synthesis of drugs
3. Learn about the fundamentals of alkaloids and drugs

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B.Sc. Biotechnology (Hons./Hons. With Research)
Study Evaluation Scheme (Choice-Based Credit System)
Effective from the session 2025-26

III Year: V Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT502	Animal and Plant Biotechnology	4	0	0	25	75	100	4	Major	Own faculty
2	BBT504	Biostatistics	3	0	0	25	75	100	3	Minor	Own faculty
3	BBT505	Bioprocess Technology	4	0	0	25	75	100	4	Major	
4		Interdisciplinary Elective-2	4	0	0	25	75	100	4	Minor	Own faculty
5	BBT531	Communication Skills and Personality Development	2	0	0	25	75	100	2	AEC	Any faculty
6	BBT533	Understanding India	2	0	0	25	75	100	2	VAC	
Practical											
5	BBT556	Bioprocess Technology Lab	0	0	2	25	75	100	1	Major	Own faculty
6	BBT554	Animal and Plant Biotechnology lab	0	0	2	25	75	100	1	Major	Own faculty
7	BBT553IS	Industrial Training/Internship	0	0	4	25	75	100	2	SI	Own faculty
Total			17	0	4	175	525	700	23		

Evaluation Scheme, promotion scheme, grading system, and CGPA calculation adopted from CCFUP, by UGC 2022.

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AEC	Ability Enhancement Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective
MD	Multidisciplinary
VAC	Value-added courses common for all UG
SI	Summer Internship

Interdisciplinary Elective-2	
Course Code	Course Name
BBT5102	Food Microbiology
BBT5103	Medical Microbiology

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III Year: V Semester (THEORY)

Animal and Plant Biotechnology

Code: BBT502

L	T	P	C
4	0	0	4

Course objectives: The course aims to help students gain knowledge of the current trends and techniques in animal and plant biotechnology. The specific objectives of the course are as follows:

1. To develop an understanding of animal cell culture and gene delivery methods for the production of transgenic animals.
2. To gain knowledge about the stem cells and their various applications
3. To enable students, acquire knowledge of the fundamental principles of plant tissue culture.
4. To impart knowledge about the diverse applications of plant biotechnology and genetically-modified crops.

UNIT I: Animal cell culture

Introduction to basic tissue culture techniques; chemically defined and serum free media; animal cell cultures, their maintenance and preservation; culture types: suspension, continuous flow and immobilized cultures; somatic cell fusion; cell cultures as a source of valuable products; organ cultures.

UNIT II: Gene transfer methods and transgenic animals

Microinjection, embryonic stem cell, gene transfer, retroviral gene transfer, integration of foreign genes and their validation; gene targeting; methods and strategies; improving transgene integration efficiency. Strategies for the production of transgenic animals; applications of transgenic animals

UNIT III: Stem cell and its applications

Stem cells: types and sources; characteristics of stem cells, potency and plasticity of stem cells; stem cell markers; induced pluripotent stem cells; applications of stem cells in disease cure.

UNIT IV: Introduction to plant tissue culture

Plasticity and totipotency; plant tissue culture media and growth regulators; design of a plant tissue culture lab; culture types: callus culture, protoplast culture, suspension culture; meristem and shoot tip culture; organogenesis and embryogenesis; micropropagation, its advantages and disadvantages, application of plant tissue culture.

UNIT V: Somaclonal variations and applications of plant genetic engineering

Somaclonal variations, *Agrobacterium tumefaciens* and Ti plasmid; vectors for plant transformation; direct gene-transfer methods (particle bombardment, electroporation, PEG-mediated transformation, silicon carbide fibres); chloroplast and mitochondrial DNA transformation; plant genome editing. Generation of transgenic insect-resistant, disease-

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resistant, herbicide-resistant plants; increasing shelf life of fruits; provitamin A content enhancement in plants (e.g. Golden Rice).

SUGGESTED READING

1. Pinkert, C 2014. Transgenic Animal Technology, 3rd ed. Elsevier
2. Ranga, M 2010. Animal Biotechnology, 3rd ed. Agrobios.
3. Bhojwani, SS and Razdan, MK 2004. Plant Tissue Culture: Theory and Practice, Revised ed. Elsevier, New Delhi.
4. Brown, TA 2010. Gene cloning and DNA analysis: An Introduction, 6th ed. Wiley-Blackwell.
5. Chawla, HS 2002. Introduction to Plant Biotechnology, 2nd ed. Science Publishers.
6. Smith, RH 2013. Plant Tissue Culture: Techniques and Experiments, 3rd ed. Academic Press, Elsevier.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Comprehend the fundamental concepts of animal cell culture and its applications.
2. Understand the significance of transgenesis and stem cells with reference to animals.
3. Learn about different kinds of plant culture techniques
4. Get an overview of diverse applications of plant biotechnology and how Ti plasmid biology been utilized for making transgenic plants.

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III Year: V Semester (THEORY)
Biostatistics

Code: BBT 504

L	T	P	C
3	0	0	3

Course objectives: This is an introductory course on statistics and bioinformatics. The specific objectives of the course are as follows:

1. To teach students the basic principles of statistics, data types and collection of data.
2. To make students understand the various methods of data presentation and measures of central tendency and probability.

Unit I: Introduction to Biostatistics & Data Handling

Definition, scope, and significance of biostatistics, Types of data and scales of measurement, Data collection methods and classification, Tabulation and frequency distribution, Diagrammatic and graphical representation of data, Line Graphs, Bar Charts, Pie Charts, Histograms, Frequency Polygons

Unit II: Measures of Central Tendency and Dispersion

Concepts and applications of statistical measures, Central Tendency: Mean, Median, Mode, Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation, Coefficient of Variation

Unit III: Measures of Relationship

Correlation: types and interpretation, Karl Pearson's Coefficient of Correlation, Spearman's Rank Correlation, Simple Linear Regression Analysis

Unit IV: Sampling Techniques and Probability

Population and sample definitions, Sampling criteria and determination of sample size, Types of sampling techniques, Basic Concept of Probability, Normal Probability Curve, Concepts of Skewness and Kurtosis

Unit V: Hypothesis Testing & Statistical Software

Basics of hypothesis formulation, Types of hypotheses, critical region, errors (Type I and II), significance level, p-value, Parametric and non-parametric tests: Chi-Square Test (χ^2), Student's t-tests (independent and paired), F-test, Z-test, ANOVA

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

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.
- 2- Explain about the methods to characterise and manage the different types of Biological data.



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III Year: V Semester (THEORY)

Bioprocess Technology

Code: BBT505

L	T	P	C
4	0	0	4

Course objectives: The specific objectives of the course are as follows:

1. To impart the knowledge of cultivation and growth kinetics of microorganisms.
2. To make students understand the basic concept of sterilization and the different parts of a bioreactor.
3. To teach the application of bioprocess technology in industries.
4. To make students understand about thermal death kinetics of microorganisms.

UNIT I: Introduction to bioprocess technology

Introduction to bioprocess technology; range of bioprocess technology and its chronological development; basic principal components of fermentation technology; types of microbial culture and its growth kinetics: batch, fed batch and continuous culture.

UNIT II: Components of bioreactor and sterilization

Design of bioprocess vessels: significance of impeller, baffles, sparger; types of culture/production vessels; airlift; cyclone Column; packed tower and their application in production processes; principles of upstream processing: media preparation, inocula development, and sterilization.

UNIT III: Kinetics of bioprocess

Theories of diffusion; gas-liquid mass transfer; introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting K_La thermal death kinetics of microorganisms.

UNIT IV: Microbial production of compounds and its downstream processing

Bioprocess measurement and control system with special reference to computer aided process control; introduction to downstream processing; product recovery and purification; microbial production of ethanol, amylase, lactic acid and single cell proteins.

UNIT V: Application of bioprocess engineering in industries

Food industry (baker's yeast production); environmental industry (biological wastewater treatment); medical applications of bioprocess engineering.

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.

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4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Tom Brody (1999). *Nutritional Biochemistry (2nded.)*. Harcourt Braces. ISBN: 9814033251, 9789814033251.
6. James M J.. 2000. Modern Food Microbiology, 6th Ed. Aspen Publishers, Inc., Gaithersburg, Maryland, USA.
7. Frazier WC, and Westhoff DC. Food Microbiology. Fourth edition, MacGraw Hills publication
8. Lopez GFG, Canaas G, Nathan EV. Food Sciences and Food biotechnology.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Know the history and role of biotechnology in food preservation.
2. Develop the concepts of role of enzyme and microorganism food production.
3. Understand food processing and preservation technologies.
4. Learn the various diseases associated with food and water contamination.

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III Year: V Semester(THEORY)

Interdisciplinary Elective-2

Food Microbiology

Code: BBT5102

L	T	P	C
4	0	0	4

Objectives: This course will enable the student to:

1. To know the important genera of microorganisms associated with food and their characteristics.
2. To understand the role of microbes in fermentation, spoilage and food-borne diseases.

Unit I: Introduction to Food Microbiology & Foods as a substrate for microorganisms:

History and Development of Food Microbiology, Definition and Scope of food microbiology, Inter-relationship of microbiology with other science. Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. Microbial spoilage of various foods: Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned foods.

Unit II: Principles and methods of food preservation

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO₂, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Unit III: Fermented foods

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi, and cheese, other fermented foods: dosa, sauerkraut, soy sauce, and tempeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in the market.

Unit IV: Foodborne diseases (causative agents, foods involved, symptoms, and preventive measures):

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and *mycotoxins*; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonellosis*, *Shigellosis*, *Yersinia enterocolitica*, *Listeria monocytogenes*, and *Campylobacter jejuni*.

Unit V: Food sanitation and control:

HACCP, Indices of food sanitary quality and sanitizers. Cultural and rapid detection methods of foodborne pathogens in foods and introduction to predictive microbiology.

SUGGESTED READINGS

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P)

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Limited Publishers, New Delhi, India.

2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersburg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Understand the important genera of microorganisms associated with food and their characteristics.
2. Understand the role of microbes in fermentation, spoilage and food borne diseases.
3. Understand the beneficial and toxicological role of micro-organisms in food.
4. Learn about the techniques of methods of isolation and cultivation of food microbes.



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III Year: V Semester (THEORY)

Interdisciplinary Elective-2

Medical Microbiology

Code: BBT5103

L	T	P	C
4	0	0	4

Course objectives: The objectives of this course are:

1. To introduce basic principles and application relevance of microbiological diseases
2. To gain knowledge about the bacterial agents responsible for infectious diseases.
3. To understand the pathology of the viruses and fungal diseases.
4. To gain the knowledge about laboratory diagnosis

UNIT I: Introduction of Medical Microbiology:

Introduction: Normal microflora of the human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, and biosafety levels.

UNIT II: Laboratory diagnosis of pathogenic gram-positive bacteria:

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures, and chemotherapy of gram-positive bacteria: *S.aureus*, *S.pyogenes*, *B.anthraxis*, *C.perferinges*, *C.tetani*, *C.botulinum*, *C.diphtheriae*, *M.tuberculosis*, *M. leprae*.

UNIT III: Laboratory diagnosis of pathogenic **gram-negative bacteria:**

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram-negative bacteria: *E.coli*, *N. gonorrhoea*, *N. meningitidis*, *P. aeruginosa*, *S. typhi*, *S. dysenteriae*, *Y. pestis*, *B. abortus*, *H. influenzae*, *V. cholerae*, *M. pneumoniae*, *T. pallidum*, *M. pneumoniae*, *Rickettsiaceae*, *Chlamydiae*.

UNIT IV: Diseases caused by viruses:

Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS), and Hepatitis viruses, **COVID 19**

UNIT V Fungal and Protozoan infections:

Dermatophytoses (Trichophyton, Microsporun, and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidioides) and opportunistic fungal infections (*Candidiasis*, *Aspergillosis*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

SUGGESTED READINGS

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1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Course Learning Outcome (CLO): Upon successful completion of this course, students should be able to understand:

1. Learn basic principles and application relevance of microbiological diseases.
2. Learn about the bacterial agents responsible for infectious diseases.
3. Understand the pathology of the viruses and fungal diseases.

②.2



Mahayogi Gorakhnath University, Gorakhpur
Faculty of Health and Life Sciences
Department of Biotechnology

III Year: V Semester (THEORY)

Communication Skills and Personality Development

Code: BBT531

L	T	P	C
2	0	0	2

Course objectives: The specific objectives of the course are as follows:

1. To introduce Communication skills and Personality development
2. Focuses on learning the important skill sets that helps you effectively communicate
3. To introduce efficiently communicate your ideas and messages in simple ways and also on time.

UNIT I: Personality Development

Understanding Personality, Definition and Meaning of Personality, Types of Personality, Components of Personality, Determinants of Personality, Assessment of Personality.

UNIT II: Personal grooming

Dress for success, Make up & skin care, Hair care & styles for formal look, Art of accessorizing, Oral Hygiene.

UNIT III: Interview preparation and group discussion

Meaning and Types of Interviews [Face to Face, Telephonic, Video], Interview procedure [Opening, Listening, Closure], Preparation for Interview, Resume Writing, LinkedIn Etiquette, Meaning and methods of Group Discussion, Procedure of Group Discussion, Group Discussion simulation, Group discussion common error.

UNIT IV: Body language and behavior

Concept of human behavior, Individual and group behavior, Developing Self-Awareness, Behavior and body language, Dimensions of body language: Proxemics, Haptics, Oculistics, Paralanguage, Kinesics, Sign Language, Chromatics, Chronemics, Olfactics, Cultural differences in Body Language, Business Etiquette & Body language, Body Language in the Post Corona Era, Virtual Meeting Etiquette, Social Media Etiquette.

UNIT V: Art of good communication

Communication Process, Verbal and Non-verbal communication, 7 C's of effective communication, Barriers to communication, Paralinguistics, Pitch, Tone, Volume, Vocabulary, Word stress, Pause, Types of communication, Assertive, Aggressive, Passive Aggressive, Listening Skills, Questioning Skills, Art of Small Talk, Email Writing.

SUGGESTED READING

1. Cloninger, S.C., "Theories of Personality: Understanding Person", Pearson, New York, 2008, 5th edition.
2. Luthans F, "Organizational Behaviour", McGraw Hill, New York, 2005, 12th edition.

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3. Barron, R.A. & Brian D, “Social Psychology”, Prentice Hall of India, 1998, 8th edition.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. To understand the concept of Personality and personal grooming pertains
3. To learn effectively interview and resume preparation.
4. To understand effectively in group discussions and explore communication beyond language
5. To understand good communication skills and develop confidence.

Q. 2



Mahayogi Gorakhnath University, Gorakhpur
Faculty of Health and Life Sciences
Department of Biotechnology

III Year: V Semester (THEORY)

Understanding India

BBT533

L	T	P	C
2	0	0	2

Course Objectives

1. To expose students to the rich cultural and civilizational background of India.
2. To acquaint students with India's struggle for independence.
3. To provide a foundational understanding of the Indian Constitution.
4. To introduce the patterns of economic development in independent India.

UNIT I: Geographical Features of India

India on the world map and its neighboring countries, Physical features: mountains, plateaus, plains, coasts, islands, Natural resources: vegetation, rivers, soils, and climate

UNIT II: Religious and Artistic Traditions

Religious Traditions: Vedic Age, Buddhism and Jainism, Bhakti and Sufi Movements, Social Reform Movements and Revivalism. Art and Architecture: Indus Valley Town Planning, Rock-Cut Architecture, Temple Architecture Styles, Indo-Islamic and Colonial Architecture, Ajanta Paintings and the Bengal School of Art

UNIT III: India's Freedom Struggle

Revolt of 1857, Formation of the Indian National Congress, Swadeshi Movement, Gandhian Movements, Subhas Chandra Bose and the Indian National Army (INA), Independence and Partition of India

UNIT IV: Constitution of India

The Preamble, Salient Features, Fundamental Rights, Fundamental Duties

UNIT V: Indian Economy

Nature of the Mixed Economy, Role of the Planning Commission, Economic Liberalization after 1991

Suggested Readings

1. Basham, A.L. The Wonder That Was India. New Delhi: Rupa, 1994.
2. Basu, Durga Das. Introduction to the Constitution of India. New Delhi: Lexis Nexis, 2012.
3. Chandra, Bipan et al. India's Struggle for Independence. New Delhi: Penguin, 1989.
4. Chandra, Satish. History of Medieval India. New Delhi: Orient BlackSwan, 2009.
5. Dutt, R. & Sundharam. Indian Economy. New Delhi: S. Chand & Co., 2018.
6. Hussain, Majid. Geography of India, Ed. Tasawwur Husain Zaidi. Noida: McGraw Hill, 2022.

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7. Lahiri, Nayanjot. *Marshaling the Past: Ancient India and Its Modern Histories*. New Delhi: Permanent Black, 2012.
8. Ray, Tirthankar. *The Economic History of India 1857–1947*. New Delhi: Oxford University Press, 2006.
9. Sharma, R.S. *India's Ancient Past*. New Delhi: Oxford University Press, 2007.
10. Thapar, Romila. *The Penguin History of Early India: From the Origins to AD 1300*. New Delhi: Penguin India, 2003.

Course Learning Outcomes (CLOs) : Upon successful completion of this course, students will be able to:

1. Understand the **geographical features** and diversity of India.
2. Gain insights into the **cultural traditions and population dynamics** of the country.
3. Analyze **India's struggle for freedom** and key historical events.
4. Comprehend the **basic structure and features of the Indian Constitution**, including fundamental rights and duties.
5. Develop an overview of the **Indian economy and its post-independence transformation**.



Mahayogi Gorakhnath University, Gorakhpur
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III Year: V Semester (PRACTICAL)

Bioprocess Technology Lab

Code: BBT 556

L	T	P	C
0	0	2	1

Course objective:

1. To learn the setup of Biomass Production.
2. To understand the basic knowledge of Bioprocess Technology
3. The course provides the basics of microbiology to build a foundation for more advanced studies in microbiology, biotechnology and environmental engineering.

Practical

1. Estimation of Biomass Production.
2. Determination of the specific growth rate and generation time of a bacterium during submerged fermentation.
3. Estimation of the effect of temperature and pH on the growth of microbes.
4. Estimation of the effect of substrate concentration on the growth of *E.coli*.
5. Estimation of Monod Parameters for microbial growth kinetics.
6. Calculation of thermal death point (TDP) of a microbial sample.
7. Isolation of industrially important microorganisms from natural resource.
8. Screening of microbes for the production of enzymes.
9. Optimization of production and analysis of ethanol.
10. Biological treatment of wastewater originating from an industrial source.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. After completing this practical course, the student will be able to define a microorganisms give examples of structurally different microbes, and list microbes by their energy metabolism and carbon sources.
2. The student will be able to evaluate the cultivation, enrichment and growth prevention methods for microbes.
3. The student will be able to explain the roles of microbes in elemental cycles on Earth and, the waste decontamination methods based on microbial activities.
4. Students will be able to judge how microbes and enzymes could be applied in industry.

Q. 2



Mahayogi Gorakhnath University, Gorakhpur
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Department of Biotechnology

III Year: V Semester(PRACTICAL)

Animal and Plant Biotechnology Lab

Code: BBT554

L	T	P	C
0	0	2	1

Course objectives: The course aims to make students gain knowledge in the current trends and techniques in animal and plant biotechnology. The specific objectives of the course are as follows:

1. To develop an understanding of animal cell culture and gene delivery methods for the production of transgenic animals.
2. To gain knowledge about the stem cells and their various applications
3. To enable students, to acquire knowledge of the fundamental principles of plant tissue culture.
4. To impart knowledge about the diverse applications of plant biotechnology and genetically modified crops.
5. Introduction of animal cell culture
6. Learn types of cell culture and preparation for cell culture
7. Introduce cancer cell and tissue engineering

PRACTICALS

1. Sterilization Techniques
2. Preparation of Media
3. Preparation of Sera
- 4 Primary Cell Culture
- 5 Preparation of established Cell lines
- 6 Cell Counting and Viability
- 7 Staining of Animal Cells
- 8 Preservation of Cells

Q. 2



III Year: V Semester(PRACTICAL)

Industrial Training/Internship

Code: BBT553IS

L	T	P	C
0	0	4	2

Course Learning Objectives: The overall objective of the industrial training is to expose the student to the work environment in the field of biotechnology. In particular, the industrial training program will:

1. Enable the students to gain valuable practical experience, and test the students' career interests.
2. Provide the students with in depth knowledge about career fields.
3. Develop the students' job-related skills.
4. Enhance the students' biotechnology knowledge acquired in class through lab experience.
5. Teach the students on how to deal with the society outside the university.
6. Provide the training organizations with a better assessment of the quality of future human resources, and suggest improvements.

Industrial Training/Internship

Industrial Training/Internships are an essential part of the academic curriculum. It is a bridges the widen gap between theoretical learning and practical exposure by giving students first-hand exposure to identify the inputs and outputs for different Industrial operations and processes performed at the workplace.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to

1. Analyze the different career prospects available in biotechnology-related establishments
2. Understand the technology implemented in the manufacturing of products in real-world scenario
3. Understand the entrepreneurial skills required to establish biotechnology-related manufacturing units
4. Understand the cost-cutting strategies adopted by manufacturing units

②.2



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B.Sc. Biotechnology (Hons./Hons. With Research)
Study Evaluation Scheme (Choice-Based Credit System)
Effective from the session 2025-26

III Year: VI Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT603	Genomics and Proteomics	4	0	0	25	75	100	4	Major	Own faculty
2	BBT607	Bioanalytical Tool	4	0	0	25	75	100	4	Major	Own faculty
3	----	Minor Elective 2	3	0	0	25	75	100	3	Minor	Own faculty
4		Vocational Elective-I	3	0	0	25	75	100	3	Minor	Own faculty
5	BBT631	Analytical Ability and Digital Awareness	2	0	0	25	75	100	2	AEC	Own faculty
6	BBT632	Artificial Intelligence in Biological Sciences	2	0	0	25	75	100	2	VAC	Outsourced
Practical											
6	BBT651	Bioanalytical Tool Lab	0	0	2	25	75	100	1	Major	Own faculty
7	BBT653	Genomics and Proteomics Lab	0	0	2	25	75	100	1	Major	Own faculty
8	BBT653SM	Seminar	0	0	4	25	75	100	2	SEC	Own faculty
Total			17	0	4	200	600	800	22		

Evaluation Scheme, promotion scheme, grading system, and CGPA calculation adopted from CCFUP, by UGC 2022.

L	Lecture
	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AEC	Ability Enhancement Course
SEC	Skill Enhancement Courses
SE	Discipline Specific Elective
MD	Multidisciplinary
VAC	Value-added courses common for all UG

Minor Elective 2	
Course Code	Course Name
BBT6110	Industrial Biotechnology
BBT6111	Animal Cell Culture
BBT6112	Medical Biotechnology
BBT6113	Scientific Writing

Vocational Elective	
Course Code	Course Name
BBT6210	Food Processing and Preservation
BBT6211	Mushroom Culture https://onlinecourses.swayam2.ac.in/nos20_ge07/preview
BBT6213	Api Culture https://onlinecourses.swayam2.ac.in/nos19_as10/preview

***3-year UG Degree:** Students who wish to undergo a 3-year UG program will be awarded UG Degree in the Major discipline after successful completion of three years, securing 120 credits and satisfying the minimum credit requirement as given in table 2.

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III Year: VI Semester (THEORY)

Genomics and Proteomics

Code: BBT603

L	T	P	C
4	0	0	4

Course objectives: The broad objective of the course is to make students aware about the importance of the modern methods of genome and proteome analysis and the significance of these on the changing paradigm in genetics, medicine and agriculture. The specific objectives of the course are as follows:

1. To introduce the basic concepts of genomics and next generation sequencing.
2. To acquaint students with various genome databases and their applications.
3. To make students aware about the applications of genomics in various industries.
4. To makes students understand the techniques of proteome analysis diverse applications and benefits of genome and proteome analysis.

UNIT I: Introduction to Genomics

Introduction to Genomics, DNA sequencing methods: Maxam& Gilbert; Sanger's method; Next-generation sequencing: Pyrosequencing, Nanopore sequencing; Genome Sequencing: Shotgun & Hierarchical (clone contig) methods; Genome sequence assembly software: Newbler.

UNIT II: Genome databases

Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organism's Genomes and Databases: *E.coli*, *Mus musculus*, *Homo sapiens*, *Arabidopsis thaliana*; Human genome project.

UNIT III: Application of genomics

Comparative genomics: comparison of genomes; pharmacogenomics: variable drug response of individuals; metagenomics; epigenomics: New tool in studying complex diseases.

UNIT IV: Introduction to proteomics

Introduction to Proteomics, Two-dimensional polyacrylamide gel electrophoresis (2D-PAGE): isoelectric focusing and SDS-polyacrylamide gel electrophoresis, staining methods of 2D gels; mass-spectrometry: Matrix Assisted Laser Desorption Ionization Time of Flight (MALDI-ToF); peptide mass fingerprinting; Edman degradation.

UNIT V: Applications of proteomics

Clinical application of proteomics; proteomic biomarkers for disease diagnosis; plasma proteome; cancer proteomics; applications of proteomics in toxicology; plant proteomics in plant development, plant physiology and ecology; interaction proteomics and protein networks.

SUGGESTED READING

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1. S. B. Primrose and R.M. Twyman - Principles of Genome Analysis and Genomics, 7 th Edition, Blackwell Publishing, 2006.
2. S. Sahai - Genomics and Proteomics, Functional and Computational Aspects, Plenum Publication, 1999.
3. Andrezej K Konopka and James C. Crabbe, Compact Hand Book - Computational Biology, Marcel Dekker, USA, 2004.
4. Pennington & Dunn - Proteomics from Protein Sequence to Function, 1 st edition, Academic Press, San Diego, 1996.
5. Liebler, DC and Yates III, JR 2002. Introduction to Proteomics: Tools for New Biology, 1st ed. Humana Press.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Understand differentiate between eukaryotic and prokaryotic genomes and will be able to use genome databases.
2. Learn basic concepts of next generation sequencing.
3. Learn techniques used to analyze genome and proteome.
4. Understand the relevance of genomics and proteomics in modern biology.

Q. 2



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III Year: VI Semester(THEORY)

Bioanalytical Tools

Code: BBT607

L	T	P	C
4	0	0	4

Course objectives: The broad objective of the course is to make students aware about the importance and significance of the diverse tools and techniques used to study and understand the biological world. The specific objectives of the course are as follows:

1. To introduce the basic principle, types and application of microscopy.
2. To study concepts applications and types of centrifugations.
3. To acquaint students with chromatography and spectroscopy techniques.
4. To makes students understand the techniques of electrophoresis and blotting.

UNIT I: Microscopy

Principle and applications of: Light microscopy; phase contrast microscopy; fluorescence microscopy; confocal microscopy; transmission electron microscopy (TEM) and scanning electron microscopy (SEM); live cell imaging.

UNIT II: Centrifugation

Principles of centrifugation and concept of RCF; types of centrifugations: preparative, density gradient centrifugation; analytical ultracentrifuge; applications of centrifuges in cell fractionation techniques; isolation of sub-cellular organelles and particles.

UNIT III: Chromatography

Introduction to the principles of chromatography; Paper chromatography; thin layer chromatography; column chromatography: size-exclusion chromatography, ion exchange chromatography, and affinity chromatography.

UNIT IV: Electrophoresis and blotting

Introduction to electrophoresis; polyacrylamide gel electrophoresis (PAGE): native and SDS-PAGE; agarose-gel electrophoresis; pulse field gel electrophoresis; immuno-electrophoresis; isoelectric focusing; Southern, Northern and Western blotting.

UNIT V: Spectroscopy

Basic concepts of spectroscopy; Beer Lambert's law; principles and applications of UV-visible spectroscopy; Turbidimetry; fluorescence spectroscopy; atomic absorption spectrophotometry; infrared spectroscopy and Nuclear Magnetic Resonance spectroscopy (NMR).

SUGGESTED READING

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

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2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Understand the principles and applications of microscopy.
2. Remember the concepts applications and types of centrifugations.
3. Comprehend techniques used for chromatography and spectroscopy.
4. Appreciate the relevance of electrophoresis and blotting technology in modern biology.

Q. 2



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III Year: VI Semester(THEORY)

Minor Elective 2

Industrial Biotechnology

Code: BBT6110

L	T	P	C
3	0	0	3

Course objectives: This course presents an overview of industrial and environmental biotechnology. After completion of this course, students will be able to;

1. Know the process of microbial production of different essential compounds
2. Understand the nature of pollutants and biological techniques to improve the environmental health.
3. To know the importance of biofertilizers and treatment of effluents by biological methods
4. Understand the importance of biotechnology in medical and other industries

UNIT I: Production of alcohols, antibiotics and enzymes

Production of alcohols (Ethanol) and organic acids (citric and acetic). Production of biologically active compounds: antibiotics (penicillin) and enzymes (amylase, protease). Production of microbial food and single cell proteins, Bioreactor for immobilized cells/enzyme system, Biosensors and their applications, concept of BOD and COD.

UNIT II: Bioconversions:

Biomining and bioleaching of ores, Use of thermophilic microorganisms in industrial microbiology, Bio-gas, Bio-leaching, bio-diesel.

UNIT III: Microorganisms in agriculture and bioremediation

Microorganisms in Agricultural Waste water treatment, Vermiculture, Microbial pesticides. Petroleum prospecting and formation of oil spills, Wastewater treatment, chemical degradation, heavy Metals.

UNIT IV: Technology of microbial cell maintenance

Steps to maintain microbial culture in an aseptic & sterile environment (how to inoculate, preserve & maintain), Strain preservation, maintenance and strain improvement by mutation of gene transfer processes.

UNIT V: Biotechnology in specific medical & industrial applications

Retting of jute, microbial process for immunization (Production of monoclonal antibodies), Deterioration of paper, textiles, painted surfaces and their prevention, Biofilms, microbial biopolymers, biosurfactants, Microbial culture selection with high yield potential.

SUGGESTED READING

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1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
1. Salisbury, Whitaker and Hall. Principles of fermentation Technology
2. Wainwright, M 1999. An Introduction to Environmental Biotechnology, 1st ed. Springer, USA.
3. Singh, RL 2017. Principles and Applications of Environmental Biotechnology for a Sustainable Future, 1st ed. Springer Singapore

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Know the significance of microbial production of various important molecules and compounds
2. Develop the concepts of bioremediation and their varied applications.
3. Understand the role of biotechnology in providing solution to various environmental problems.
4. Learn the role of GMO to clean the environment.

②.2



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III Year: VI Semester(THEORY)

Minor Elective 2

Animal Cell Culture

Code: BBT6111

L	T	P	C
3	0	0	3

Course objectives: The specific objectives of the course are as follows:

1. Introduction of animal cell culture
2. Learn types of cell culture and preparation for cell culture
3. Introduce cancer cell and tissue engineering

UNIT I: Introduction of animal cell culture

Introduction of Animal Cell and Tissue Culture, History of the development of Animal cell culture techniques, Significance and Applications of tissue culture techniques.

UNIT II: Preparation for cell culture

Requirements in Animal Cell Culture, Equipment used in Cell culture, Culture vessels, Aseptic techniques, Culture media, designing of culture media, Serum-free media development.

UNIT III: Types of cell culture

Primary culture, secondary culture, cell line, cryopreservation, contaminations, organotypic culture, Insect Cell Culture: An Overview, In vitro transformation of animal cells, Types of cell culture. Cell culture in vaccine production and drug/therapeutics development.

UNIT IV: Cancer cell

Cell cycle analysis and Synchronization of cultures, cancer studies using cell culture, production of hybridoma, and monoclonal antibody production.

UNIT V: Tissue engineering

Animal cloning, Therapeutic cloning, Tissue engineering, Knock out animals. 3D printing.

SUGGESTED READING

1. Culture of Animal Cells R.Ian Freshney, Wiley Liss Publication, New York
2. Modern Concepts of Biotechnology H.D. Kumar Vikas Publishing House Pvt. Ltd., New Delhi
3. Biotechnology Fundamentals and Applications S.S. Purohit & S.K. Mathur Agrobotanica, India
4. Agricultural Biotechnology S.S. Purohit Agrobotanica, India
5. Fungi in Biotechnology Anil Prakash CBS Publishers, New Delhi
6. Biotechnology B.D. Singh Kalyan Publishers, New Delhi
7. Biotechnology J.E. Smith Cambridge University Press

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8. Biotechnology D. Balasubramaniam, K.Dharmalingam, K.Jayaraman. University Hyderabad
9. Animal Cell Culture John R.W. Masters Oxford University Press

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Comprehend the fundamental concepts of animal cell culture and its applications.
2. Understand the methods for preparation of cell culture.
3. Learn about different kinds of plant culture techniques
4. Get an overview of cancer cell culture and transgenic animal

Q. 2



Mahayogi Gorakhnath University, Gorakhpur
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III Year: VI Semester(THEORY)

Minor Elective2

Medical Biotechnology

Code: BBT6112

L	T	P	C
3	0	0	3

Course objectives:The main objective of this course is to:

1. To empower students with the knowledge of allied biomedical sciences
2. Introduce to create a work force for advanced research
3. Introduce diagnostics in a medical environment.

UNIT I: Methods for diagnosis of human diseases Karyotyping of human chromosomes, Chromosome banding– G banding and R-banding technique, Inheritance patterns in Man– Pedigree, Diagnosis using monoclonal antibodies- ELISA, DNA/RNA based diagnosis– HBV, HIV.

UNIT II: Inherited disorders

Chromosomal disorders caused due to structural chromosomal abnormalities (Deletions, duplications, Translocations), Chromosomal disorders caused due to numerical chromosomal abnormalities (autosomal and allosomal), Monogenic disorders (autosomal and X-linked diseases), Mitochondrial diseases – LHON, MERRF.

UNIT III: Cancer biology

Cancer – types, the molecular basis of colon cancer and breast cancer, lung cancer, leukemia, lymphoma.

UNIT IV: Gene therapy

Gene therapy – *ex-vivo* and *in-vivo* gene therapy; somatic and germline gene therapy; Strategies of gene therapy:

UNIT V: Therapeutic approaches for human diseases

Gene augmentation – ADA deficiency; Prodrug therapy/suicide gene – glioma, Stem cells – potency definitions; embryonic and adult stem cells; applications of stem cells – cell based therapies and regenerative medicine, Encapsulation technology and therapeutics-Diabetes, DNA-based vaccines, subunit vaccines – Herpes Simplex Virus, Recombinant attenuated vaccines– Cholera.

Suggested Readings:

1. Medical Biotechnology-PratibhaNallari, V.Venugopal Rao-Oxford Press
2. Introduction to Human Molecular Genetics – J.J Pasternak, John Wiley Publishers
3. Human Molecular Genetics –Tom Strachen and A P Read, Bios Scxientific Publishers
4. Molecular Biotechnology, Glick and Pasternak

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Course Learning Outcome (CLO): Successful students will be able to:

4. Students will develop an ability to identify, organize and answer problems in Medical Biotechnology.
5. Students will develop an ability to use skills and modern technological tools necessary for medical biotechnological practices.

Q. 2



Mahayogi Gorakhnath University, Gorakhpur
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III Year: VI Semester (THEORY)

Minor Elective 2

Scientific Writing and Communication

Code: BBT6113

Course objectives: The main objective of this course is to address some of the more practical skills involved in writing about complex scientific information.

Unit I: Introduction; Importance and basic rules of scientific writing; English in academic writing; Common error in Language; Structure of an original research article

Unit II: Writing an abstract; Literature review: Introduction, Source of literature; Process of literature review; Online literature databases; Literature management tools; Citing and Referencing; Different tools available, an Introduction to Mendeley and getting started with Mendeley, Add and managing references in Mendeley, Sharing, collaborating and other tools

Unit III: Module 3

Ethics and Plagiarism: Introduction; Tools for the detection of plagiarism; Avoiding plagiarism

Unit IV: Review Paper Writing, Research paper writing; Thesis Writing; Abstract/ Conference Paper/ Book/ Book Chapter writing;

Unit V: OERs: basic concept and licenses Open Educational Resources (OERs) for learning & Research; OERs development

Suggesting Readings:

1. Katz, Michael Jay. From research to manuscript: A guide to scientific writing. Springer Science & Business Media, 2009.
2. Boland, Angela, Gemma Cherry, and Rumona Dickson, eds. "Doing a systematic review: A student's guide." (2017). 2nd edition SAGE publications
3. Wanderer, Nancy A. "Writing Better Opinions: Communicating with Candor, Clarity, and Style." Me. L. Rev. 54 (2002): 47.

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Mahayogi Gorakhnath University, Gorakhpur
Faculty of Health and Life Sciences
Department of Biotechnology

III Year: VI Semester(THEORY)

Vocational Elective

Food Processing and Preservation

Code: BBT6210

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are as follows:

1. To teach students about various food processing methods.
2. To impart the basic knowledge of laws regulating food industry.
3. To know the different types of food additives.
4. To understand the different types of food contamination.

UNIT I: Food processing operations: Refrigeration and freezing

Requirements of refrigerated storage; controlled low temperature, air circulation and humidity; changes in food during refrigerated storage; progressive freezing, changes during freezing; freezing methods: direct and indirect, still air sharp freezer, blast freezer, fluidized freezer, plate freezer, spiral freezer and cryogenic freezing.

UNIT II: Food processing operations: Dehydration

Normal drying curve; effect of food properties on dehydration; changes in food during drying; drying methods and equipment: air convection dryer, tray dryer, tunnel dryer, continuous belt dryer, fluidized bed dryer, drum dryer, vacuum dryer, freeze drying, foam mat drying.

UNIT III: Food processing operations: Thermal processing of foods

Classification of thermal processes; principles of thermal processing; commercial canning operations; aseptic Processing; UHT; irradiation and microwave heating: Principles, dosage, applications of irradiation; mechanism of microwave heating and applications.

UNIT IV: Food additives and contaminants

Food Additives: Introduction, the need of food additives in food processing and preservation; characteristics and classification of food additives; chemical, technological, and toxicological aspects of food additives; contamination in food: Physical, chemical (heavy metals, pesticide residues, antibiotics, veterinary drug residues, dioxins, environmental pollutants, radionuclides, solvent residues); natural toxins.

UNIT V: Food regulations

Laws related to food packaging and nutrition labeling; food laws and regulations: Codex, HACCP, ISO, FSSAI, etc.

Suggested Readings:

Volume No: IV

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Department of Biotechnology

1. Desrosier NW and Desrosier JN, The Technology of Food Preservation, CBS Publication, New Delhi, 1998. Paine FA and Paine HY, Handbook of Food Packaging, Thomson Press India Pvt Ltd, New Delhi- 1992
3. Potter NH, Food Science, CBS Publication, New Delhi, 1998
4. Ramaswamy H and Marcott M, Food Processing Principles and Applications CRC Press, 2006
5. Rao PG, Fundamentals of Food Engineering, PHI Learning Pvt Ltd, New Delhi, 2010
6. Toledo Romeo T, Fundamentals of Food Process Engineering, Aspen Publishers, 1999
7. B. Srilakshmi, Food science, New Age Publishers, 2002
8. Meyer, Food Chemistry, New Age, 2004
9. Bawa. A.S, O.P Chauhan et al. Food Science. New India Publishing agency, 2013
10. Frazier WC and Westhoff DC, Food Microbiology, TMH Publication, New Delhi, 2004
11. Manay, NS and Shadaksharaswamy, M 1987. Food Facts and Principles. New Age International (P) Ltd. Publishers, New Delhi.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Understand about different food processing methods like refrigeration and freezing.
2. Learn about the dehydration techniques with the use of advanced technology of types of dryers.
3. Understand the different types of thermal processing techniques.
4. Learn about the importance of food regulations like Codex, HACCP, ISO, FSSAI, etc. in food packaging and labeling.

Course Objectives: The objectives of the course are as follows:

1. To teach students about various food processing methods.
2. To impart the basic knowledge of laws regulating food industry.
3. To know the different types of food additives.
4. To understand the different types of food contamination.

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Mahayogi Gorakhnath University, Gorakhpur
Faculty of Health and Life Sciences
Department of Biotechnology

III Year: VI Semester(THEORY)

Vocational Elective

Mushroom Culture

L	T	P	C
3	0	0	3

Code: BBT6211

Course Objectives: The objectives of the course are as follows:

1. To teach students about Mushroom Culture, covering its cultivation, types of edible mushrooms
2. To impart the basic knowledge of Cultivation Techniques for Specific Mushroom Varieties
3. To know the different sustainable farming practices.
4. To understand the Marketing of Value-Added Products

UNIT-I: Introduction to Mushroom Culture:

Overview of mushroom cultivation, Types of edible mushrooms, Life cycle of mushrooms, Selection of mushroom species, Importance of mushrooms in agriculture.

UNIT-II: Mushroom Substrate and Spawn Production:

Substrate preparation for mushroom cultivation, Mushroom spawn and its production, Inoculation techniques, Environmental factors for mushroom growth, Disease and pest management in mushroom farms.

UNIT-III: Cultivation Techniques for Specific Mushroom Varieties: Cultivation of button mushrooms (*Agaricus bisporus*), Shiitake mushroom cultivation (*Lentinula edodes*), Oyster mushroom cultivation (*Pleurotus* spp.), Specialty mushroom varieties, Organic and sustainable mushroom farming.

UNIT IV: Pest and Disease Management and Post-Harvest Handling and Processing:

Common pests in mushroom cultivation, Sanitation practices, Preventive measures and controls, Harvesting techniques for different mushrooms, Sorting and grading, Drying and dehydration methods, Packaging and storage techniques, Transportation guidelines, Value addition techniques, Shelf life enhancement, Preservation methods, Waste mushroom processing, Quality standards and regulations.

UNIT-V: Marketing, Value-Added Products, and Future of Mushroom Culture:

Marketing strategies for mushroom farmers, Value-added mushroom products, Mushroom-based bioactive compounds, Research and innovations in mushroom culture, Challenges and opportunities in mushroom farming.

Reference Books

1. Mushroom Cultivation: An Illustrated Guide to Growing Your Own Mushrooms at

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Department of Biotechnology

Home by Tavis Lynch

2. Mushroom Biology: Concise Basics and Current Developments by Philip G. Miles and Shu-Ting Chang

3. Mushroom Cultivation: Growing Mushrooms at Home for Food by Ben Haggard

4. Mushroom Pest and Disease Control: A Color Handbook by T. R. Glare and T. G. A. Green

5. The Shiitake Way: Vegetarian Cooking with Shiitake Mushrooms by Jennifer Snyder

6. Oyster Mushroom Cultivation: Simple and Advanced Techniques by Satyajit Panda and Hajra Pandit

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Faculty of Health and Life Sciences
Department of Biotechnology

III Year: VI Semester(THEORY)

Vocational Elective

Api Culture

Code: BBT6213

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are as follows:

1. To teach students about Apiculture, starting with an introduction to Beekeeping
2. To impart the basic knowledge of Honey Production and Products
3. To know the different sustainable farming practices.
4. To understand the Marketing of Value-Added Products

UNIT-I

Introduction to Apiculture and Honey Bees:

Overview of apiculture (beekeeping), Types of honeybees, Hive construction and equipment, Beekeeping history and significance, Sustainable beekeeping practices.

UNIT-II

Bee Biology and Hive Management:

Honeybee life cycle and behavior, Hive inspection and maintenance, Swarm prevention and management, Queen bee rearing and genetics, Disease identification and control.

UNIT-III

Honey Production and Products: sources and honey production, Extracting and processing, honey, Beeswax and other hive products, Pollination services and beekeeping income, Marketing honey and hive products.

UNIT -IV

Floral Calendar and Foraging Management:

Understanding floral sources and nectar plants, Seasonal floral availability and mapping, Bee foraging behavior and distances, Major nectar and pollen plants by region, Cultivated crops and wild flora for beekeeping, Migratory beekeeping practices, Honey flow periods and site shifting, Intercropping for bee forage enhancement, Managing bee colonies during dearth periods, Enhancing honey production through flora planning.

UNIT-V

Challenges, Sustainability, and Future of Apiculture:

Challenges in beekeeping (e.g., colony collapse disorder), Sustainable beekeeping practices, Organic beekeeping and certification, Innovations in beekeeping technology, Future trends and opportunities in apiculture.

Reference Books

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1. The Beekeeper's Problem Solver: 100 Common Problems Explored and Explained by James E. Tew
2. Beekeeping at Buckfast Abbey by Brother Adam
3. Beekeeping For Dummies by Howland Blackiston
4. The Beekeeper's Handbook by Diana Sammataro and Alphonse Avitabile
5. Honey Bee Biology and Beekeeping by Dewey M. Caron and Lawrence John Connor



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Faculty of Health and Life Sciences
Department of Biotechnology

III Year: VI Semester (THEORY)

Analytic Ability and Digital Awareness

Code: BBT631

L	T	P	C
2	0	0	2

Course objectives: The objectives of the course are as follows:

1. To teach analogy, number system, set theory and its applications, number system and puzzles.
2. Understand the basics of Syllogism, figure problems, and critical and analytical reasoning.
3. Students will learn with word processing applications and worksheets.
4. Students will understand the basics of web surfing and cyber security.

UNIT I: Analytic ability

Alphabet test, Analogy, Arithmetic Reasoning, Blood relations, Coding and Decoding, Inequalities, Logical Venn diagram, Seating Arrangements, Puzzles and Missing numbers

UNIT II: Analytical and decision making

Syllogism, Pattern completion and figure series, Embedded Figure and counting of figures, Cube & Dice, Paper cutting and folding, Data sufficiency, Course of Action, Critical Reasoning, Analytical and decision making.

UNIT III: Computer basics

Block diagram of Digital Computer, Classification of Computers, Memory System, Primary storage, Auxiliary memory, Cache memory, Computer Software (System/Application Software). MS Word Basics: The word screen, Getting to word documents, typing and Revising text, Finding and Replacing, Editing and Proofing tools, Formatting text characters, Formatting Paragraph, Document templates., Page set up, tables, Mail Merge, Macros, protecting documents, printing a document.

UNIT IV: MS-Excel

Introduction, Worksheet basics, Creating worksheet, Heading information, Data & Text, Date & Time, Alphanumeric values, Saving & quitting worksheet, Opening and moving around in an existing worksheet, Toolbars and Menus, Excel shortcut and function keys, Working with single and multiple workbook, Working with formulae & cell referencing, Auto sum, coping formulae, Absolute & relative addressing, Worksheet with ranges, Formatting of worksheet, Previewing & Printing worksheet, Graphs and charts, Database, Creating and using macros, Multiple worksheets- concepts.

Introduction of Open Source Applications: LibreOffice, OpenOffice and Google Docs etc.

UNIT V: Web Surfing and Cyber Security

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An Overview: working of Internet, Browsing the Internet, E-Mail, Components of E-Mail, Address Book, Troubleshooting in E-Mail, Browsers: Netscape Navigator, Microsoft Internet Explorer, Google Chrome, Mozilla Firefox, Tor, Search Engines like Google, DuckDuckGo etc, Visiting web sites: Downloading. Cyber Security: Introduction to Information System, Type of information system, CIA model of Information Characteristics, Introduction to Information Security, Need of Information Security, Cyber Security, phishing, spamming, fake news, general issues related to cyber security, Business need, Ethical and Professional issues of security.

Suggested Readings:

1. Sharma, A., "How to prepare for Data Interpretation and Logical Reasoning for the CAT" McGraw Hill Education Pvt. Ltd., New Delhi, India, 2011, Ed. 5, ISBN 978 2007 070 481
2. Aggarwal, R.S., "A Modern Approach to Verbal and Non-verbal Reasoning" S. Chand Publishers New Delhi, India, 2010, ISBN 10: 8121905516
3. Madan, Sushila, Introduction to Essential tools, Jain Book Agency, New Delhi/India, 2009, 5th ed..
4. Goel, Anita, Computer Fundamentals, Pearson Education, India, 2012
5. Michael E. Whitman and Herbert J. Mattord, "Principles of Information Security," Sixth Edition, Cengage Learning, 2017

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Familiarize with analogy, number system, set theory and its applications, number system and puzzles.
2. To understand the basics of Syllogism, figure problems, critical and analytical reasoning.
3. Familiarize with word processing application and worksheet.
4. To understand the basics of web surfing and cyber security.

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Department of Biotechnology

IV Year: VII Semester (THEORY)
Artificial Intelligence in Biological Sciences
Code: BBT 7105

L	T	P	C
2	0	0	2

Course Objective:

1. To learn various concepts of AI Techniques.
2. To learn various Application in Pharmaceutical
3. To application in drug designing and Precision Medicine
4. To learn about AI in medical imaging, agriculture and synthetic biology

UNIT 1: Introduction to AI

Concept of AI, history, current status, scope, agents, environments Biological Intelligence Vs Artificial Intelligence, AI Basics: concepts, terminologies and workflow, ML, DL.

UNIT 2: Applications of AI in Pharma:

Applications of AI in the Pharmaceutical Industry, AI-driven applications for drug design, lead optimization, and clinical trials, Artificial Intelligence for Biomarker Discovery

UNIT 3: AI in Health and Medicine:

AI in Precision Medicine, AI in shaping the future of Bioinformatics, AI in health diagnostics / Confluence of AI and Smart Devices for Monitoring Health and Disease, AI in medical imaging

UNIT 4 : AI in Biotechnology and Life Science

Artificial Intelligence and Synthetic Biology, Transforming Agriculture with AI, AI in biology and bioinformatics

UNIT 5 : Future and Ethical Concerns of AI

Future Prospects of AI in healthcare and research, Technological advancements and their potential impact on AI in biotech, new trends and opportunities for AI-powered biotech in the future. Risks involved and ethical concerns, Need of regulatory frameworks for AI in biotech

Course Outcomes

1. Understand the various concepts of Artificial Intelligence in Biotech & health tech companies globally
2. Understand how New Companies are being built by combining Biotech & Artificial Intelligence
3. Experience how Artificial Intelligence is revolutionizing health care

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SUGGESTED READING

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach” , 3rd Edition, Prentice Hall.
2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Tata McGraw Hill
3. Carl Townsend, “Introduction to Prolog Programming”
4. Ivan Bratko, “PROLOG Programming for Artificial Intelligence”, Addison-Wesley, 2nd Edition.
5. Trivedi, M.C., “A Classical Approach to Artificial Intelligence”, Khanna Publishing House, Delhi.
6. David Poole and Alan Mackworth, “Artificial Intelligence: Foundations for Computational Agents”, Cambridge University Press 2010
7. SarojKaushik, “Artificial Intelligence”, Cengage Learning India, 2011

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III Year: VI Semester(PRACTICAL)

Bioanalytical Tools Lab

Code: BBT651

L	T	P	C
0	0	2	1

Course objective: This practical course is introduced to bridge the gap between academics, research and industry.

1. This course begins with a review of basic bio analytical technique and an introduction to general terminologies in term of practical.
2. This practical course contains bio-analytical techniques along with their working principal, common instrumentation and possible applications.
3. This course will be equally beneficial to various scientific areas.
4. Students will be exposed to hand on training in various biological techniques and their applications in identification, isolation of different biological molecules.

PRACTICAL

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

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. Learn the basic concepts and applications of modern techniques used in Biochemistry and Molecular Biology.
2. Understand the principle and working of different chromatography techniques.
3. Understand the principle and working of gel electrophoresis techniques.
4. Understand the principle and working of different Electrophoretic and molecular biology techniques.

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Mahayogi Gorakhnath University, Gorakhpur
Faculty of Health and Life Sciences
Department of Biotechnology

III Year: VI Semester(PRACTICAL)

Genomics and Proteomics Lab

Code: BBT653

Course objective:

L	T	P	C
0	0	2	1

1. To understand the basic knowledge of genomic and proteomic
2. To know the analysis of genomes using in silico bioinformatics tools like
3. To explain principles of basic methods of genomic and proteomic analysis
4. To teach the microarray applications and analysis.

PRACTICAL

1. Identification of unknown sequence by BLAST and its functional annotation.
2. SNP analysis using SNP database of NCBI.
3. Comparison of genomes of two organisms using SynMap of CoGe.
4. Demonstration of microarray applications and analysis of microarray data.
5. Computation of pI and molecular weight of a protein using ExPASyProtParam tool.
6. Demonstration of 2D PAGE and data analysis.
7. Generation of protein interaction networks using STRING software.
8. Subcellular protein localization study using CELLO tool.
9. Protein motif identification using MEME software.
10. Conserved domain analysis using NCBI batch-CD research.

Course Learning Outcomes (CLOs): On completion of this course, the students will be:

1. Able to understand introductory knowledge concerning genomics, proteomics and their applications.
3. Understand the basic concept of genomics and proteomics.
4. Elucidate different techniques involved in Genomics and proteomics.
5. Understand different methods of genome sequencing and assembly

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III Year: VI Semester(PRACTICAL)

Seminar

Code: BBT653SM

L	T	P	C
0	0	4	2

Course objectives: The objective of this course is

1. To acquire the skills necessary to read and evaluate original research articles. Most of the course will involve the discussion of current issues in the domain of biotechnology.
2. To encourage the students to study advanced engineering developments
3. To prepare and present technical reports.
4. To encourage the students to use various teaching

Seminar

Conducting Seminar emphasizes upon the general guidelines for conduction of seminars. Activity of seminar includes preparation, and implementation of assigned topic presented by the student. Each student shall assign topic for seminar and they will prepare the power point presentation. The implementation of presentation will be evaluated by expert.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to

1. Survey the changes and updating of selected topic to know the current research of particular area
2. **Analyze** and compile the data of selected topic and **interpret** the impact on the society and environment
3. **Compile** the report of the study and present to the audience with following the ethics.
4. **Develop** an **understanding** to review, and compile the data and also developed the presentation skills
6. . Perfrom independent as well as team work to accomplish lab based tasks

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B.Sc. Biotechnology (Hons./Hons. With Research)
Study Evaluation Scheme (Choice-Based Credit System)
Effective from the session 2025-26

IV Year: VII Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT702	Intellectual Property Right	4	0	0	25	75	100	4	Major	Own faculty
2	BBT704	Computational and Structural Biology	4	0	0	25	75	100	4	Major	Own faculty
3		Interdisciplinary Elective-3	3	0	0	25	75	100	3	Minor	Own faculty
4	BBT705	Agricultural Biotechnology	4	0	0	25	75	100	4	MD	Own faculty
5	BBT706	Plant Tissue Culture	3	0	0	25	75	100	3	Major	Own faculty
6	BBT707	Biofuels and Bioenergy	3	0	0	25	75	100	3	Minor	Own faculty
Practical											
7	BBT752	Computational and Structural Biology Lab	0	0	2	25	75	100	1	Major	Own faculty
8	BBT753	Agricultural Biotechnology Lab	0	0	2	25	75	100	1	Major	Own faculty
Total			21	0	2	200	600	800	23		

Evaluation Scheme, promotion scheme, grading system, and CGPA calculation adopted from CCFUP, by UGC 2022.

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AEC	Ability Enhancement Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective
MD	Multidisciplinary
VAC	Value-added courses common for all UG

Interdisciplinary Elective -3	
Course Code	Course Name
BBT7101	Nanobiotechnology
BBT7104	Introduction to Biosensors

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IV Year: VII Semester (THEORY)

Intellectual Property Rights

Code: BBT702

L	T	P	C
4	0	0	4

Course objectives: The course aims to explain to students about intellectual property rights and patents. The specific objectives of the course are as follows:

1. To make students aware of types of IPRs and their utility.
2. To make students understand the procedure of filing a patent.
3. To teach students about the bioethical and biosafety practices related to biotechnology.
4. To familiarize students with copyright, trademarks, designs, and information technology act.

UNIT I: Introduction to IPR

Basic understanding of intellectual property rights; utility of IPRs; different types of IPRs; introduction to Indian patent law; World Trade Organization and its related intellectual property provisions world organizations: WIPO and TRIPS agreement, international treaties and conventions on intellectual property.

UNIT II: Protection of IPRs

Intellectual/industrial property and its legal protection in research, design and development. Forms of protection of IPRs: Introduction to copyrights and its applicability; fundamental concepts and importance of trademarks and trade secrets; geographical indications; design layout design of integrated circuits.

UNIT III: Patents

Methods of patenting and general concept of patent; patenting agencies; use of technical information in patent documents; revocation of patent; patenting of biological material like microorganisms, plant and animal, patenting in biotechnology, economic, ethical and depository considerations.

UNIT IV: Copyright

Nature of Copyright; subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings; registration, procedure, term of protection; ownership of copyright; assignment and licence of copyright.

UNIT V: Trademarks

Concept of Trademarks; different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks); non-registrable trademarks; registration of trademarks; rights of holder and assignment and licensing of marks.

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Suggested Readings:

1. Entrepreneurship: New Venture Creation: David H. Holt
2. Patterns of Entrepreneurship: Jack M. Kaplan
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers
6. Pandey, N and Dharni, K 2014. Intellectual Property Rights, 1st ed. PHI Learning Pvt. Ltd.
7. Tomkowicz, R 2011. Intellectual Property Overlaps: Theory, Strategies and Solutions, 1st ed. Routledge.

Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Understand types of IPRs and their utility.
2. Understand the procedure of filing a patent.
3. Gain knowledge about the bioethical and biosafety practices related to biotechnology.
4. Learn about copy right, trademarks, designs and information technology act.

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IV Year: VII Semester (THEORY)

Computational and Structural Biology

Code: BBT704

L	T	P	C
4	0	0	4

Course Objective: This course introduces fundamental concepts and methods of bioinformatics and structural bioinformatics. Emphasis of the classes is on the understanding of bioinformatics concepts and the practical utilization, with the objective to help students to use cutting-edge bioinformatics tools/methods to solve problems in their own research. The specific objectives of this course are as follows:

1. To provide foundation in fundamental concepts, tools and resources in computational biology
2. To inculcate skills in protein sequence analysis and structure modelling
3. To develop basic understanding about computational techniques in proteomics
4. To provide training in molecular docking and ADME predictions
5. To develop appreciation about computational drug design techniques

UNIT I: Introduction to Computational Biology:

Bioinformatics and its application; Overview of primary, secondary and composite biological databases; Introduction to protein structure and specialized databases; Overview of various database search engines (Text based and motif based); Overview of Genome Databases (FlyBase, WormBase, TAIR), Human Genome Project

UNIT II: Sequence Alignment:

Sequence Analysis – concepts of sequence similarity, Sequence identity vs homology. Definitions of homologues, orthologues, paralogues and xenologues; Scoring matrices: basic concept and construction of a scoring matrix; PAM and BLOSUM matrix and their derivatives. Sequence-based database searches: algorithm of BLAST and FASTA and interpretation of results. Algorithms for generation of sequence profiles; profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches.

UNIT III: Protein Structure Prediction:

Introduction to protein structure: Primary, Secondary and Tertiary; protein motifs and domains; Protein structure visualization software: RasMol, PyMol, PDB

UNIT IV: Protein Structure Visualization:

Viewer; Methods for prediction tertiary structure of proteins along with analysis and interpretation of results Homology modeling: Threading, Ab Initio; Online protein structure prediction tools: PHYRE-2, i-TASSER, MODELLER.

UNIT V: Computational approaches in Drug Design:

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Applications of bioinformatics in target identification & validation, binding site prediction. Lead compound identification: Structure-based & ligand-based approaches; Molecular docking-algorithms and scoring functions; Virtual screening- combinatorial chemistry and ligand databases; Design of ligands for known target sites- de novo techniques. Lead optimization. Pharmacophore-ligand based & target based. QSAR - molecular descriptors, bio-activity predictions. ADME Predictions.

SUGGESTED READINGS

1. Webster David (Editor). Protein Structure Prediction: Methods and Protocols (Methods in Molecular Biology) Volume 143. Publisher: New Jersey Humana Press. 2000. ISBN: 0896036375.
1. D. C. Rapaport, The Art of Molecular Dynamics Simulation, 2004, ISBN 0-521-82568-7
2. M. P. Allen, D. J. Tildesley, Computer simulation of liquids, 1989, Oxford University Press, ISBN 0-19-855645-4.
3. R. J. Sadus, Molecular Simulation of Fluids: Theory, Algorithms and Object-Orientation, 2002, ISBN 0-444-51082-6
4. J.M.Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
5. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.
6. Guy H. Grant and W. Graham Richards. Computational Chemistry Oxford Chemistry Primers, 291995. 9780198557401
7. Andrew R. Leach. Molecular Modelling: Principles and Applications, second edition. Pearson Education EMA, January 2001 ISBN 0-582-38210-6

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

1. Understand the evolution of biological structure and function.
2. Understand the architecture and building blocks of proteins.
3. Evaluate protein folds and the nature of the protein universe



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IV Year: VII Semester(THEORY)

Interdisciplinary Elective -3

Nanobiotechnology

Code: BBT7101

L	T	P	C
3	0	0	3

Course Objective: The aim of this course is to

1. Provide basic knowledge in the interface between chemistry, physics and biology
2. Introduce nanostructure level with a focus on biotechnological usage.
3. Introduce Techniques of nanomaterial characterization
4. Introduce Drug delivery and Biosensors

UNIT I: Introduction to Nanobiotechnology: Nanotechnology basic concepts; Cellular Nanostructures; Nanopores; Bimolecular motors; Chemical, physical and biological properties of biomaterials

UNIT II: Techniques of Nano material characterization:Preparation and characterization of nanoparticles: nanoparticular carrier system, Electron microscopy Atomic force microscopy

UNIT III: Nanostructures and Nanosystems: Carbon nanotubes, Fullerenes, Nanowires, Metallic nanoparticles, Dendrimers, Quantum dots, Ultrasound contrast agents, Nanoarrays, DNA computers, DNA motors, Nanopore technology, Biogenic nanoparticles, Stealth nanoparticles, Virus like nanoparticles.

UNIT IV: Drug delivery:Nanoparticular carrier system, micro and nano fluidics, drug and gene delivery system, microfabrication, chip technologies, nano-imaging.

UNIT V: Biosensors: Introduction and basic characteristics of biosensors, basic characteristics feature of ideal biosensor, different types of biosensors: Piezo electric sensors; Optical sensors; Calorimetric sensors; Electrochemical sensors, Gold nanoparticles as biosensors.

SUGGESTED READING

1. Multilayer Thin Films, Editor(s): GeroDecher, Joseph B. Schlenoff Publisher: Wiley-VCH Verlag GmbH & Co. KGaA ISBN: 3527304401
2. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Publisher: Wiley-Liss ISBN: 047141719X
3. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press ISBN: 0-8247-2579-

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Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. To Apply engineering and physics concepts to the nano-scale and non-continuum domain.
2. Identify and compare state-of-the-art nanofabrication methods and perform a critical analysis of the research literature.
3. Design processing conditions to engineer functional nanomaterials.



IV Year: VII Semester (THEORY)
Interdisciplinary Elective -3

Introduction to Biosensors
Code:BBT7104

L	T	P	C
3	0	0	3

Course objective (CO)

1. To study about biosensors and their application.
2. To explain the different types of transducers and their application.
3. To understand the bioelectronics design for a biomolecular photonic computer.

Unit I: Introduction

Biosensors- Advantages and limitations, various components of biosensors, Biocatalysts based biosensors, Bioaffinity-based biosensors & Microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions.

Unit II: Transducers in Biosensors

Various types of transducers; principles and applications Calorimetric, Optical, Potentiometric Amperometry, conduct metric, Resist metric, Piezoelectric, Semiconductor, Impedimetric, Chemiluminescence - based Biosensors

.Unit III: Application and Uses of Biosensors

Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and Food Low cost - biosensor for industrial processes for online monitoring; Application of enzymes in analysis; design of enzyme electrodes and their application as biosensors in industry, healthcare, food and environment.

Unit IV: Bioelectronics

Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores; molecular wires and switches; mechanisms of unit assembly.

Units V: Design for a biomolecular photonic computer

Assembly of photonic biomolecular memory store; Information processing, commercial prospects for biomolecular computing systems.

Suggested Readings-

1. Gardner, J W. Microsensors , Principles and Application, John Wiley and Son (1994).
2. Kovacs , G.T.A. Micromachined Transducer Sourcebook, McGraw-Hill (2001).
3. Turner , A.P.F Karube, I and Wilson G.S, Biosensors –Fundamentals and Application Oxford University Press (2008).

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Course Learning Outcomes (CLO)

At the end of the course, the student should be able to:

1. Study about biosensors and their application.
2. Explain the different types of transducers and their application.
3. Understand the bioelectronics design for a biomolecular photonic computer.



Mahayogi Gorakhnath University, Gorakhpur
Faculty of Health and Life Sciences
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IV Year: VII Semester (THEORY)

Agriculture Biotechnology

Code: BBT705

L	T	P	C
4	0	0	4

Course objectives: The main objective of this course is to:

7. To introduce develop green fuel.
8. To introduce transgenic methods to enhance crop productivity.
9. Introduce to produce pest resistant varieties of plant.

UNIT I: Green Biotechnology

Green biotechnology: Definition, concept and implication; Applications of green biotechnology

UNIT II: Green fuel

Bio-fertilizers and biopesticides; Plant growth promoting rhizobacteria; Production of biofuels, biodiesel and bioethanol; Biomass enhancement through biotechnological interventions; Generation of alternate fuels in plants;

UNIT III: Bioremediation

Identification and manipulation of micro-organisms for biodegradation of plastics and polymers; GMOs for bioremediation and phytoremediation, their roles; Strategies for detection and control of soil, air and water pollutants.

UNIT IV: Genetic engineering for crop productivity

Carbon sequestration; Methanogenic microbes for methane reduction; Microbes for phytic acid degradation; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency;

UNIT V: Transgenic strategies

Ti plasmid, *Agrobacterium tumefaciens*, Marker-free transgenic development strategies; Development of disease resistant and pest resistant crops through biotechnological tools.

Suggested Readings:

1. Kumar A. 2004. Environmental Biotechnology. Daya Publishing House.
2. Murray DC. 2011. Green Biotechnology. Dominant Publishers and Distributors

Course Learning Outcome (CLO): Successful students will be able to:

1. explain the basics of the physiological and molecular processes that occur during plant growth and development and during environmental adaptations
2. understand how biotechnology has been used to develop knowledge of complex processes that occur in the plant

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3. use basic biotechnological techniques to explore molecular biology of plants
4. understand the processes involved in the planning, conduct and execution of plant biotechnology experiments
5. explain how biotechnology is used for plant improvement and discuss the ethical implications of that use

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IV Year: VII Semester (THEORY)

Plant Tissue Culture

Code: BBT706

L	T	P	C
3	0	0	3

Course objectives: The specific objectives of the course are as follows:

1. To learn the basic techniques of plant tissue culture.
2. To introduce about laboratory organization for plant tissue culture.
3. To know the technique of the preparation of media for plant tissue culture.
4. To introduce the various aseptic techniques for organ culture.

UNIT I: Introduction and cell culture techniques

Introductory history, Laboratory organization, Media, Aseptic manipulation. Cell culture, Cellular Totipotency, Somatic embryogenesis.

UNIT II: *In-vitro* culture: approaches & methodologies

Preparation steps for tissue culture, surface sterilization of plant tissue material, basic procedure for aseptic tissue transfer, incubation of culture.

UNIT III: Tissue culture methodologies

Composition of culture media, Growth hormones, Vitamins, Unidentified supplements, selection of media; Callus culture, Cell suspension culture, Organ micro-culture, plant micro-propagation

UNIT IV: Cloning & selection of specific cell types

Cloning, somatic cell fusion, Medium suspension fusion, selection of hybrid clone

UNIT V: Organ Culture

anther Culture: Development of haploids, diploidization and its applications. Culture of embryonic organs, whole embryo culture, culture of adult organs.

SUGGESTED READING

4. Thorpe, T.A. 1981. Plant Tissue Culture Academic Press, London.
5. Trivedi, P.C. (Ed.) 2000. Plant Biotechnology - Recent Advances. Panima Publishing Co. New Delhi.
6. WulfCrueger and AnnelieseCrueger. 2000. Biotechnology - A Text book of Industrial Microbiology. 21. Robert N. Trigiano and Dennis J. Gray. 2000. Plant Tissue Culture Concepts and Laboratory Exercises. 2nd edit., CRC Press LLC, 454 pp.
7. Wenhao Dai. 2006. PLSC 484/684-Plant Tissue Culture and Micropropagation Laboratory Manual.

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Course Learning Outcome (CLO): Upon successful completion of this course the student will:

1. Learn the basis of plant tissue culture.
2. Understand about laboratory organization for plant tissue culture.
3. Understand the methodologies for plant tissue culture
4. Learn the various aseptic condition for organ culture.



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IV Year: VII Semester (Theory)

Biofuels & Bioenergy

Code: BBT 707

L	T	P	C
3	0	0	3

Course Objectives (CO)

1. To introduce the student to the different areas in which biotechnology is developed and to environmental application methods in terms of biofuels & bioenergy
2. Emphasize knowledge of the different types of environmental biotechnological processes that exist in the field of Global Energy Scenario.
3. To introduce the impact of energy systems on environment

Unit I Energy Resources

Coal, Oil, Natural Gas, Nuclear Power and Hydroelectricity, Solar, geothermal, tidal and wave energy. Need for use of new and renewable energy sources. Waste as a source of energy: Industrial, domestic and solid waste as a source of energy.

Unit II Biofuels

What are biofuels? Need, Advantages and limitations of biofuels. Production and impacts of bioethanol, biohydrogen, biogas, bioelectricity and biodiesel.

Unit III Global Energy Scenario

Role of energy in economic development and social transformation: - International Energy Policies of G-8 Countries, G-20 Countries, OPEC Countries, International Energy Treaties (Rio, Montreal, Kyoto), Future Energy Options: Sustainable Development,

Unit IV Indian Energy Scenario

Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Framework of Central Electricity Authority (CEA), Central & States Electricity Regulatory Commissions (CERC & ERCs), National Solar Mission.

Unit V: Impact of Energy Systems on Environment: Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SO_x, NO_x, SPM in air, thermal and water pollution, depletion of ozone layer, global warming, Green House Gases Emission, biological damage due to environmental degradation.

Suggested Readings:

1. Energy for a sustainable world: Jose Goldenberg, Thomas Johansson, A.K.N.Reddy, Robert Williams (Wiley Eastern).
2. Energy policy for :B.V.Desai (Weiley Eastern).
3. TEDDY Year Book Published by Tata Energy Research Institute (TERI).
4. World Energy Resources : Charles E. Brown, Springer 2002.
5. Environmental Impact Analysis Handbook -J.G.Rau, D.C.Wood (McGraw Hill).

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6. Energy & Environment – J.M. Fowler, (McGrawHill)
7. Web site of Ministry of New and renewable energy.

Course Learning Outcomes (CLO):

On completion of this course, students should be able to:

1. Understand and assimilate the specific concepts and terminology of environmental biotechnology.
2. Find and manage information from various Energy Resources and Bio fuels
3. Describe the scientific bases that are applied by environmental biotechnology.

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IV Year: VII Semester(PRACTICAL)

Computational and Structural Biology Lab

Code: BBT752

L	T	P	C
0	0	2	1

Course Objectives:

1. The students will learn to compare and analyze genome sequences using NCBI
2. Students will gain hand on training experience in computer lab on Computational and Structural Biology experiments like sequence search and run FASTA, BLAST etc
3. Students will understand the function and structure of biomolecules

PRACTICAL

1. To analyse and compare HIV and Bacillus Subtilis genome using NCBI.
2. To explore SCOP and CATH protein secondary structure databases.
3. To carry out FASTA based database searches for protein and DNA sequences.
4. To conduct identification of different structural motifs in protein.
5. To analysis protein structures from PDB (NMR and X-ray) database.
6. To carry out protein secondary and tertiary structure prediction using online tools.
7. To conduct structural analysis of protein entries for active and inactive states of protein using Pymol.
8. To carry out protein secondary structure prediction using online tools.
9. Homology based protein structure prediction and quality estimation of modeled protein structure (ProCheck, PROSA, Verify 3D, Errat etc.).
10. To carry out energy minimization based mutational analysis of proteins (using SwissPDB-Viewer).

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

1. To understand the evolution of biological structure and function.
2. Understand and identification of different structural motifs using tools
3. Tools using for sequence search for DNA and protein in FASTA format
4. To understand the hierarchy of protein using bioinformatics tools

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IV Year: VII Semester(PRACTICAL)

Agricultural Biotechnology Lab

Code: BBT753

L	T	P	C
0	0	2	1

Course Objectives:

1. To learn and gain Practical knowledge about Concept of application of diversifiedbiotechnological applications in the field of Agriculture by doing necessary hands on Practical
2. Learn to apply Practical technical knowledge and skills required for understanding and application of the Agriculture Biotechnology by doing necessary hands on Practical and industry sessions etc.

PRACTICAL

1. Introduction to microbiology laboratory and its equipment's.
2. Microscope- parts, principles of microscopy, resolving power and numerical aperture.
3. Methods of sterilization.
4. Nutritional media and their preparations.
5. Broth culture, agar slopes, streak plates and pour plats, turbid metric estimation of microbial growth
6. Enumeration of microbial population in soil- bacteria, fungi, actinomycetes.
7. Methods of isolation and purification of microbial cultures.
8. Isolation of Rhizobium from legume root nodule.
9. Isolation of Azotobacter from soil.
10. Isolation of *Azospirillum* from roots.
11. Isolation of BGA.Staining and microscopic examination of microbes.
12. examination of stained cells by simple staining and Gram staining.
13. mushroom culture- Spawn production, Culture and production techniques, harvesting, packing and storage.
14. Hands on Experience on Biofertilizer, Biopesticide production in relevant Industries

Course Learning Outcomes (CLO):

- 1.Evaluate the situation and present status prevailing in the field and act accordingly by doing necessary hands on Practical and industry sessions.

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B.Sc. Biotechnology (Hons./Hons. With Research)
Study Evaluation Scheme (Choice-Based Credit System)
Effective from the session 2025-26

IV Year: VIII Semester

S No	Course Code	Course	L	T	P	Evaluation Scheme		Total	Credits	Course Type	Faculty
						CIE	ESE				
Theory											
1	BBT801	Research Methodology	4	0	0	25	75	100	4	Major	Own faculty
2	BBT802	Research Publication Ethics	2	0	0	25	75	100	2	Minor	Own faculty
3	BBT804	Entrepreneurial Biotechnology	4	0	0	25	75	100	4	Major	Own faculty
Practical											
4	BBT852SI	Entrepreneurial Biotechnology Seminar	0	0	4	25	75	100	2	Major	Own faculty
5		Total	10	0	2	100	300	400	12		
OR											
1	BBT853PJ	Research Project/ Dissertation	0	0	24			400	12	Major	

B.Sc. (Honours)/ B.Sc. (Honours with Research) in Biotechnology*

Evaluation Scheme, promotion scheme, grading system, and CGPA calculation adopted from CCFUP, by UGC 2022.

L	Lecture
T	Tutorial
P	Practical
CIE	Continuous Internal Evaluation
ESE	End Semester Examination
GE	Generic Elective
AEC	Ability Enhancement Course
SEC	Skill Enhancement Courses
DSE	Discipline Specific Elective
MD	Multidisciplinary
VAC	Value-added courses common for all UG

***4-year UG Degree (Honours):**A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree program with 160 credits and have satisfied the credit requirements as given in table 2 in Section 5.

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. 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 160 credits, including 12 credits from a research project/dissertation, are awarded UG Degree (Honours with Research).

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IV Year: VIII Semester(THEORY)

Research Methodology

Code: BBT801

L	T	P	C
4	0	0	4

Course objective:

1. To introduce the nature of problem to be studied and identifying the related area of knowledge.
2. To analyzing data appropriate to the problem.
3. To reviewing literature to understand how others have approached or dealt with the problem.
4. To know the idea of paper and thesis writing.

UNIT I: Introduction of research methodology:

Meaning of research, objectives of research, types of research, significance of research, problems encountered by researchers in India.

UNIT II: Research problem:

Definition, necessity and techniques of defining research problem, Formulation of research problem, Objectives of research problem.

UNIT III: Research design:

Meaning, need and features of good research design, Types of Research Designs, Basic Principles of Experimental Designs, Design of experiments, and Synopsis design for research topic.

UNIT IV:Editing, Data Collection and Validation:

Primary and secondary data, Methods of collecting primary and secondary data, Importance and methods of editing and data validation.

UNIT V: Paper/Thesis Writing and Report Generation:

Basic concepts of paper their writing and report generation, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing, Types of Research reports, Methods of presentation of report.

SUGGESTED READINGS

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.

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4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.
6. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
7. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
9. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
10. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
11. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
12. Satarkar, S.V., 2000. Intellectual property rights and Copy right. EssEss Publications.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

1. Understand the limitations of particular research methods.
2. Develop skills in qualitative and quantitative data analysis and presentation.
3. Develop advanced critical thinking skills



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IV Year: VIII Semester(THEORY)

Research Publication Ethics

Code: BBT802

L	T	P	C
2	0	0	2

Course objective: The main purpose of research is

1. Introduce creating and disseminating knowledge in the world.
2. Teach importance in the development of humankind.
3. Introduce behavior of researchers is bounded by set of written and unwritten rules known as Research Ethics.

Unit I Philosophy and Ethics:

Introduction to Philosophy- definition, nature and Scope, Concept, Branches 2. Ethics: definition, moral philosophy, nature of moral judgements and reaction

Unit II Scientific Conduct:

Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication, and Plagiarism(FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data.

Unit III Publication Ethics:

Publication ethics: definition, introduction and importance, Best practices /Standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types, Violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals.

Unit IV: Open Access Publishing:

Open access publications and initiatives, SHEERPA/RoMEO online resource to check publisher copyright & Self – archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder /Journal suggestion tools viz. JANE., Elsevier journal Finder, Springer Journal Suggester, etc.,

Unit V: Databases and Research Metrics:

A. Databases 1. Indexing databases 2. Citation databases: Web of Science, Scopus, etc. B. Research Metrics 1. Impact Factor of Journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score 2. Metrics: h-index, g index, i10 index, altimetric.

SUGGESTED READINGS

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1. Bird, A.(2006). Philosophy of Science.Routledge
2. MacIntyre, Alasdair (1967) A Short History of Ethics. London
3. P.Chaddah, (2018) Ethics in Competitive Research: Do not get Scooped; do not get Plagiarized, ISBN :978-9387480865 National Academy of Sciences,
4. National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to responsible conduct in Research: Third Edition, National Academies Press.
5. Resnik, D.B.(2011) What is ethics in research & why is it important. National institute of Environmental Health Science, 1-10 Retrieved from <https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm>
6. Beall, J: (2012) Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. <https://doi.org/10.1038/489179a>
7. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance(2019),ISBN:978-81-939482-1-7.
http://www.insaindia.res.in/pdf/Ethics_Book.pdf

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

1. Understanding of ethical issues related to Research and Publication Skills gained
2. Write research papers/thesis following publication ethics. Related issues. Competency developed
3. Publish ethically.

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Mahayogi Gorakhnath University, Gorakhpur
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IV Year: VIII Semester(THEORY)

Entrepreneurial Biotechnology

Code: BBT804

L	T	P	C
4	0	0	4

Course Objectives:

1. This course is beneficial for students to understand the concepts of entrepreneurship and business opportunity in the field of biotechnology.
2. To understand Ethical concerns of biotechnology research

Unit I: Basics of Bioethics: Ethical concerns of biotechnology research and innovation- Biosafety concerns at the level of individuals, institutions, society, region, country, and the world.

Unit II: Introduction to Bioethics and Entrepreneurship: Introduction to bio-business in Indian context, SWOT analysis of bio-business. Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship-its barriers.

Unit III: Plant Biotechnology based Entrepreneurship.

Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique, polyhouse culture, and Hydroponic technique. Herbal bulk drug production, Nutraceuticals, value added herbal products and Medicinal Mushroom

Unit IV: Microbes-based Entrepreneurship Integrated compost production:

microbe enriched compost. Bio pesticide/insecticide production. Fermented products- probiotic and prebiotics.

Unit V: Entrepreneurship in India: Building Biotech business challenges in Indian context-biotech partners (BICEPS, BIRAC, DBT, Incubation centres etc.), operational biotech parks in India. Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Business incubation support schemes, Successful start-ups-case study

SUGGESTED READINGS

1. Principles of Management by P. C. Tripathi, P.N. Reddy Tata McGraw Hill Fifth Edition
2. Entrepreneurship Development by S A Kumar, S C Poornima, M K Abraham
3. Practical Approach to IPR by Rachna Singh Puri, Arvind Viswanathan

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4. Bioethics & Biosafety R Rallapalli & Geetha Bali APH Publication

Course Learning Outcomes (CLO):

1. .To understand the concepts of entrepreneurship including identifying a winning business opportunity, gathering funding, and launching a business.
2. To understand basic concept of Essential requirement, marketing, strategies, schemes, challenges, and scope for business.
3. To remember the basics of microbes-based business and their analysis.
4. To understand management and development of life science companies and projects.



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Entrepreneurial Biotechnology Seminar

Code: BBT852SM

L	T	P	C
0	0	4	2

Course objectives: The objective of this course is

1. To acquire the skills necessary to present the idea of self-entrepreneurship in the public domain.
2. To encourage the students to adopt recent requirements of the market and develop a product
3. To prepare and present technical reports and funding for startups
4. To encourage the students to face various problems and challenges in planning startups.

Entrepreneurial Biotechnology Seminar

Conducting Seminar emphasizes upon the general guidelines for conduction of seminars. Activity of seminar includes preparation, and implementation of assigned topic presented by the student. Each student shall assigned topic for seminar and they will prepare the power point presentation. The implementation of presentation will be evaluated by expert.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to

5. Survey the changes and updating of selected topic to know the current research of particular area
6. **Analyze** and compile the data of selected topic and **interpret** the impact on the society and environment
7. **Compile** the report of the study and present to the audience with following the ethics.
8. **Develop** an **understanding** to review, and compile the data and also developed the presentation skills

Q. 2



OR

B.Sc. Biotechnology (H) in Research

IV Year: VIII Semester(Research)

Research Project/ Dissertation

Code: BBT853PJ

L	T	P	C
0	0	24	12

Students choosing a 4 year bachelor degree (Honours with Research) are required to take up a research project under the guidance of a faculty member. The students are expected to complete the research project in last semester. The Research outcome of their project work may be published in peer reviewed journals or may be presented in conferences /seminars or may be patented.

1. Student will execute the plans in form of results
2. Independently analyze the results and, write down discussion and conclusion
3. Project work will present in front of subject expert committee
4. Prepare the thesis report
5. Published their work in journal

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

1. Present papers and **analyze** the data obtained and will write thesis report, present the power point presentation and will write a paper for a journal
2. Design, posters and will have understanding about how to present the results in the crisp and interesting manner.
3. Have better understanding of industrial communication and improve their skills.
4. Enhance their scientific, interpersonal communication, team work and readiness for industry/research organization, which will be interpreted into a good scientific human resource

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