ADAMAS UNIVERSITY

SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

Department of Biotechnology

M.Sc. (Biotechnology)

Program Code: BIT4201

NEP 2020 based curriculum

(2026-27)

Total Credits-95

Course Structure for M.Sc. Biotechnology (2 Years)

ADAMAS UNIVERSITY DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM SEMESTER - I (Course Code: BIT4201)								
S. No.	**Type of the Paper**	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
1	**CC**	**BIT415**	**Applied Microbiology**	**5**	**2**	**1**	**1**	**4**
2	**CC**	**BIT416**	**Biophysical Chemistry and Bioanalytical Techniques**	**5**	**2**	**1**	**1**	**4**
3	**CC**	**BIT417**	**Ecology and Evolution**	**5**	**2**	**1**	**1**	**4**
4	**DSE/ MDE**	**BIT456/ BIT457/**	**Applied Genetics (BIT456)/ Molecular Basis of Infectious Diseases (BIT457)/ MDE courses of other disciplines**	**4**	**3**	**1**	**0**	**4**
5	**RM**	**BIT418**	**Research Methodology and cGLP**	4	**3**	**1**	**0**	**4**
6	**AEC**	**AEC408/ AEC409/ AEC410**	**French I (AEC408)/ German I AEC409/ Spanish I (AEC410)**	2	**2**	**0**	**0**	**2**
7	**SEC**	**BIT419**	**Exposure to Entrepreneurship**	**2**	**0**	**0**	**2**	**2**
8	**SEC**	**CLL 406**	**Advanced soft skills and Aptitude I**	1	**1**	**0**	**0**	**1**
Total				**28**	**15**	**5**	**5**	**25**

ADAMAS UNIVERSITY DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM SEMESTER – II								
S.No.	**Type of thePaper**	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
1	**CC**	**BIT501**	**Advanced Immunology**	**5**	**2**	**1**	**1**	**4**
2	**CC**	**BIT502**	**Molecular Biology and Genetic Engineering**	**5**	**2**	**1**	**1**	**4**
3	**CC**	**BIT503**	**Applied Bioinformatics and Biostatistics**	**5**	**2**	**1**	**1**	**4**
4	**DSE**	**BIT551/ BIT552**	**Applied Nanobiotechnology (BIT551)/ Omics Biotechnology (BIT552)**	**4**	**3**	**1**	**0**	**4**
5	**MDE**		**To be chosen from pool of discipline specific elective courses/ elective courses of other disciplines/ SWAYAM MOOC courses approved by the department**	**4**	**3**	**1**	**0**	**4**
6	**AEC**	**AEC503/ AEC504/ AEC505**	**French II (AEC503)/ German II AEC504/ Spanish II (AEC505)**	**2**	**2**	**0**	**0**	**2**
7	**SEC**	**BIT504**	**AI in Biotechnology**	**2**	**2**	**0**	**0**	**2**
8	**SEC**	**CLL407**	**Advanced Soft Skills and Aptitude II**	**1**	**1**	**0**	**0**	**1**
Total				**28**	**17**	**5**	**3**	**25**

Exit option with Post-Graduate Diploma after the first year or two semesters with the completion of courses equivalent to 50 credits

2nd Year of PG curricular structure for 2-year PG Programmes
One-year PG Programme after completion of Four-Year UG Programme (4+1)

PG Curricular Structure with Coursework and Research

ADAMAS UNIVERSITY DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM SEMESTER – III								
S.No.	**Type of the Paper**	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
1	**CC**	**BIT505**	**Advanced Plant and Animal Biotechnology**	**5**	**2**	**1**	**1**	**4**
2	**CC**	**BIT506**	**Bioprocess Technology**	**5**	**2**	**1**	**1**	**4**
3	**DSE/ MDE**	**BIT553/ BIT554**	**Applied Food Biotechnology (BIT553)/ Industrial Biotechnology (BIT554) /** MDE courses of other disciplines	**4**	**3**	**1**	**0**	**4**
4	**CC**	**BIT507**	**Project Proposal writing in Biotechnology**	**2**	**2**	**0**	**0**	**2**
5	**INT**	**BIT508**	**Internship**	**2**	**0**	**0**	**2**	**2**
6	**SEC**	**CLL503**	**Advanced Soft Skills and Aptitude III**	1	**1**	**0**	**0**	**1**
7	**Project**	**BIT591**	**Dissertation Part I***	**9**	**0**	**0**	**6**	**6**
	Total			**28**	**10**	**3**	**10**	**23**

ADAMAS UNIVERSITY DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM SEMESTER - IV								
S.No.	Type of the Paper	Paper Code	Theory / Practical	Contact Hours Per Week	L	T	P	Credit
1	CC	BIT509	Regulatory Affairs in Biotechnology	4	3	1	0	4
2	DSE/ MDE	BIT555/ BIT556/ BIT557	Agricultural Biotechnology/ Drug Design and development/ Cancer Biology/ MDE (Civil Service / General Studies)	4	3	1	0	4
3	ENT	BIT510	Innovations and Entrepreneurship in Biotechnology	2	2	0	0	2
4	Project	BIT592	Dissertation Part II**	18	0	0	12	12
Total				28	8	2	12	22

PG Curricular Structure with only Research

ADAMAS UNIVERSITY DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM SEMESTER – III								
S.No.	**Type of the Paper**	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
1	**CC**	**BIT505**	**Advanced Plant and Animal Biotechnology**	**5**	**2**	**1**	**1**	**4**
2	**DSE/ MDE**	**BIT553/ BIT554/**	**Applied Food Biotechnology (BIT553)/ Industrial Biotechnology (BIT554) /** MDE courses of other disciplines	**4**	**3**	**1**	**0**	**4**
3	**CC**	**BIT507**	**Project Proposal writing in Biotechnology**	**2**	**2**	**0**	**0**	**2**
4	**SEC**	**CLL503**	**Advanced Soft Skills and Aptitude III**	1	**1**	**0**	**0**	**1**
5	**Project**	**BIT593**	**Research Project I***	**18**	**0**	**0**	**12**	**12**
Total				**30**	**8**	**2**	**13**	**23**

ADAMAS UNIVERSITY DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM SEMESTER - IV								
S.No.	**Type of the Paper**	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
1	**SEC**	**BIT511**	**Field Project in Biotechnology**		**0**	**0**	**2**	**2**
2	**Project**	**BIT594**	**Research Project Part II****	**30**	**0**	**0**	**20**	**20**
	Total			**30**	**0**	**0**	**22**	**22**

List of MDE courses offered

Course code	Course Name	L	T	P	Credit	Semester
BIT558	**Bioanalytical Instrumentation and Techniques**	**3**	**1**	**0**	**4**	**I**
BIT559	**Bioprocess Manufacturing Technology**	**3**	**1**	**0**	**4**	**II**
BIT560	**Sustainable Agrotechnology**	**3**	**1**	**0**	**4**	**III**

* Offering of subjects will vary from year to year, subject to the availability of faculty Total Credits- 95

Semester	I	II	III	IV	Total Credits
Credits	25	25	23	22	95

*The following **four** outcomes must be achieved by the end of III Semester

1) Research Problem identification
2) Review of literature
3) Research design formulation
4) **Phase I** of research (for e.g. Initial phase of research experimentation, completion of pilot project etc.)

The following **three outcomes must be achieved by the end of IV Semester

1) **Phase II** of research - Final phase of experimentation/ fieldwork
2) Dissertation/ project report submission
3) Attain **at least one** of the following outcomes:

i) Developed a prototype or product which meets the **Technology Readiness Level 3/4** (TRL-3 or TRL-4) as defined by CSIR
ii) Publication/submission with proof, in Scopus/Equiv. indexed journals #
iii) Patent
iv) Any other scholastic work as recommended by the University R&D Cell and approved by the Academic Council
v) Publication of a book by a reputed publisher (National/International) as recommended by the R&D Cell and approved by the Academic Council.

Publication must be in Scopus indexed journals and the authors have to be the student concerned and his/her supervisor(s). All PG dissertation should comply with the guidelines set by R&D Cell and duly approved by the Academic Council.

SEMESTER I
MSc Biotechnology

BIT415	APPLIED MICROBIOLOGY	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	B.Sc. LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

- **To provide students with a solid theoretical foundation in microbiology,** including microbial structure, physiology, growth, control, and their roles in industrial and environmental applications.
- **To enable students to develop practical skills** in microbial culture, staining, microscopy, sterilization, and enumeration techniques essential for laboratory and industrial microbiological work.

Course Outcomes

On completion of this course, the students will be able to:

 Differentiate between prokaryotic and eukaryotic microorganisms and explain their morphological and nutritional characteristics.

 Demonstrate competence in microbial culture techniques, sterilization methods, and staining procedures using light microscopy.

 Analyze microbial growth patterns and employ various methods for measuring and characterizing microbial populations.

 Evaluate physical and chemical methods of microbial control, and understand the mechanisms and uses of different antimicrobial agents.

 Apply microbiological principles to industrial processes including vaccine production, bioremediation, biofuel generation, and environmental waste treatment.

Course Description

The course on *Applied Microbiology* aims to provide students with a comprehensive understanding of microorganisms, their structure, classification, physiology, and the various roles they play in natural and industrial processes. It introduces fundamental concepts such as microbial

growth, culture techniques, sterilization, and staining, while also highlighting the importance of microbial control methods and the applications of microbiology in fields like agriculture, healthcare, and environmental management. The course is designed to build foundational knowledge as well as practical skills essential for applied research and biotechnological innovations.

Course Content
Applied Microbiology (BIT415)

Unit I: Introduction to microbiology
Comparison of prokaryotic and eukaryotic cells, Overview of microbes and their types, Viruses, Bacteria, fungi and protozoans – Morphology and classification. Nutritional requirements of bacteria, physical requirements, Koch's postulates, AI for microbial identification.

Unit II: Microbial culture & staining techniques
Theory and practice of sterilization, principles of Microbial nutrition: different types of culture media & their preparations, axenic culture, Isolation of pure cultures, maintenance and preservation of the pure cultures, staining techniques, basics of light microscopy.

Unit III: Microbial Physiology
The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; continuous culture; growth as affected environmental factors; enumeration of cells by direct and indirect methods; microbial characterization methods

Unit IV: Control of micro-organisms
Concept of sterilization and disinfection. Physical and chemical methods of microbial control. Chemotherapeutics, susceptibility test (broth procedures and diffusion methods), mode of action of antibiotics, narrow and broad spectrum (Penicillin, ampicillin, sulfonamide, vancomycin, tetracycline, chloramphenicol), antifungals (clotrimazole, fluconazole), antiretroviral (tenofovir, AZT), Role of AI in AMR prediction.

Unit V: Industrial applications of microbial technology
Overview of applications of microbial technology in agriculture, healthcare- quality control microbiology for production of biopharmaceuticals (SDG 3: good health and well-being), biomining and recovery of petroleum, bioremediation, biofuel production (SDG 7: affordable and clean energy), and waste treatment (SDG 6: clean water and sanitation).

Tentative List of Practicals

- Aseptic techniques and Media preparation (Both liquid and solid)
- Isolation and enumeration of bacteria from different sources by serial dilution agar plating method
- Staining of bacteria (Simple staining, negative staining, gram staining, etc.)
- Biochemical tests of bacteria (Starch hydrolysis, casein hydrolysis, IMVIC test, catalase activity)
- Antibiotic sensitivity test of different microbial isolates
- Determination of Minimum Inhibitory Concentration of different antibiotics

Textbooks:

1. Cell and Molecular Biology: Concepts and Experiments by Gerald Karp & James G. Patton, 6th Edn., 2013.
2. Prescott's Microbiology by Joanne Willey, Linda Sherwood, Cristopher J. Woolverton, 8th Edn., 2011.

Reference books:

1. Microbial biotechnology: fundamentals of applied microbiology by Alexander N. Glazer & Hiroshi Nikaido, 1st Edn., 2007.
2. Industrial microbiology by L.E. Casida, 2nd Edn., 2019.
3. Microbiology: A Laboratory Manual, Book by James G. Cappuccino and Natalie Sherman, 2013.

BIT416	Biophysical Chemistry & Bioanalytical Techniques	L	T	P	C
Version 1.0	Contact Hours - 75	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of Biochemistry theory and practical at UG level				
Co-requisites	Basic knowledge of analytical techniques				

Course Objectives

1. To develop a comprehensive understanding of the physical principles governing protein structure, folding, molecular transport, and membrane biophysics, enabling students to analyze biological systems from a quantitative and mechanistic perspective.

2. To equip students with the theoretical knowledge and practical insight into advanced spectroscopic and separation techniques used for molecular identification, structure elucidation, and protein purification in biophysical research.

Course Outcomes

On completion of this course, the students will be able to

1. **Explain the hierarchical structure of proteins and describe the physical forces** and energy principles involved in protein folding pathways.
2. **Analyze transport phenomena** such as diffusion, viscosity, and Brownian motion, and apply relevant physical laws to biological systems.
3. **Describe the mechanisms of ion transport**, membrane potentials, osmotic pressure, and Donnan equilibrium in membrane biophysics.
4. **Interpret data obtained from spectroscopic techniques** such as UV-Vis, fluorescence, IR, mass spectrometry, X-ray crystallography, NMR, and cryo-EM for molecular identification and structure determination.
5. **Apply the principles of centrifugation and chromatography techniques** for the separation and purification of biomolecules, particularly proteins.

Course Description

This course provides an integrated understanding of the physical principles underlying biological systems, with a focus on protein structure, dynamics, and function. It begins with the fundamentals of protein folding, exploring the various levels of protein structure and the interatomic forces—both strong and weak—that govern folding pathways. The course also delves into the mechanical and energetic aspects of molecular interactions, including bond energies, non-central forces, and spring constants, providing a solid foundation for understanding protein behaviour in biological contexts.

Further, the course covers essential topics in transport phenomena such as diffusion, Brownian motion, and fluid dynamics, along with membrane biophysics concepts like ion transport, membrane potentials, and osmotic balance. It introduces key spectroscopic techniques—UV-Vis, IR, fluorescence, mass spectrometry, X-ray crystallography, NMR, and cryo-EM—for identifying and determining the structure of biomolecules. In addition, students learn about

modern separation and purification techniques including centrifugation, chromatography (TLC, HPLC, FPLC), and methods specific to protein isolation, equipping them with practical tools used in molecular biology and biophysics research.

Course Content

Unit I

Protein structure and function

Protein folding: Protein structure, Forces in protein folding - Interatomic Potentials for Strong and weak bonds, non-central forces, bond energies, spring constant; protein folding pathways

Unit II

Transport phenomenon

Brownian motion, Diffusion - diffusion coefficient, Viscosity - Hooke's law, Newton's law, Reynolds number, Stokes–Einstein formula

Unit III

Membrane biophysics

Ion pumping, membrane potential, resting potential, osmotic pressure – derivation, osmotic potential, Donnan equilibrium. **Industrial application of osmotic equilibrium**

Unit IV

Spectroscopy for molecule identification

UV-Visible Spectroscopy, Fluorescence, Phosphorescence Spectroscopy and Energy transfer. IR spectroscopy, Mass spectroscopy

Spectroscopy for structure elucidation

X-ray crystallography, NMR, Cryo-EM techniques to investigate protein structure and interactions

Unit V

Separation techniques

Principle of centrifugation. Differential & density gradient centrifugation. TLC, HPLC & FPLC. Protein purification - Size-exclusion Chromatography, Affinity chromatography, Ion-exchange Chromatography. **Industrial application of chromatographic techniques**

Suggested Books:

1. Introduction to protein structure, by Carl Branden and John Tooze. New York: Garland Publishing Company
2. Biophysical Chemistry: Part I: The Conformation of Biological Macromolecules 1st Edition by Charles R. Cantor, Paul R. Schimmel
3. Biophysical Chemistry: Part II: Techniques for the Study of Biological Structure and Function (Pt. 2) 1st Edition by Charles R. Cantor, Paul R. Schimmel
4. Biophysical Chemistry: Part III: The Behavior of Biological Macromolecules, 1st Edition by Charles R. Cantor, Paul R. Schimmel
5. Fundamentals of Molecular Spectroscopy, by Colin Banwell and Elaine Mccash. Affiliated East-West Press; Sixth edition
6. Elements of X-Ray Diffraction, by B.D. Cullity. Pearson; 3rd edition

Tentative Lists of Practical

1. Analysis of physicochemical properties of protein from amino acid sequence
2. Cell lysis and separation of protein extract using centrifugation technique
3. Protein purification techniques
   i. Salting out
   ii. Ni-affinity chromatography
   iii. Size-exclusion chromatography
4. SDS PAGE analysis of proteins
5. Measurement of protein concentration through UV-Vis spectroscopy technique
6. Fluorescence activity analysis of protein

BIT417	Ecology and Evolution	L	T	P	C
Version 1.0	Contact Hours - 75	2	1	1	4
Pre-requisites/Exposure	B.Sc Biology discipline				
Co-requisites	Basic knowledge of Mathematics				

Course Objectives:

1. Provide students with the scope to develop knowledge base covering all attributes of the environment and enable them to attain scientific/technological capabilities to find answers to the fundamental questions before the society with regards to human action and environmental effects with due diligence.
2. Enhance the ability to apply this knowledge and proficiency to find solutions relating to environmental and ecological concerns of varied dimensions of present times through research activities.
3. Provide with a direction and technical capability to carry on collaborative endeavor, and decision making.
4. Help graduates appreciate requirement of framing environmental policy guidelines.
5. Motivate graduates to appreciate that they are an integral stakeholder in the environmental management of India irrespective of their future jobs or working.

Course Outcomes

On completion of this course, the students will be able to

CO1: Explain fundamental concepts in ecology and evolution, including natural selection, species interactions, and ecosystem dynamics.

CO2: Analyze the interactions between organisms and their environment and how these relationships shape evolutionary processes.

CO3: Apply evolutionary theories to understand patterns of adaptation, speciation, and extinction in ecological systems.

CO4: Evaluate the effects of human activities, such as habitat destruction and pollution, on ecological and evolutionary processes.

CO5: Evaluate and formulate conservation strategies that incorporate evolutionary and ecological principles to enhance biodiversity and ensure ecosystem sustainability through application-based approaches.

Course Description

This course provides a comprehensive understanding of ecological and evolutionary principles, encompassing population dynamics, community interactions, ecosystem functions, and biodiversity conservation. Through exploration of both classical theories and contemporary advancements, students will examine the relevance of evolutionary processes to modern human life and environmental sustainability. The course is designed to foster critical thinking and practical application of knowledge through a combination of lectures, PowerPoint presentations, audio-visual content, and virtual lab sessions. Tutorials will emphasize real-world problem-solving strategies, facilitated by the course coordinator, encouraging student participation in discussions and analytical exercises. Aligned with the United Nations Sustainable Development Goals—SDG 6 (Clean Water and Sanitation), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land)—this course equips students with the conceptual and practical tools needed to address pressing ecological challenges and contribute to sustainable environmental management.

Course Content:

Unit I:

A. Principles and methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy.

B. The Environment: Physical environment; biotic environment; biotic and abiotic interactions.

C. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Unit II:

A. Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); the concept of metapopulation – demes and dispersal, intergenic extinctions, age-structured populations.

B. Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis, lotka volterra model.

C. Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

D. Ecological succession: Types; mechanisms; changes involved in succession; the concept of climax.

Unit III:

A. Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (freshwater, marine, eustarine).

B. Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

C. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Unit IV:

A. Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism, Geological time scale.

B. Sources of variations and Population genetics: Heritable variations and their role in evolution, Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium.

C Natural selection: (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies), Speciation.

Unit V:

A. Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches).

B. Phylogenetic trees: construction of phylogenetic trees, interpretation of trees

B. Animal Behaviour: Instinctive and learning behaviour, Fixed action pattern, Communication in honeybees (dance Language), Elements of Sociobiology: Altruism and selfishness.

Reference books:

Diversity of Life: The Five Kingdoms by Lynn Margulis, 2009
The Diversity of Living Organisms by Richard Stephen Kent Barnes, 2009
Ecology by Michael L. Cain, William D. Bowman, 2020
Fundamentals of Ecology by Odum and Barrett, 2005
Biodiversity: an introduction by Kevin J. Gaston, 2009

Tentative Lists of Practical

1. Preparation of winogradsky column to create artificial ecosystem for bacteria.
2. Demonstration of AAS to study Water Pollution.
3. Assessing Vegetation Health and Habitat Quality Using NDVI from Satellite Imagery
4. Determine the required size of quadrat to study the vegetation by species area curve method.
5. Biodiversity assessment of forest tree community.

Field study in ecology using both qualitative and quantitative studies (Checklist/Quadrat /Transect) from any one of the following bio-geographical area (coastal/ forest/ Hills) with report submission.

BIT456	Applied Genetics	L	T	P	C
Version 1.0	Contact Hours - 75				
Pre-requisites/Exposure	B SC in Biological Science				

Course Objectives:

- To develop a foundational and advanced understanding of genetic principles including Mendelian and non-Mendelian inheritance, gene interactions, population genetics, and molecular mapping to explain heredity and variation at organismal and population levels.
- To apply genetic knowledge to real-world problems in health, agriculture, and industry, with emphasis on human genetic disorders, gene therapy, crop improvement, marker-assisted selection, and genome editing technologies like CRISPR.
- To explore cutting-edge tools in molecular genetics and functional genomics, such as transcriptomics, proteomics, and synthetic biology, while fostering awareness of ethical, legal, and social implications in applied genetic research.
- **This course is aligned with SDG 15: Life on Land**

Course Outcomes:

On completion of this course, the students will be able to

CO1. Illustrate in detail Mendelian and non-Mendelian Genetics.
CO2. Explain in detail various aspects of population genetics.
CO3. Demonstrate application of applied genetics in health care.
CO4. Explain and summarize the basic application of applied genetics in Agriculture.
CO5. Discuss in detail Advanced topics in Applied Genetics.

Catalogue Description

Applied Genetics is a challenging lecture course that covers a range of basic topics including various branches of genetics like classical, population genetics etc. The course takes a broader approach and covers many aspects of mendelian, non-Mendelian and population genetics. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies using digital platforms, such as analysis of video scenes and debates. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, videos, DVDs, and newspapers etc.

Course Content: Applied Genetics-

Unit I: Physical basis of Heredity and Genetic interactions:
Mendelian principles, monohybrid and dihybrid crosses, dominance, codominance and incomplete dominance, gene interaction and epistasis; non-Mendelian inheritance: Maternal Effect; Cytoplasmic inheritance: mitochondria and chloroplasts; Genetic linkage, mapping, and recombination.

Unit II: Hardy-Weinberg equilibrium:
Population structure and effective population size; Hardy-Weinberg Equilibrium: Allele and genotype frequency measurements, Random and non-random mating, inbreeding depression and inbreeding co-efficient; causes of changes in allele frequency through natural selection/artificial selection; migration and random genetic drift; equilibrium at sex-linked loci; Linkage and Linkage Disequilibrium

Unit III: Applied Genetics in Health and Disease:
Human genetic disorders: monogenic and polygenic**,** Genetic basis of cancer, metabolic, and neurodegenerative diseases**,** Pharmacogenomics and personalized, Gene therapy strategies: viral and non-viral vectors, Ethical, legal, and social implications (ELSI) in medical genetics

Unit IV: Applications in Agriculture and Industry:
Genetic improvement of crops: MAS, transgenics, gene editing, Molecular markers aided selection – foreground and background selection, concept of graphical genotypes, elimination of linkage drags.

Unit V: Advanced Topics in Molecular Genetics:
Functional Genomics: Transcriptomics, proteomics, and metabolomics; **Genome Editing:** CRISPR-Cas9 technology, applications, and ethical considerations; **Synthetic Biology:** Design principles, genetic circuits, and applications.

Tentative Lists of Practical

Visualization and analysis of chromosome structure and aberrations
Demonstration and hands-on practice of hybridization
Goodness of fit test using Mendelian Genetics concept
Determination of gender from buccal smear by identification of Barr bodies
Application of Statistics in Genetics

Text Books
1. Molecular markers in Plant Genetics and Biotechnology, Vienne D – INRA.
2. Modern Genetic Analysis, Griffiths AJF et al., - Freeman.

3. Genetics: Analysis of Genes and Genomes, Hartle DL and Jones EW – Jones and Bartlett.
4. Principles of Genetics by Sinnet et.al (Mc Graw Hill).
5. Principles of Heridity by Robert Tumarin.
6. Genetics by M.W.Strick Berger (Mac Millan).

BIT457	Molecular Basis of Infectious Diseases		L	T	P	C
Version 1.0	Contact Hours - 60		3	1	0	4
Pre-requisites/Exposure	Basic knowledge of Microbiology at UG level					
Co-requisites	Basic knowledge of Infectious Disesaes					

Course Objectives:

1. **To provide students with a comprehensive understanding of molecular mechanisms of pathogenicity** of various infectious agents, including bacteria, viruses, fungi, and parasites and their roles in emerging and re-emerging infectious diseases from a molecular epidemiological perspective.
2. **To create understanding of** host-pathogen interactions at the molecular and cellular levels, including immune evasion strategies and host immune responses and evaluate the molecular basis of antimicrobial resistance and understand the genetic changes that lead to treatment failure.
3. **To equip students with the skills to analyze genetic and biochemical factors** that contribute to microbial virulence, transmission, and disease progression and interpret molecular diagnostic techniques used to detect infectious agents and understand their applications in clinical and research settings.
4. **To enable students to apply molecular biology tools** (e.g., PCR, sequencing, CRISPR, transcriptomics) to study infectious diseases and identifying disease biomarkers and vaccine development.

Course outcomes:

By the end of this course, students will be able to:

1. **Identify and describe** the molecular structures and functions of major classes of infectious agents, including viruses, bacteria, protozoa, and fungi.
2. **Compare and contrast** molecular mechanisms of infection, colonization, and pathogenesis, including toxin production, adherence, invasion, and immune system evasion by different pathogens.
3. **Analyze host-pathogen interactions** using molecular biology principles and assess how these interactions contribute to disease progression and **evaluate** molecular basis of antimicrobial resistance
4. **Apply molecular diagnostic methods** (e.g., PCR, ELISA, sequencing) to identify and study infectious agents in clinical or research contexts**.**
5. **Demonstrate** understanding of molecular approaches to immunity against infectious vaccine and therapeutic development for infectious diseases.

Course Description:

This course explores the molecular and cellular mechanisms underlying infectious diseases caused by viruses, bacteria, fungi, and parasites. Emphasis is placed on understanding the molecular interactions between pathogens and their hosts, including mechanisms of infection, immune evasion, and host defense responses. Students will examine the roles of virulence factors, genetic regulation, and microbial adaptation in disease progression. The course also covers modern molecular diagnostic tools, antimicrobial resistance mechanisms, and current strategies in vaccine and therapeutic development. Through a combination of lectures, case studies, and analysis of current research literature, students will gain a comprehensive understanding of how infectious diseases are studied and managed at the molecular level.

Course Content:

Unit 1: ***Classification Of Infectious Agents***

Bacteria, Viruses, protozoa and fungi. Past and present emerging and re-emerging infectious diseases and pathogens. Source, reservoir and transmission of pathogens, Antigenic shift and antigenic drift. Host parasite relationship, types of infections associated with parasitic organisms. Overview of viral and bacterial pathogenesis. Infection and evasion, Understanding mechanisms of pathogens aids in

reducing mortality and improving global health

Unit 2: ***Overview Of Diseases Caused by Bacteria and Viruses***
Detailed study of tuberculosis, AIDS: History, causative agent, molecular basis of host specificity, infection and pathogenicity, Diagnostics, Therapeutics, drugs, inhibitors and vaccines. Drug resistance and implications on public health. Other bacterial diseases including Typhoid, Diphtheria, Pertussis, Tetanus, Typhoid and Pneumonia. Other viral diseases including hepatitis, influenza, rabies, chikungunya and polio.

Unit 3: ***Overview Of Diseases Caused by Parasites and Other Organisms***
Detailed study of Malaria, history, causative agents, Vectors, life cycle, Host parasite interactions, Diagnostics, Drugs and Inhibitors, Resistance, Vaccine development. Other diseases including leishmaniasis, amoebiasis. Fungal diseases, General characteristics. Medical importance of major groups, pathogenesis, treatment.

Unit 4: ***Antibiotics and Diagnostics***
Principles for antibiotics mechanisms. Definition of bacteriostatic and bactericidals. Mechanisms for origin of antibiotics resistance and its importance within the healthcare. Growth of microorganisms. The main types of microscopy: use at analysis of infectious diseases. Molecular surveillance methods: PCR, RT-PCR, immunofluorecsence, ELISA, FACS and Western blotting. Research and development of molecular diagnostics and biotechnology.

Unit 5: ***Immunology and Vaccines***
Natural barriers. Function of pathogen associated molecular patterns (BIGWIG) and Toll receptors. Inflammatory reactions. Basic principles for vaccination. Socio-economic aspects on vaccination. Importance of adjuvant. New types of vaccine. The basis for phage therapy. Recent developments in vaccine production and antimicrobial drugs. Importance of global collaboration in tackling pandemics. Role of international health organizations and scientific cooperation.

Suggested Books:

1. Prescott, Harley, Klein's Microbiology (2008) 7th Ed., Willey, J.M., Sherwood, L.M., Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978 007-126727.
2. Mandell, Douglas and Bennett.S, Principles and practices of Infectious diseases, 7th edition, Volume 2, Churchill Livingstone Elsevier.
3. Sherris Medical Microbiology: An Introduction to Infectious Diseases by Kenneth J.Ryan, C. George Ray, Publisher: McGraw-Hill.
4. Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier Health Sciences

BIT455	Research Methodology and cGLP	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	Familiarity with Laboratory Practices, Basic Computer Literacy at UG level				
Co-requisites	Basic knowledge of Biology, Biostatics, Microsoft office				

Course Objectives:

1. To introduce students to scientific research methodology and critical thinking.
2. To provide knowledge of current Good Laboratory Practices (cGLP) and their application in academia and industry.
3. To develop skills in statistical data analysis, scientific communication, and project documentation.
4. To integrate concepts of AI tools and SDGs into research planning and ethical decision-making.

Course Outcomes:

1. Design and plan biotechnology research projects.
2. Apply appropriate statistical and analytical tools for data interpretation.
3. Implement cGLP guidelines in laboratory settings to ensure reliability and safety.
4. Prepare scientific reports, manuscripts, and presentations as per standard norms.
5. Experimental planning, data collection and analysis.

Course Description:

This course introduces foundational principles of research methodology and cGLP, with a focus on experimental design, ethical compliance, statistical analysis, and scientific writing. Industrial relevance is addressed through case studies in pharmaceutical, biotech, and environmental sectors. The integration of AI tools like automated data analysis and AI-assisted literature reviews provides a modern edge. Students are encouraged to align their work with SDG goals, promoting responsible and impactful research.

Course Content:

Unit I: Research Methodology Basics

Scope and importance of research in biotechnology, Types of research: Qualitative, Quantitative, Mixed, Research process: Problem identification, hypothesis formulation, Literature review and database tools: PubMed, Scopus, Web of Science

Unit II: Research Design and Statistical Methods

Experimental design: Randomization, replication, control, **Descriptive statistics:** Mean, median, standard deviation, variance, **Inferential statistics:** t-test, chi-square test, ANOVA, **Regression and correlation analysis**, Introduction to statistical modeling and significance levels (p-value, confidence intervals), Hypothesis testing

Unit III: Statistical Tools and Data Handling

Data visualization: Histograms, box plots, scatter plots, Software for statistical analysis: **R, MiniTab**, Basics of data cleaning, coding, and transformation, Handling large datasets in biotechnology research

Unit IV: Research Ethics and Scientific Writing

Ethics in life science research, plagiarism, and IPR, Good citation practices and reference management (EndNote, Mendeley), Writing research papers, reports, and proposals, Literature review using digital tools (e.g., Zotero, EndNote, ChatGPT); Reference management, AI Application: Use of AI tools like Elicit.org, ResearchRabbit, and ChatGPT for literature.

Unit V: Current Good Laboratory Practices (cGLP)

Principles and objectives of cGLP in biotechnology, OECD guidelines and regulatory framework, Laboratory organization, SOP preparation, record keeping, Instrument calibration, validation, and quality assurance, Biosafety, bioethics, waste management, Audits, inspections, and certification processes

Probable list of practical

- Literature search and review preparation using database tools
- Designing an experimental plan and hypothesis testing
- Hands-on training in statistical analysis using **R, Minitab**
- Preparation of SOPs, GLP documentation, and mock audits
- Data visualization and preparation of publication-ready graphs (Origin).

Suggested Books:

1. Kothari, C. R., & Garg, G. (2019). Research Methodology: Methods and Techniques (4th ed.). New Age International Publishers.
2. OECD. (2020). OECD Series on Principles of Good Laboratory Practice and Compliance Monitoring. OECD Publishing.
3. Ghosh, B. N. (2021). Scientific Method and Social Research (5th ed.). Sterling Publishers.
4. Davis, M. (2012). Scientific Papers and Presentations (3rd ed.). Academic Press.
5. Muralikrishna, I. V., & Manickam, V. (2017). Environmental Management: Science and Engineering for Industry. Butterworth-Heinemann.

	AEC408	L	T	P	C
Version 1.0	**Contact Hours - 30**	2	0	0	2
Pre-requisites/Exposure					
Co-requisites	-				

Programme Educational Objectives (PEO)

The French Programme aims to equip students with fundamental linguistic, cultural and communicative competencies for practical applications. The educational objectives are:

PEO1 – Equip students with essential French language skills for basic communication in everyday contexts

PEO2 – Strengthen linguistic competence through a structured progression of vocabulary, grammar and writing skills

PEO3 – Foster an appreciation of Francophone cultures, enhancing intercultural sensitivity and global perspectives

Course Description

This beginner-level course is designed to introduce students to the fundamentals of the French language while fostering an appreciation for Francophone culture. Through a communicative and immersive approach, students will develop essential skills in listening, speaking, reading and writing, along with a foundational understanding of French grammar and cultural nuances.

Course Content

Module 1: French Communication [8 hours]

- French alphabets, pronunciation and accents
- Basic expressions of greetings, expressions of politeness
- Numbers (cardinal, ordinal), Counting
- Communication in the class

Asking and giving information about someone
Saying the date and asking and telling the time
Colours
Days of the week and months of the year

Module 2: Grammar [10 hours]

- Definite and Indefinite Articles, Subject Pronouns
- Countries and nationalities
- Common adjectives to describe someone
- Irregular Verbs: être, avoir, aller, s'appeler

- Regular Verbs: ER, IR, RE group, Expressions with être and avoir
- Negative sentences

Module 3: French Culture and Civilisation
[6 hours]

- French gastronomy: French cheese and wines
- Famous French perfumes
- French cities and tourist places
- Francophone countries
- Renowned French personalities
- Significance of the French flag and currency

Module 4: Writing
[6 hours]

- Self-introduction
- Introducing someone else
- Basic conversation between two persons expressing their likes and dislikes

Course Outcomes (CO):

On completion of this first-semester course, the students will be able to

CO1 - Recall and recognize basic French alphabets, pronunciation rules, numbers, days, months and commonly used greetings and polite expressions
CO2 - Understand and explain the use of French grammatical elements such as articles, subject pronouns, common adjectives and regular/irregular verbs in simple sentences
CO3 - Evaluate and compare aspects of French culture and civilization, such as cuisine, cities, famous personalities and the role of Francophone countries, to appreciate cultural diversity
CO4 - Create short written dialogues or compositions in French involving self-introduction, presenting others and exchanging preferences

Programme Outcomes (PO):

Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 - Speak in basic French
PO2 - Understand and apply elementary French Grammar
PO3 - Demonstrate familiarity with French culture
PO4 - Write short French e-mails and paragraphs

Programme Specific Outcomes (PSO):

PSO1 – Speak and respond confidently in daily communication scenarios and understand and apply common greetings and polite expressions
PSO2 – Grasp key grammatical concepts involving Definite and Indefinite Articles, Subject Pronouns, Adjectives, Regular, Irregular and Pronomial Verbs, Interrogative Adverbs

and Prepositions

PSO3 – Get acquainted with aspects of French culture, like French cuisine, cities, tourist places, famous personalities, markets, festivals, media and Francophone countries

PSO4 – Communicate in French through short e-mails, paragraphs and dialogues

Correlation Matrix between CO and PO and CO and PSO:

	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	2			1	3			1
CO2	3	3		3	3	3		3
CO3			3				3	
CO4	2	2	1	3	2	2	1	3

Degree of Correlation: 1 – low, 2 – medium, 3 – high

	AEC409	L	T	P	C
Version 1.0	**Contact Hours - 30**	2	0	0	2
Pre-requisites/Exposure					
Co-requisites	-				

Programme Educational Objectives (PEO)

The German Programme aims to equip students with fundamental linguistic, cultural and communicative competencies for practical applications. The educational objectives are:

PEO1 – Develop foundational skills in speaking, reading, writing, and listening, enabling effective
communication in German
PEO2 – Gain insight into German cultural practices, traditions and social etiquette
PEO3 – Acquire the ability to use German in real-life contexts, such as introducing oneself, in
restaurant interactions, in supermarkets, in commuting and in formal writing
PEO4 – Develop competence in German grammar, understanding articles, pronouns, conjunctions,
verb conjugations and sentence structures

Course Description

This beginner-friendly first-semester course is designed to introduce students to the fundamentals of German while immersing them in the rich cultural and linguistic landscape of German-speaking countries. This course will lay a strong foundation for communication, comprehension and cultural knowledge. Through interactive lessons, pronunciation drills, vocabulary-building exercises and cultural insights, students will gain the confidence to speak, listen and understand the basics of German in everyday scenarios.

Course Content

Module 1: Introduction [2 hours]

- Overview of the Indo-European Family of Languages
- Concept of Germanic, Romance and Slavic Languages
- European Countries where German is spoken:

Germany, Austria, Switzerland, Luxembourg, Lichtenstein et. al.

- Variation of German accents across Germany, Austria and Switzerland

Hochdeutsch, Österreichisches Deutsch and Schweizerdeutsch

Module 2: The German Alphabet [2 hours]

- Letter by Letter – Building Blocks of a New Language

- A Fun Intro to German Letters
- The four special German characters – ä, ö, ü, ß and their significance

Module 3: Pronunciation Rules (From Bahnhof to Brötchen – Speaking Like a Local)
[8 hours]

- Rules for Vowels: a, o, e
- Rules for Special characters: ä, ö, ü
- Rules for Diphthongs: ie, ei, ai, au, aü, eu
- Rules for Consonants: b/d/g, h, j, r, s, v, y, z
- Rules for Consonant Clusters: ch, sch, tsch, chs, sp/st, pf, ck, tz, ng
- Rule for ig

Activities: Pronouncing unknown German words from a Word Montage
Reading elementary, unknown German texts with correct pronunciation

Module 4: German Numbers
[3 hours]

- High-Five to German!

- The eins, zwei, drei of German numbers: counting from 1 to 100
- Activity: Listening Exercises on Numbers

Module 5: Reading the Clock like a Native German – Tick-Tock auf Deutsch
[3 hours]

- Formal Time
- Informal Time
- Exercise: Telling the time by looking at pictures of clocks

Module 6: Grammar - Mission: Grammatik Possible
[2 hours]

- Definite and Indefinite Articles in the Nominativ
- Personal Pronouns in the Nominativ

Module 7: Speaking German – Basic German Greetings and Expressions:
[3 hours]

- Hallo or Guten Tag?

Navigating the Art of First Impressions - Mastering German Greetings

- From Tschüss to Bis Bald! – Saying Goodbye

Farewell in German

- Wie Geht's? – How are you?

Conversational Starters

- Danke, Bitte, Entschuldigung – The Magic Words You'll Use Every Day

Essential German Politeness

- Ja, Nein, Vielleicht – Yes, No, Perhaps

Common Responses & Reactions

- Jawohl! Ach So! – Expressions That Make You Sound Like a Local

Authentic German Exclamations

Module 8: German Culture
[3 hours]

- Why Germans Love Punctuality – And How to Never Be 'Zu Spät!' Again!

(Understanding Social Etiquette)

- Dining Etiquette: How to say "Guten Appetit!" and "Prost!" correctly
- The 'Feierabend' Philosophy – How Germans Unwind After Work

Work-Life Balance & Leisure Culture

- "Kuchen und Kaffee" – What Germans eat and drink

Traditional German Food and Everyday Eating Habits

- Karneval , Oktoberfest, Ostern, Christmas Markets & Silvester

German Festivals and Seasonal Events

Module 9: Elementary Vocabulary
[4 hours]

- Schwarz, Weiss & everything in between – A Colourful Dive into German!

- Making colours fun

- From Oma to Onkel – Who's Who in the Family Tree?

-Navigating Family Vocabulary

- From Küche to Keller – A Tour of Your House in German

-Essential Home Vocabulary

- Hop On, Hop Off – Mastering German Transport Without Missing Your Bus

- Understanding Transport Terms

- Audio Comprehensions

Course Outcomes (CO):

On completion of this first-semester course, the students will be able to

CO1 - Understand the historical and linguistic background of German within the Indo-European language family
CO2 - Master basic pronunciation rules and apply them to pronounce German words
CO3 - Learn to count and tell time in German
CO4 - Develop a foundation in elementary German grammar, in articles and personal pronouns
CO5 – Learn basic German greetings and expressions and practice speaking
CO6 - Gain insights into German cultural norms, traditions and etiquette, helping them blend into native conversations
CO7 - Build essential vocabulary for greetings, family, colours, transport and daily interactions

Programme Outcomes (PO):

Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 - Know about the origin of the German language vis-à-vis other European languages
PO2 - Develop German pronunciation skills
PO3 - Learn to count and tell time in German
PO4 - Understand and apply elementary German Grammar
PO5 - Speak in basic German

PO6 - Demonstrate familiarity with German culture
PO7 - Write short German sentences and messages
PO8 - Gain knowledge of basic German vocabulary

Programme Specific Outcomes (PSO):

PSO1 – Learn about German as a Germanic language and its place in the Indo-European School of Languages
PSO2 – Recognize German diphthongs, consonant clusters, sounds and phonetic patterns for accurate pronunciation.
PSO3 – Understand formal and informal time and cardinal numbers in German
PSO4 – Grasp key grammatical concepts involving main verbs, modal verbs, conjunctions and articles and personal pronouns as subjects
PSO5 – Speak and respond confidently in daily communication scenarios and understand and apply common greetings, expressions and conversational starters
PSO6 – Get acquainted with aspects of German culture, like food and dining etiquette, punctuality, festivals, media, football craze and cars
PSO7 – Communicate in German through short e-mails and messages and use conventional German salutations and valedictions
PSO8 – Acquire knowledge of vocabulary related to areas like colours, family, home, clothes, transport, cities, weather and parts of the body

Correlation Matrix between CO and PO and CO and PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3								3							
CO2		3	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3			3								3					
CO4				3	3		3					3	3			3
CO5					3	2	1						3	2	1	
CO6						3		3						3		3
CO7			1		2	2	3	3			1		2	2	3	3

Degree of Correlation: 1 – low, 2 – medium, 3 – high

	AEC410	L	T	P	C
Version 1.0	**Contact Hours - 30**	2	0	0	2
Pre-requisites/Exposure					
Co-requisites	-				

Programme Educational Objectives (PEO)

The Spanish Programme aims to equip students with fundamental linguistic, cultural and communicative competencies for practical applications. The educational objectives are:

PEO1 – Equip students with the ability to communicate effectively in basic spoken and written
Spanish in familiar contexts
PEO2 – Provide a strong foundation in Spanish grammar, vocabulary and pronunciation
PEO3 – Develop cross-cultural awareness and appreciation of Hispanic cultures and global diversity
PEO4 – Enable students to engage in real-life situations using Spanish through listening, speaking,
reading and writing practice

Course Description

This first-semester course offers a lively introduction to the Spanish language. Beginning with the Spanish alphabet and fundamental pronunciation, students will explore practical expressions used in greetings, introductions and everyday conversations. With a blend of situational vocabulary and grammar, learners will acquire useful words related to daily life—covering topics such as food, travel, time and the classroom. Simultaneously, students will master basic grammar concepts including verb conjugation, personal pronouns and articles.

Course Content

Module 1: Introduction [2 hours]

- Introduction to Spanish Language and Alphabet

Module 2: Expressions [4 hours]

- Greetings and Farewell
- Introducing yourself: name, nationality, profession

Module 3: Gender and Number
[3 hours]

- Introduction to gender and number

(masculine/feminine, singular/plural)
Module 4: Spanish Number System
[2 hours]

- Counting from 1 to 100

Module 5: Time in Spanish
[3 hours]

- Units of Time: Days, Months, Seasons
- Telling Time and Date

Module 6: Basic Vocabulary
[6 hours]

- Colours and Shapes
- Food and Drinks
- Travel and Directions
- Classroom and University

Module 7: Elementary Grammar
[10 hours]

- Regular verb conjugations in the present tense (ar, er, ir)
- Verb "ser" and nationalities

Verb "estar" and location

- Personal Pronouns
- Articles (Definite / Indefinite)

Course Outcomes (CO):

On completion of this first-semester course, the students will be able to

CO1 - Master the Spanish alphabet and build a foundation in pronunciation
CO2 - Use basic expressions to greet others and introduce themselves
CO3 - Understand gender and number agreement in nouns and adjectives
CO4 - Count in Spanish, tell time and express dates, days, months and seasons
CO5 - Identify and use common vocabulary related to food, colours, directions, and classroom settings to support communication in relevant contexts
CO6 - Demonstrate understanding of elementary grammar, including personal pronouns, articles and present tense conjugation of regular and essential irregular verbs

Programme Outcomes (PO):

Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 - Demonstrate understanding of fundamental Spanish pronunciation, vocabulary and sentence structures
PO2 - Communicate simple ideas, personal information and routine expressions clearly and appropriately in Spanish
PO3 - Construct grammatically accurate sentences in present tense using parts of speech learnt
PO4 - Comprehend short written texts and auditory messages related to everyday

situations

PO5 - Write structured paragraphs, brief emails and personal details in correct Spanish form

PO6 - Apply cultural knowledge to interact respectfully and meaningfully in Spanish-speaking contexts

PO7 - Use basic interpretive strategies to extract meaning from signs, public information and short videos

Programme Specific Outcomes (PSO):

PSO1 – Engage in role-plays, basic dialogues and oral presentations to navigate familiar situations in Spanish, like shopping, asking for directions, describing people or places

PSO2 – Interpret and analyze simple reading passages and media content in Spanish with contextual understanding.

PSO3 – Apply accurate grammatical rules—including the use of personal pronouns, articles, verb conjugations, possessive adjectives and reflexive structures—in oral and written tasks

PSO4 – Draw cultural parallels and make meaningful comparisons between Indian and Hispanic customs, festivals and traditions

Correlation Matrix between CO and PO and CO and PSO:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2		2		1		2	2		
CO 2	2	3	2		1				2		
CO 3	1	1	3					1	1	3	
CO 4	2			1	1		2	1	1		
CO 5	3	2		2	2		1	2	2		
CO 6	2	2	3	1	3		2	3	1	3	

Degree of Correlation: 1 – low, 2 – medium, 3 – high

BIT419	Exposure to Entrepreneurship	L	T	P	C
Version 1.0	Contact Hours - 30	0	0	2	2
Pre-requisites/Exposure	Not required				
Co-requisites	Not required				

Course Objectives

1. Introduce students to the fundamentals of entrepreneurship and the entrepreneurial mindset.

2. Provide experiential learning through practical activities related to idea generation, business planning, and execution.

3. Develop essential entrepreneurial skills such as creativity, problem-solving, communication, teamwork, and financial literacy.

4. Expose students to real-world entrepreneurial ecosystems including incubators, start-ups, and industry mentors.

5. Enable students to create and present innovative business ideas with social, economic, or technological impact.

Course Outcomes

On completion of this course, the students will be able to

CO1: Identify entrepreneurial traits and analyze opportunities in different sectors.

CO2: Generate innovative ideas, perform basic market research, and validate business opportunities.

CO3: Develop essential entrepreneurial skills including team building, communication, and financial basics.

CO4: Draft a simple business plan and understand resource mobilization.

CO5: Present and defend business ideas to peers, mentors, or potential investors.

Course Description

This practical-oriented course provides hands-on exposure to the entrepreneurial process, enabling students to experience idea generation, market research, networking, business planning, and pitching. Students will engage in experiential learning through workshops, group assignments, case studies, industry interactions, and field visits. The course aims to build an entrepreneurial mindset and prepare students for entrepreneurial, intrapreneurial, or leadership roles.

Course Content

Unit I: Introduction to Entrepreneurship and Self-Assessment

- Activity 1: Self-assessment of entrepreneurial traits (personality tests, aptitude tools).
- Activity 2: Case study analysis of successful entrepreneurs (local and global).

- Activity 3: Group discussion on entrepreneurship vs. employment mindset.
- Activity 4: Visit to a start-up/incubation center to observe entrepreneurial journeys.

Unit II: Idea Generation and Opportunity Analysis
- Activity 1: Brainstorming sessions on innovative ideas (individual & group).
- Activity 2: Market survey/field visit for need analysis (customer pain points).
- Activity 3: Opportunity screening and SWOT analysis of selected ideas.
- Activity 4: Guest lecture by entrepreneur/mentor on idea validation.

Unit III: Entrepreneurial Skills Development
- Activity 1: Role play for leadership, negotiation, and conflict resolution.
- Activity 2: Workshop on communication & networking skills for entrepreneurs.
- Activity 3: Basics of financial literacy (budgeting, cost estimation, pricing).
- Activity 4: Team-building exercise for collaborative entrepreneurship.

Unit IV: Business Planning and Resource Mobilization
- Activity 1: Preparation of a simple business model canvas (BMC).
- Activity 2: Drafting basic components of a business plan (vision, product/service, target customers, resources).
- Activity 3: Simulation of funding process (pitching to mock investors).
- Activity 4: Interaction with local entrepreneurs/angel investors/start-up founders.

Unit V: Pitching, Feedback, and Reflection
- Activity 1: Preparation of elevator pitch for selected business idea.
- Activity 2: Final presentation of business plan before peers/faculty/mentors.
- Activity 3: Peer and mentor feedback on entrepreneurial projects.
- Activity 4: Reflection report – personal learning and entrepreneurial aspirations.

Suggested Books:

1. Byers, T., Dorf, R., & Nelson, A. Technology Ventures: From Idea to Enterprise. McGraw Hill.
2. Barringer, B.R., & Ireland, R.D. Entrepreneurship: Successfully Launching New Ventures. Pearson.
3. Taneja, S. Entrepreneurship Development. Himalaya Publishing.
4. Selected case studies from NITI Aayog's Atal Innovation Mission, Stanford eCorner, and Harvard Business Review.

	CLL406	L	T	P	C
Version 1.0	**Contact Hours - 15**	1	0	0	1
Pre-requisites/Exposure					
Co-requisites	-				

Programme Educational Objectives (PEO)

The Three-Semester Soft Skills Programme aims to equip postgraduate students with the interpersonal, communication and professional competencies necessary for career success in academia and industry. The Programme Educational Objectives (PEO) are designed to ensure career and personal growth through structured skill development.

PEO1 – Impart skills required for employability and ensure career readiness
PEO2 – Instill professionalism and a sense of ethical work culture
PEO3 – Ensure proficiency in professional communication
PEO4 – Develop leadership skills and ability for effective teamwork
PEO5 – Encourage self-reflection, continuous learning and personal growth

Course Description

This foundational semester focuses on equipping students with essential soft skills to enhance their academic and professional success. Through interactive sessions, students will refine their communication skills, master professional documentation, develop confidence in group discussions and interviews and gain practical experience in delivering impactful presentations. The course integrates theoretical insights with hands-on practice, ensuring students are prepared for both academia and industry.

Course Content

Module 1: Introduction to Soft Skills [1 hour]

- Concept of Soft Skills
- Soft Skills vis-à-vis Hard Skills (Subject Knowledge / Technical Skills)
- Importance of Soft Skills in Academia (Presentations and Seminars) and Industry (Internships, Projects, Placements and Workplace Success)
- Overview of the Course

Module 2: Professional Communication [2 hours]

- Types of Communication (Verbal, Non-Verbal et. al.)
- Components of effective Communication: Confidence, Enthusiasm, Listening
- Barriers to Communication (Language Differences, Semantic, Physical, Psychological, Physiological, Perceptual, Cultural, Hierarchical)
- Strategies to overcome Communication Barriers

Module 3: Curricula Vitae, Résumés, Crafting Cover Letters [3 hours]

- Understanding the difference between a CV and Résumé and when to use each (Academic / Research, Corporate)
- Key Components of a Professional Résumé

(Contact Information, Educational Background, Work Experience, Skills and Certifications, Achievements, Internships, Projects)

- Cover Letters

Purpose and Importance
Structure and Format: Introduction, Body, Closing
Tailoring Cover Letters to Job Descriptions / Specific Roles
Common Mistakes and how to avoid them
Live Drafting of a Cover Letter based on a real Job Posting with instant Peer Review and Faculty Feedback

Module 4: Group Discussions
[3 hours]

- Why GDs are used in admissions, interviews and placements
- Types of GDs

(Structured / Unstructured / Case-based or Situation-based / Abstract)

- Skills and Strategies for effective participation in a GD

How to start a GD: The art of Initiation
Structuring Arguments and speaking with clarity
Listening actively and interjecting diplomatically
Building on the points of others vs. contradicting respectfully
Handling dominance, interruptions and time pressure

- Non-verbal communication - posture, gestures, and eye contact
- Common do's and don'ts in a GD
- Practice GD with Observer Feedback

Module 5: Interview Skills
[3 hours]

- Stages of an Interview:

Pre-Interview Preparation, Actual Interview Process, Post-Interview Follow-Up

- Pre-Interview Preparation:
  Importance of pre-interview preparation
  Understanding job descriptions and role expectations
    Mapping skills and qualifications to job roles
  Industry and employer research techniques
  Interview Dress
- Post-Interview Follow-Up:
    Thank-you emails: tone, structure, timing
    Accepting Job Offers gracefully
    Handling rejections and requesting feedback
    Maintaining professional relationships for future opportunities
- Employer Expectations and Common Evaluation Criteria
- Mock Interview with Feedback

Module 6: Presentation Skills [3 hours]

- 7Cs of Presentation

Clarity: Ensuring the message is clear and concise
Conciseness: Keeping the presentation brief and to the point
Consistency: Maintaining a consistent style and format
Confidence: Projecting confidence through body language and voice modulation
Connection: Engaging the audience and maintaining eye contact
Creativity: Using creative elements to make the presentation memorable
Conclusion: Summarizing key points and providing a strong closing

- Live Presentations by Students with instant Peer Review and Faculty Feedback (General and Domain-Related Topics)

Course Outcomes (CO):

On completion of this first-semester course, the students will be able to

CO1 - Understand the significance of soft skills in academic and professional settings
CO2 - Identify and overcome communication barriers in diverse environments
CO3 - Craft professional cover letters tailored to industry requirements
CO4 - Participate strategically in group discussions, demonstrating clarity and confidence
CO5 - Navigate interviews effectively, from preparation to follow-up
CO6 - Deliver engaging presentations using structured techniques

Programme Outcomes (PO):

Upon successful completion of this three-semester programme, students will develop the following competencies:

PO1 - Professional Documentation and Career Readiness
PO2 - Excellence in Interviews and Group Discussions
PO3 - Resilience, adaptability and goal-setting strategies for continuous career growth
PO4 - Teamwork, problem-solving and decision-making skills essential for collaborative work environments
PO5 - Proficiency in verbal, non-verbal and written communication across academic and professional settings
PO6 - Mastery of Non-Verbal Communication and Professional Etiquette

Programme Specific Outcomes (PSO):

PSO1 - Craft ATS-friendly, professionally tailored résumés and cover letters for diverse industry roles
PSO2 - Demonstrate expertise in multiple interview formats
PSO3 - Articulate well-reasoned perspectives in group discussions, handling challenges with diplomacy and strategic thinking
PSO4 - Conduct personal SWOT analysis and goal-setting through self-reflection strategies
PSO5 - Utilize body language effectively to enhance professional presence and leadership communication
PSO6 - Adhere to business etiquette norms, ensuring professionalism in written and interpersonal Interactions

Correlation Matrix between CO and PO and CO and PSO:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6
CO 1	2	2	3	3	2	2	1	3	3	3	3	3
CO 2	1	2	1	3	3	3	1	2	2	1	3	2
CO 3	3	2	1		2	2	3	1				2
CO 4		3	1	3	2	2			3	1	2	2
CO 5	1	3	2	1	3	3	1	3		2	2	2
CO 6	1	2	1	2	3	3		2	2	1	2	2

Degree of Correlation: 1 – low, 2 – medium, 3 – high

SEMESTER II
MSc Biotechnology

BIT501	Advanced Immunology	L	T	P	C
Version 1.0	Contact Hours - 75	2	1	1	4
Pre-requisites/Exposure	**Graduate level degree in biology or relevant area**				
Co-requisites	**Basic knowledge of Chemistry**				

Course Objectives:

1. To provide basic understanding of our immune system and its medical implication.
2. To provide basic understanding of the activation, mechanism and regulation of the immune system and Host pathogen interaction.
3. To understand how an altered signaling pathways of the immune system lead to Immune disorder.

Course Outcomes

On completion of this course, the students will be able to

CO1: Explain the basic principles of the immune system, including its components, functions, and types of immune responses.
CO2: Illustrate the principles and applications of key immunotechnology techniques, such as ELISA, immunoblotting, and flow cytometry.
CO3: Apply immunological techniques for disease diagnosis and research.
CO4: Evaluate the use of immunotherapy and vaccines in treating diseases and preventing infections.
CO5: Design immunotechnology-based strategies for disease prevention, diagnosis, and treatment through practical based approaches.

Course Description:

This course offers an advanced exploration of the principles and mechanisms underlying the immune system, with applications in infectious diseases, cancer immunology, and immune-related disorders. Emphasis is placed on both foundational theories and emerging immunotechnological advancements, fostering a deep understanding of immune responses in clinical and environmental contexts.

The course is aligned with the United Nations Sustainable Development Goals, particularly:

SDG 6 (Clean Water and Sanitation): through insights into immunity and pathogen control in waterborne diseases,
SDG 12 (Responsible Consumption and Production): via responsible use of biomedical technologies and bioproducts,
SDG 13 (Climate Action) and SDG 14 (Life Below Water): by addressing climate-linked disease emergence and immune defense in aquatic environments,
SDG 15 (Life on Land): through the application of immunological principles in managing zoonotic diseases and biodiversity-related health risks.

By bridging theoretical knowledge with real-world challenges, this course prepares students to contribute to global health, sustainable biotechnology, and environmental resilience.

Course Content:

Unit I

Immunology- fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte **homing; Mucosal and Cutaneous** associated Lymphoid tissue.(MALT&CALT); Mucosal Immunity; Basis of self –non-self discrimination; Kinetics of immune response.

Unit II

Antigens and Immune responses generated by B and T lymphocytes

Antigens - immunogens, haptens; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.

Immunoglobulins-basic structure, classes & subclasses of immunoglobulins,

antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor;

Immunoglobulin superfamily; Principles of cell signaling;memory cell generation;

B cell maturation, activation and differentiation; Generation of antibody diversity;

T-cell maturation, activation and differentiation and T-cell receptors; Functional

T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties,

receptors and therapeutic uses;

Unit III

Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Immunodeficiency-Primary immunodeficiencies, Acquired or secondary immunodeficiencies.

Unit IV

Vaccine technology

vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Role and properties of adjuvants, recombinant DNA and protein based vaccines

Clinical Immunology

Recognition and entry processes of different pathogens like bacteria viruses into animal and plant host cells, Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group)

Unit V

Antigen-antibody interactions

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy.

Suggested Books:

1. Kuby Immunology by Judy Owen, Jenni Punt, Sharon Stranford, 2022
2. Roitt's Essential Immunology (Essentials) by Ivan M. Roitt, 2021
3. Medical Microbiology & Immunology by Warren Levinson, 2022
4. Basic and Clinical Immunology by Mark Peakman, 2022

Tentative Lists of Practical:

1. Quantitative precipitation assay
2. Radial immunodiffusion assay
3. Immunoelectrophoresis.
4. Rocket immunoelectrophoresis
5. Immunoprecipiation assay
6. Immunoinformatics

BIT502	Molecular Biology and Genetic Engineering	L	T	P	C
Version 1.0	Contact Hours - 75	2	1	1	4
Pre-requisites/Exposure	Basic Cell Biology, Microbiology, Molecular Biology				
Co-requisites	Basic knowledge on bioinformatics tools, GLP.				

Course Objectives

1. To provide an in-depth understanding of molecular mechanisms governing cellular functions.
2. To explain the structure, function, and regulation of nucleic acids and proteins.
3. To introduce fundamental and advanced concepts of genetic engineering.
4. To equip students with knowledge on cloning, PCR, gene expression analysis, and advanced genetic manipulation tools.
5. To build practical proficiency in molecular biology lab techniques and experimental design.

Course Outcomes

On completion of this course, the students will be able to

CO1	Explain the central dogma of molecular biology in both prokaryotic and eukaryotic systems.
CO2	Understand the process of recombinant DNA technology, including the applications and implications of gene cloning in various fields such as medicine, agriculture, and biotechnology.
CO3	Apply the techniques of recombinant DNA technology to design and conduct experiments related to gene cloning and genetic engineering.
CO4	Analyze the advantages and limitations of recombinant DNA technology in the context of scientific research and biotechnological applications.
CO5	Develop novel strategies and approaches for the advancement of recombinant DNA technology, and propose innovative solutions to biological challenges using genetic engineering techniques.

Course Description:
This course emphasizes theoretical foundations and practical applications of molecular biology and genetic engineering. Students will explore the structure and manipulation of genetic material using state-of-the-art molecular techniques. Through lectures, tutorials, and practicals, students will develop a comprehensive understanding of cloning, gene expression, DNA analysis, and related technologies, preparing them for academic research or biotechnology industry roles.

Course Content

Unit I: Nucleic Acid Architecture, Replication and Gene Expression,
Nucleic Acid Structure and Function, DNA and RNA: structures, forms, and topology, Chromatin organization and nucleosome structure, DNA replication: models, enzymes, replication forks, Telomeres and telomerase activity,

Unit II: Transcription and RNA Processing, Transcription in prokaryotes and eukaryotes, Transcription factors, enhancers, silencers, RNA polymerases and promoter recognition, RNA splicing, editing, transport, and degradation, Non-coding RNAs and their roles.

Unit III: Translation and Post-Translation Regulation
Genetic code and tRNA charging, Ribosome structure and function, Mechanism of translation in prokaryotes and eukaryotes, Post-translational modifications, Protein targeting and degradation (ubiquitin-proteasome pathway).

Unit IV: Basics of DNA cloning
Simple cloning and cloning using linkers and adaptors. Cloning into various kinds of vectors – plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs. Selection and screening of clones. Southern and Northern Blotting. Isolation and purification of DNA. DNA fingerprinting and its application in forensics, in disease diagnosis and in identification of strains. Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins. Western Blotting analysis.

Unit V: Polymerase Chain Reaction
Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Long PCR, Inverse PRC, Vectorette PCR, RT-PCR, 5' and 3' RACE, qPCR, Real Time PCR using SYBR Green, Scorpion primers and TaqMan probes, MOPAC, Multiplex PCR, Differential Display PCR, RAPD fingerprinting of micro-organisms, Ligation Chain Reaction, Overlap PCR, Rolling Circle Amplification Technology. Overexpression and tagging of recombinant proteins in *E.coli,* driven by lac, T7 and Tet-regulated promoters, Expression in *B. subtilis*.

Tentative List of Lab/Practical Components:

- DNA Isolation & Electrophoresis
- RNA Isolation & Electrophoresis
- PCR Amplification and Analysis
- Preparation of Plasmid Vector and Ligation
- Competent Cell Preparation & Transformation
- Screening of Recombinant Clones (Blue-white screening)
- Protein Expression & SDS-PAGE
- Use of Bioinformatics Tools for Primer Design

Books & Other Resources

1. Molecular Biology of the Gene (7th Edition, 2020)
By James D. Watson, Tania A. Baker, Stephen P. Bell et al.

2. Molecular Biotechnology: Principles and Applications of Recombinant DNA (5th Edition, 2020)
By Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten

3. Genes XII (2021)
By Benjamin Lewin

Reference Book:

J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vol 1-3, CSHL, 4th Edition.

BIT503	Applied Bioinformatics and Biostatistics	L	T	P	C
Version 1.0	Contact Hours - 75	2	1	1	4
Pre-requisites/Exposure	UG level				
Co-requisites	Basic knowledge on bioinformatics tools, GLP.				

Course Objectives

1. To provide those students with apt introductory level knowledge to Biostatistics, Bioinformatics & ComputerApplications.
2. It will also provide in depth knowledge ofbiostatistics.
3. Elaborating the database and biological database
4. Explore the knowledge of modern methods of Bioinformatics such as Microarray experiment, Clustering of microarray data, Principal componentanalysis,.

Course Outcomes

On completion of this course, the students will be able to

CO1. Explain biostatistics techniques.

CO2. Demonstrate the biological database and their role in bioinformatics.

CO3. Interpret the knowledge of Cluster analysis; Phylogenetic clustering, Sequence Comparison.

CO4. Explain modern methods of Bioinformatics such as Microarray experiment,

Clustering of microarray data, Principal component analysis

CO5. Demonstrate the structure based application in bioinformatics, protein structure prediction through homology modeling and current research activities in the field of biostatistics and bioinformatics

Catalogue Description

The core-course of 'Biostatistics, Bioinformatics & Computer Applications' will help to understand the introductory level knowledge to biostatistics, bioinformatics & computer applications. This course is a beginning to the biostatistics, the application of different bioinformatics methods to biological data analysis, biological database and some current research activities in the field of bioinformatics. Furthermore, the possible applications of this knowledge in biostatistics, bioinformatics & computer applications would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with

problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with thecoordinator.

Course Content

Bioinformatics and Biostatistics (BIT21585)

Unit I [10 hrs]

Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probabilityand analysis of one and two way samples; discrete and continuous probability models; Expectation andvariance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests forproportion; Equality of proportions; equality of means of normal populations(variance known, variance unknown); Chi-square test for independence; P-value of the statistic; Confidence limits; Introduction to oneway and two-way analysis of variance; Data transformations.

Unit II [10hrs]

Elements of programming languages - C and PERL; Data base concept; Database management system;Database browsing and Data retrieval; Sequence database and genome database; Data Structures andDatabases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR;PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.

Unit III [8 hrs]

Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequencepattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Markovmodels; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification;Pattern recognition methods

Unit IV [7 hrs]

Goals of a Microarray experiment; Normalization of Miroarray data; Detecting differential gene expression;Principal component analysis; Clustering of microarray data; Structure determination by X-raycrystallography; NMR spectroscopy; PDB (Protein Data Bank) and NDB (Nucleic Acid Data Bank); Fileformats for storage and dissemination of molecular structure.

Unit V [10 hrs]

Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structurecomparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; MonteCarlo and molecular dynamics simulationGraphical tools in EXCEL for presentation of data. Introduction to SYSTATpackage.Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST

BLASTn, BLASTp, PSI-BLAST, Sequencemanipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling,Protein structure Analysis, Docking, Ligplot interactions.

Tentative List of Lab/Practical Components

1. Biostatistics & Data Analysis (Excel/SYSTAT)
2. Sequence Retrieval from Databases (NCBI/EMBL/SwissProt)
3. Sequence Similarity Search (BLAST)
4. Multiple Sequence Alignment (Clustal Omega / MUSCLE)
5. Protein Structure Retrieval and Visualization
6. Homology Modeling (SWISS-MODEL / Phyre2)
7. Microarray Data Analysis
8. Protein–Ligand Interaction (Docking & Ligplot) *(optional advanced practical)*

Suggested Books:

1. Bioinformatics – D.Mount
2. Programming in C by Balaguru Swamy.
3. Introduction to Bioinformatics by Arthur M.Lesk, Oxford.
4. Biostatistics – Daniel. (Wiley).
5. Statistics by S.C.Gupta.
6. Statistical Methods by G.W.Snedecor&W.G.Cochran.
7. Fundamentals of Biostatistics – Khan & Khanum.
8. Let us C – Kanetkar.
9. Fundamentals of Biostatistics by U.B.Rastogi (Ame Books Ltd).

BIT551	Nanobiotechnology	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	Basic biochemistry and bio-analytical tools				
Co-requisites	Knowledge of microscopes, Fundamental of physics				

Course Objectives

1. **To provide a foundational knowledge of the Nanomaterial** science and its applications in biotechnology and medicinal science.
2. **To equip students with the skills to analyze biological systems at the nanoscale through experimental, and interdisciplinary approaches,** enabling them to explore nano-bio interactions, design of nanomaterials for biomedical applications, nanoscale diagnostics and therapeutics, and the integration of nanobiotechnology in cutting-edge research and medicine.

Course Outcomes

On completion of this course,

1. The students will be able to know about the fundamentals of nanomaterial science, which helps them to **demonstrate** the basic concept about nanotechnology and nanobiotechnology
2. Students will be able to **illustrate** the basic techniques involved in nano material fabrication
3. Students will be able familiar with carbon nanotube, quantum dots and DNA origami and **interpret** their applications in biosensors
4. Students will be able to **examine** the upcoming concepts currently under development in different laboratories
5. Students will be able to **develop** new ideas from existing technology with an application in diagnosis and treatments.

Course Description

This course will introduce the concept of materials, biomaterials, and nanomaterials, improve the fundamental understanding of the properties of materials at different scales, methods used in nanofabrication, and the interaction of materials with cells and the human body. The course also gives exposure to diverse applications of material science, emphasizing the precise application of nanomaterials in the pharmaceutical industry, diagnostics (biosensors), healthcare, and medicine.

Course Content

Unit I

Introduction to Materials and nanobiotechnology

Surface and bulk properties of materials, Types of biomaterials - porous materials, Concept of bulk versus nanomaterials and dependence of properties on size, Classifications of nanomaterials as 1D 2D 3D nanomaterials and nanostructures,

Unit II

Synthesis of and characterization of nanomaterials

'Top down' vs. 'Bottom up' approach of synthesis of nanomaterials with suitable examples, Characterization of nanomaterials - Scanning Electron Microscopy, Energy Dispersive X-Ray Analysis, Atomic Force Microscopy, Transmission Electron Microscopy, High-Resolution Transmission Electron Microscopy, Scanning Tunneling Microscopy, Ultraviolet-Visible Spectroscopy, Raman Spectroscopy, Fourier Transform Infrared Spectroscopy, X-Ray Diffraction, Dynamic Light Scattering, Zeta Potential

Unit III

Nanotechnology and Nanomedicine

Industrial application of nanomaterials, pharmaceutically important nanoparticles — dendrimers, liposomes, Cellular uptake mechanisms of nanomaterials, in vitro methods to study antibacterial and anticancer properties of nanomaterials. **Clinical nanomedicine - personalized medicine**

Unit IV

Nanotoxicology and Biosafety

Classification of nanostructures based on toxicity, Route to enter into the body, Assessment of nanomaterial toxicity — cyto and hematotoxicity

Unit V

Nano bio-analytics

Nanotechnology in point-of-care diagnostics, Organ-printing, Tissue engineering Nano-oncology, Nanobiosensors

Suggested Books

1. Nanobiotechnology: Concepts, Applications and Perspectives by C. M. Niemeyer, C. A. Mirkin, Wiley –VCH (2006)
2. Nanobiotechnology: Bridging Science, Nature, and Innovation by Dr. S. Anju and Dr. Y. Aparna, Notion Press (2024)
3. Personalized and Precision Nanomedicine for Cancer Treatment by M. A. Aziz (Editor), Springer Nature (2024)
4. Nanotechnology: Principles and Practices by S.K. Kulkarni
5. Bionanotechnology: Lessons from Nature by D S. Goodsell, John Wiley & Sons, Inc.

BIT552	Omics Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	Basic knowledge of Genomics and Proteomics at UG level				
Co-requisites	Basic knowledge of Bioinformatics				

Course Objectives:

1. **To provide students with a comprehensive understanding of genomic and proteomic technologies**, including DNA sequencing, genome mapping, annotation, and protein analysis, along with the ability to navigate and utilize biological databases effectively.
2. **To equip students with the skills to analyze biological systems through computational and comparative approaches**, enabling them to explore genome organization, molecular evolution, systems biology networks, and the applications of bioinformatics in research and medicine.

Course outcomes:

By the end of this course, students will be able to:

1. **Demonstrate understanding of genome mapping and sequencing technologies**, including classical and modern approaches, and utilize biological databases for data retrieval and analysis.
2. **Compare and contrast genome organization across different organisms**, and apply comparative genomics tools in the context of molecular evolution, disease modeling, and personalized medicine.
3. **Apply proteomics and transcriptomics techniques**, including 2-D electrophoresis, microarrays, and protein interaction assays, to study gene and protein expression patterns.
4. **Interpret systems biology concepts and models**, including biological networks and regulatory systems, to analyze complex biological interactions at the cellular and organismal levels.
5. **Analyze evolutionary relationships and genomic variations**, using bioinformatics tools such as pattern matching and phylogenetic analysis, and understand applications in genetic engineering and synthetic biology.

Course Description:

This course provides an in-depth exploration of the molecular tools and computational approaches used in modern biology. Students will learn about genetic and physical mapping techniques, DNA sequencing methods, genome annotation, and the organization of large-scale sequencing projects. The course covers comparative genomics, highlighting genome organization across life forms, the use of molecular markers, and applications in personalized medicine and drug development.

Further emphasis is placed on proteomics, including transcriptomics, protein separation and analysis, and techniques to study protein interactions. Systems biology is introduced through the modeling of biological networks, regulatory circuits, and metabolomic data. Finally, the course examines evolutionary relationships through phylogenetic analysis and discusses how bioinformatics tools can "short-circuit" natural evolution via genetic engineering. The integration of biological data with computational tools is central throughout, preparing students for advanced research and applications in life sciences.

Course Content:

Unit I

Mapping, Sequencing, Annotation, and Databases

Maps and tour guides: Genetic maps, Linkage, Linkage disequilibrium, Chromosome banding pattern maps, High-resolution maps, based directly on DNA sequences, Restriction maps; DNA sequencing:

Frederick Sanger and the development of DNA sequencing, The Maxam–Gilbert chemical cleavage method, Automated DNA sequencing; Organizing a large-scale sequencing project: Whole-genome shotgun sequencing; Annotation of sequencing project; Databanks in molecular biology

Unit II

Comparative genomics

Unity and diversity of life, Sizes and organization of genomes, Viral genomes, Genome organization in prokaryotes, Genome organization in eukaryotes, What makes us human? Model organisms for study of human diseases, The ENCODE project; Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs. **Industrial application of comparative genomics in drug design, development and personalized medicine**

Unit III

Proteomics analysis

Concept of transcriptomics and microarray; Separation and analysis of proteins: 2-D electrophoresis of proteins, SAGE, DIGE; Peptide fingerprinting; Protein-protein interactions: Protein and peptide microarray-based technology; Yest two-hybrid system, PCR-directed protein *in situ* arrays

Unit IV

System biology

Introduction, Two parallel networks: physical and logical, Statics and dynamics of networks, Pictures of networks as graphs, Sources of ideas for systems biology; The metabolome; Regulatory networks

Unit V

Evolution is exploration

Biological systematics, Measurement of biological similarities and differences, Homologues and families, Pattern matching – the basic tool of bioinformatics, Evolution of protein sequences, structures, and functions, Phylogenetic analysis, Short-circuiting evolution: genetic engineering

Suggested Books:

1. Lesk, Arthur M. Introduction to Genomics. 2012. 2nd edition. Oxford University Press
2. Jeremy Dale, Malcolm von Schantz, Nick Plant, From genes to genomes. Concepts and applications of DNA technology. 2020. Wiley Blackwell
3. Gary Walsh, Proteins: Biochemistry and Biotechnology. 2014. Wiley Blackwell
4. Richard Twyman, Principles of Proteomics. 2013. 2nd edition. Garland Science

AEC503	French II	L	T	P	C
Version 1.0	Contact Hours - 30	2	0	0	2
Pre-requisites/Exposure					
Co-requisites	-				

Programme Educational Objectives (PEO)

The French Programme aims to equip students with fundamental linguistic, cultural and communicative competencies for practical applications. The educational objectives are:

PEO1 – Equip students with essential French language skills for basic communication in everyday contexts

PEO2 – Strengthen linguistic competence through a structured progression of vocabulary, grammar and writing skills

PEO3 – Foster an appreciation of Francophone cultures, enhancing intercultural sensitivity and global perspectives

Course Description

This second-semester course builds upon foundational knowledge to deepen students' linguistic competence in the French language and awareness of French culture. Designed for learners with prior exposure to elementary French, the course reinforces everyday communication, introduces nuanced grammatical structures and expands students' confidence in both oral and written expression.

Course Content

Module 1: French Communication [6 hours]

- Asking questions
- Visualising someone's daily life
- Describing the classroom
- Portraying the house

Module 2: Grammar [12 hours]

- Interrogative adverbs, Near future, Recent past
- Possessive adjectives, Pronominal verbs
- Irregular verbs : Faire, Prendre, Mettre, Lire, Venir, Voir, Boire, Savoir, Connaître, écrire
- Prepositions

Module 3: French Culture and Civilisation [6 hours]

- Markets in France
- French Festivals
- Sports
- French Newspapers and Magazines
- French Television Channels

Module 4: Writing
[6 hours]

- Writing an informal e-mail to a friend
- Passage on unseen topic
- Writing a paragraph on: My best friend / Summer vacation / Visiting France

Course Outcomes (CO):
On completion of this second-semester course, the students will be able to

CO1 - Converse in French by asking questions and describing daily routines, items in the classroom and parts of the house
CO2 - Understand and apply French grammatical structures, including possessive adjectives, pronominal verbs, interrogative adverbs, near future and recent past
CO3 - Evaluate aspects of French culture such as markets, festivals and media
CO4 - Create written compositions in the form of informal e-mails and descriptive paragraphs

Programme Outcomes (PO):
Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 - Speak in basic French
PO2 - Understand and apply elementary French Grammar
PO3 - Demonstrate familiarity with French culture
PO4 - Write short French e-mails and paragraphs

Programme Specific Outcomes (PSO):
PSO1 – Speak and respond confidently in daily communication scenarios and understand and apply common greetings and polite expressions
PSO2 – Grasp key grammatical concepts involving Definite and Indefinite Articles, Subject Pronouns, Adjectives, Regular, Irregular and Pronomial Verbs, Interrogative Adverbs and Prepositions
PSO3 – Get acquainted with aspects of French culture, like French cuisine, cities, tourist places, famous personalities, markets, festivals, media and Francophone countries
PSO4 – Communicate in French through short e-mails, paragraphs and dialogues

Correlation Matrix between CO and PO and CO and PSO:

	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CO1	3	3			3	3		
CO2	3	3		3	3	3		3
CO3			3				3	
CO4	2	2	1	3	2	2	1	3

Degree of Correlation: 1 – low, 2 – medium, 3 – high

AEC504	German II	L	T	P	C
Version 1.0	Contact Hours - 30	2	0	0	2
Pre-requisites/Exposure					
Co-requisites	-				

Programme Educational Objectives (PEO)

The German Programme aims to equip students with fundamental linguistic, cultural and communicative competencies for practical applications. The educational objectives are:

PEO1 – Develop foundational skills in speaking, reading, writing, and listening, enabling effective communication in German

PEO2 – Gain insight into German cultural practices, traditions and social etiquette

PEO3 – Acquire the ability to use German in real-life contexts, such as introducing oneself, in restaurant interactions, in supermarkets, in commuting and in formal writing

PEO4 – Develop competence in German grammar, understanding articles, pronouns, conjunctions, verb conjugations and sentence structures

Course Description

The Second Semester of the German Language Course is designed to equip students with fundamental grammar, vocabulary, conversational skills and cultural insights essential for effective communication. Students will gain practical exposure to real-life scenarios, including introductions, ordering food, shopping and navigating public transport. Through structured activities such as role-playing, writing exercises and interactive simulations, learners will develop confidence in expressing themselves in German while understanding key aspects of German culture.

Course Content

Module 1: Grammar - Mission: Grammatik Possible

[10 hours]

- Everyday Verbs in the Present Tense
  Verbs of type: kaufen / antworten / fahren / essen / geben / lesen / haben / sein and similar verbs
- The Power of German Modal Verbs - From “Ich kann nicht!” to “Ich muss doch!”
  Modal Verbs: sollen / wollen / können / dürfen / mögen / müssen / möchten
- Coordinate Conjunctions: und / oder / aber / sondern / wenn
- Quizzes and Worksheets

Module 2: Speaking German – Real Life Scenarios in Germany:

[10 hours]

- The Art of Introducing Yourself in German - "Ich heiße... und du?”
  Speaking Topics: Personal / Family / Studies / Food / Hobbies and Spare Time
  Activity: Pair Work -
  Students pair up for casual dialogues and switch partners every 3 minutes
- Essential Ordering Phrases in a German Restaurant
  " Von Schnitzel bis Erdbeerkuchen mit Sahne”

Activity: Restaurant Simulation -
Students practice ordering different items using a mock menu

- Lost in the Aisles? Navigating a German Supermarkt Without Panic
  Shopping Conversations: Prices, Discounts, Preferences
  Activity: Simulated Shopping - "Customer and Store Attendant / Cashier" practice
- Asking for Directions and using Public Transport
  Navigating bus stops and train stations
  Buying tickets and asking about timetables
  Activity: Role Play -
  Students ask for directions to famous places in Germany
  Students buy train tickets at a railway station

Module 3: German Culture
[3 hours]

- Mastering German Greetings on Occasions and Holidays:
  Alles Gute!
  Gesundheit!
  Herzlichen Glückwunsch zum Geburtstag! / zur Hochzeit!
  Alles Gute zum Jahrestag!
  Viel Glück für die Zukunft!
  Frohe / Fröhliche Weihnachten!
  Frohes neues Jahr! / Prosit Neujahr! / Guten Rutsch ins neue Jahr!
  Frohe Ostern!
- German Media: Brief Overview
  Newspapers – Die Zeit / Frankfurter Allgemeine / Süddeutsche Zeitung / Bild
  Magazines: Spiegel / Stern / Focus / Kicker
  Television: Deutsche Welle (DW) / ZDF / ARD / RTL
  Popular talk shows (Markus Lanz, Anne Will)
- Tor! German Football: Snapshot
  Bundesliga – The top-tier football league
  German Football Clubs – FC Bayern München, Borussia Dortmund, RB Leipzig, Bayer 04 Leverkusen
- German Car Industry: Brief Overview
  Brands – Mercedes Benz, Audi, BMW, Volkswagen, Porsche

Module 4: Writing Skills
[3 hours]

- Writing 20-25 word brief e-mails or messages on instant messaging apps
  Formal e-mails -
  Greetings and Salutations: Sehr geehrte / Sehr geehrter
  Valedictory Address: Mit freundlichen Grüßen / Mit freundlichem Gruß
  Informal e-mails -
  Greetings and Salutations: Hallo / Liebe / Lieber
  Valedictory Address: Tschüss / Bis bald!
  Activity: Students write a short email / message based on a given scenario like fixing up or cancelling an appointment, then peer-review each other's work

Module 5: Elementary Vocabulary
[4 hours]

- Surviving in a German City Without Getting Lost
  Urban Vocabulary for Everyday Use: From Bahnhof to Brücke
- Dressing the German Way
  Essential Clothing Vocabulary: From Mantel to Mütze
- Talking About the Weather Like a True German
  Mastering Weather Terms: Regen oder Schnee?
- Learning about parts of the body without losing your head
  Requisite Vocabulary for Anatomy: Von Kopf bis Fuß
- Audio Comprehensions

Course Outcomes (CO):
On completion of this second-semester course, the students will be able to

CO1 - Use essential verbs, modal verbs and conjunctions to form sentences
CO2 - Introduce themselves, express personal preferences and participate in casual dialogues
CO3 - Order food, handle shopping interactions and ask for directions in German
CO4 - Learn common German greetings, football culture and about German media and German car brands
CO5 - Compose short messages and emails, using appropriate salutations and valedictions
CO6 - Recognize essential words for urban navigation, clothing, weather and parts of the body

Programme Outcomes (PO):
Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 - Know about the origin of the German language vis-à-vis other European languages
PO2 - Develop German pronunciation skills
PO3 - Learn to count and tell time in German
PO4 - Understand and apply elementary German Grammar
PO5 - Speak in basic German
PO6 - Demonstrate familiarity with German culture
PO7 - Write short German sentences and messages
PO8 - Gain knowledge of basic German vocabulary

Programme Specific Outcomes (PSO):

PSO1 – Learn about German as a Germanic language and its place in the Indo-European School of Languages

PSO2 – Recognize German diphthongs, consonant clusters, sounds and phonetic patterns for accurate pronunciation

PSO3 – Understand formal and informal time and cardinal numbers in German

PSO4 – Grasp key grammatical concepts involving main verbs, modal verbs, conjunctions and articles and personal pronouns as subjects

PSO5 – Speak and respond confidently in daily communication scenarios and understand and apply common greetings, expressions and conversational starters

PSO6 – Get acquainted with aspects of German culture, like food and dining etiquette, punctuality, festivals, media, football craze and cars

PSO7 – Communicate in German through short e-mails and messages and use conventional German salutations and valedictions.

PSO8 – Acquire knowledge of vocabulary related to areas like colours, family, home, clothes,
transport, cities, weather and parts of the body

Correlation Matrix between CO and PO and CO and PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1				3	3		3					3	3		3	
CO2		2		3	3			2		2		3	3			2
CO3		2		3	3			2		2		3	3			2
CO4		2			2	3						2	2	3		
CO5				3			3	3				3			3	1
CO6		2			1		1	3		2			1		1	3

Degree of Correlation: 1 – low, 2 – medium, 3 – high

AEC505	**Spanish II**	L	T	P	C

Version 1.0	**Contact Hours - 30**	2	0	0	2
Pre-requisites/Exposure					
Co-requisites	-				

Programme Educational Objectives (PEO)
The Spanish Programme aims to equip students with fundamental linguistic, cultural and communicative competencies for practical applications. The educational objectives are:

PEO1 – Equip students with the ability to communicate effectively in basic spoken and written
Spanish in familiar contexts
PEO2 – Provide a strong foundation in Spanish grammar, vocabulary and pronunciation
PEO3 – Develop cross-cultural awareness and appreciation of Hispanic cultures and global diversity
PEO4 – Enable students to engage in real-life situations using Spanish through listening, speaking,
reading and writing practice

Course Description

This course is the continuation of the foundational Spanish program, designed to deepen students' practical language abilities while expanding their understanding of Hispanic cultures. The course begins with thematic vocabulary relevant to daily life—covering clothes, shopping, health, weather and seasons. Grammar instruction emphasizes constructing simple but varied sentence structures using prepositions, essential irregular verbs and reflexive forms. Modules in reading and writing reinforce literacy skills through short texts, emails and practical forms, while speaking sessions offer real-life communicative practice through role plays, dialogues and short oral presentations. Listening materials, including songs and authentic audio-visual resources, support comprehension and pronunciation. A dedicated culture module invites students to explore the traditions, festivals and social customs of the Spanish-speaking world, with thoughtful comparisons to Indian contexts.

Course Content
Module 1: Basic Vocabulary [4 hours]

- Clothes and Shopping
- Body Parts and Health
- Weather and Seasons

Module 2: Elementary Grammar [9 hours]

- Basic sentence structure: affirmative, negative, interrogative
- Prepositions (en, a, de, con, etc.)
- Introduction to important irregular verbs: ser, estar, tener, ir, hacer
- Possessive Adjectives
- Introduction to Reflexive Verbs

Module 3: Reading

[3 hours]

- Reading Short Texts, Personal Info, Public Signs

Module 4: Writing
[3 hours]

- Writing brief e-mails
- Filling up Forms in Spanish

Module 5: Speaking
[5 hours]

- Guided Pronunciation Practice
- Role plays and mini dialogues
  (in markets, at a restaurant, asking for directions)
- Oral presentations (introduce a friend, describe a city)

Module 6: Listening
[3 hours]

- Audio and Video Comprehension
- Spanish Songs / Short Spanish Videos

Module 7: Spanish Culture
[3 hours]

- Introduction to Spanish-speaking countries & Spanish and
  Latin American Cultural Norms & Customs
- Famous festivals: La Tomatina, Día de los Muertos, Semana Santa
- Brief intro to Hispanic cuisine, music, cinema
  Cultural comparisons: India and the Hispanic World

Course Outcomes (CO):
On completion of this first-semester course, the students will be able to

CO1 - Demonstrate understanding of essential vocabulary related to clothing, shopping, health and weather in oral and written communication
CO2 - Construct grammatically accurate affirmative, negative and interrogative sentences using key irregular verbs, essential prepositions and reflexive structures
CO3 - Read and comprehend short Spanish texts, signs and personal information with contextual accuracy
CO4 - Write brief personal emails and fill out basic forms in Spanish for real-world communication
CO5 - Engage in guided spoken interactions through dialogues, presentations and role plays
CO6 - Comprehend the main ideas from short Spanish audio and video content, including songs and everyday conversations
CO7 - Recognize cultural aspects of the Hispanic world, including festivals, customs and social norms and relate them meaningfully to Indian contexts

Programme Outcomes (PO):
Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 - Demonstrate understanding of fundamental Spanish pronunciation, vocabulary and sentence structures
PO2 - Communicate simple ideas, personal information and routine expressions clearly

and appropriately in Spanish

PO3 - Construct grammatically accurate sentences in present tense using parts of speech learnt

PO4 - Comprehend short written texts and auditory messages related to everyday situations

PO5 - Write structured paragraphs, brief emails and personal details in correct Spanish form

PO6 - Apply cultural knowledge to interact respectfully and meaningfully in Spanish-speaking contexts

PO7 - Use basic interpretive strategies to extract meaning from signs, public information and short videos

Programme Specific Outcomes (PSO):

PSO1 – Engage in role-plays, basic dialogues and oral presentations to navigate familiar situations in Spanish, like shopping, asking for directions, describing people or places)

PSO2 – Interpret and analyze simple reading passages and media content in Spanish with contextual understanding.

PSO3 – Apply accurate grammatical rules—including the use of personal pronouns, articles, verb conjugations, possessive adjectives and reflexive structures—in oral and written tasks

PSO4 – Draw cultural parallels and make meaningful comparisons between Indian and Hispanic customs, festivals and traditions

Correlation Matrix between CO and PO and CO and PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3			1	3			2	1		
CO2	2	2	3	1	3		2	3	1	3	
CO3	2			3	1		3	1	3		
CO4	2	2	3		3	1				3	
CO5	2	3	3					3		3	
CO6	3			3		1	2		3	2	
CO7	2			2		3	2	1	2	2	3

Degree of Correlation: 1 – low, 2 – medium, 3 – high

BIT504	AI in Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 30	2	0	0	2
Pre-requisites/Exposure	Basic knowledge of Computer at UG level				
Co-requisites	Basic knowledge of bioinformatics				

Course Objectives

1. Provide an understanding of Artificial Intelligence (AI) principles and their applications in biotechnology.
2. Explore computational methods, algorithms, and tools used in biological data analysis.
3. Develop the ability to apply AI/ML approaches in genomics, proteomics, drug discovery, systems biology, and synthetic biology.
4. Familiarize students with AI-based platforms for diagnostics, personalized medicine, and bioinformatics.
5. Build skills for critical evaluation of AI applications in real-world biotechnology research and industry.

Course Outcomes

On completion of this course, the students will be able to

CO1: **Explain** fundamental concepts of AI, machine learning, and data-driven approaches in biotechnology.

CO 2: **Apply** AI tools in genomics and proteomics for data analysis, sequence prediction, and biomarker discovery.

CO3: **Analyze** applications of AI in drug design, vaccine development, and precision medicine.

CO4: **Evaluate** the role of AI in systems biology, metabolic engineering, and synthetic biology.

CO5: **Critically assess** ethical, regulatory, and translational aspects of AI in biotechnology and healthcare.

Course Description

This course introduces the interdisciplinary field of **Artificial Intelligence in Biotechnology**, highlighting how AI techniques such as machine learning, deep learning, and neural networks are transforming biological sciences. The course covers applications ranging from genomics and proteomics to drug discovery, diagnostics, and synthetic biology. Students will gain theoretical knowledge, practical insights, and critical perspectives on the integration of AI in biotechnology research and industry.

Course Content

Unit I: Foundations of AI in Biotechnology

Basics of Artificial Intelligence, Machine Learning, and Deep Learning; Biological databases: types, formats, and preprocessing for AI applications; Overview of supervised, unsupervised, and reinforcement learning; Introduction to neural networks and bioinformatics workflows; Case studies: AI-driven biological discoveries

Unit II: AI in Genomics and Proteomics

AI in genome sequencing, annotation, and comparative genomics; Gene expression profiling and pattern recognition; Protein structure prediction (AlphaFold and related tools); AI in biomarker identification and functional genomics; Applications in evolutionary studies and phylogenetics

Unit III: AI in Drug Discovery and Precision Medicine

Virtual screening and drug-target interaction prediction; Machine learning in rational drug design; AI in vaccine development (epitope prediction, antigen design); Personalized medicine: AI for patient stratification and therapy optimization; AI in pharmacogenomics and toxicology studies**Unit IV: AI in Systems Biology and Synthetic Biology**

AI for modeling biological networks and pathways; Predictive modeling of metabolic and regulatory networks; AI in metabolic engineering for bioproducts and biofuels; Designing synthetic organisms using AI; Applications in microbiome research

Unit V: Ethical, Regulatory, and Translational Aspects

Data privacy, biases, and challenges in biological AI applications; Regulatory considerations in AI-driven biotechnology and healthcare; Ethical issues in AI and genomics (e.g., CRISPR, genetic privacy); Industrial and clinical translation of AI-based biotech tools; Future perspectives: AI-driven biotechnology innovations

Suggested Books:

1. Chandra, B. & Gupta, M. Bioinformatics and Artificial Intelligence Tools for Integrative Health Informatics. Springer.
2. Janga, S.C. Applied Artificial Intelligence in Biological and Biomedical Research. Elsevier.
3. Jurisica, I. & Wigle, D.A. Knowledge Discovery in Bioinformatics: Techniques, Methods, and Applications. Wiley.
4. Tran, D. & Tran, N. Artificial Intelligence in Bioinformatics and Computational Biology. CRC Press.
5. Pierre Baldi & Søren Brunak. Bioinformatics: The Machine Learning Approach. MIT Press.
6. Relevant research articles (e.g., Nature Biotechnology, Bioinformatics, Briefings in Bioinformatics, Trends in Biotechnology).

CLL407	Advanced Soft Skills and Aptitude II	L	T	P	C
Version 1.0	**Contact Hours - 15**	1	0	0	1
Pre-requisites/Exposure					
Co-requisites	-				

Programme Educational Objectives (PEO)

The Three-Semester Soft Skills Programme aims to equip postgraduate students with the interpersonal, communication and professional competencies necessary for career success in academia and industry. The Programme Educational Objectives (PEO) are designed to ensure career and personal growth through structured skill development.

PEO1 – Impart skills required for employability and ensure career readiness
PEO2 – Instill professionalism and a sense of ethical work culture
PEO3 – Ensure proficiency in professional communication
PEO4 – Develop leadership skills and ability for effective teamwork
PEO5 – Encourage self-reflection, continuous learning and personal growth

Course Description

Building upon the foundational skills acquired in the first semester, the second semester focuses on refining and advancing professional competencies essential for today's competitive job market. This course deepens students' understanding of professional documentation, digital branding, interview etiquette, group interaction, non-verbal cues and workplace professionalism. Through interactive sessions, hands-on practice and real-time feedback, students will develop the tools to present themselves effectively and confidently in both academic and corporate settings.

Course Content

Module 1: Crafting Résumés
[3 hours]

- Formatting tips (font, alignment, sectioning)
- Formatting best practices (ATS-friendly resumes)
- Tailoring Résumés for different Job Descriptions / Specific Roles
- Action Verbs, Industry-specific Keywords, Quantifying Impact
- Resume Template Walkthrough
  (Use of Canva Resume Builder, ResumeGenius, Zety, Novo Résumé, VisualCV or other applications)
- Submission of individual Student Résumés with Correction and Feedback
  (to be continued throughout the semester, irrespective of actual classes, until each student has a professional résumé)

Module 2: Personal Branding and Online Presence [2 hours]

- Importance of online presence in modern job markets
- How recruiters screen candidates online
- Consistency between Résumé and Digital Profiles
- Creating and optimising LinkedIn Profiles

Module 3: Interview Skills
[3 hours]

- Techniques to reduce nervous habits and increase confidence in Interviews
- Importance of a Résumé in an Interview
- General Interview Questions:
  Discussion of questions asked in actual job interviews of senior university students
  Formulating responses to the questions
  Reviewing and refining answers
- Mock Interview Practice:
  Video-recording of the Interviews
  Structured feedback from Instructors using standardised rubrics

Module 4: Group Discussions [3 hours]

- Review of important points of a Group Discussion
- Hands-on Sessions (Mock Group Discussions)
  Topics: Current Affairs / Business and Economics / Social Issues / Technology / Environmental Issues / Ethical Dilemmas / Abstract Concepts / Domain related
  Video-recording of the GDs with Peer and Instructor Evaluation using Rubrics

Module 5: Non-Verbal Communication / Body Language
[2 hours]

- Understanding Non-Verbal Communication
- Key Elements of Body Language:
  Posture and Stance
  Gestures and Hand Movements
  Facial Expressions and Microexpressions
  Proxemics and Haptics
- Professional Etiquette:
  Appropriate vs. Inappropriate Body Language in Professional Settings
- Body Language for Interviews:
  Making a strong First Impression
  Confident Handshakes and maintaining Eye Contact
- Body Language for Leadership and Public Speaking:
  How to command presence in Meetings and Presentations
  Using purposeful Gestures and Vocal Tone effectively

Module 6: Professional Skills [2 hours]

- Adaptability and resilience in the workplace
  Flexibility and Importance of Relocation
- Practice Professionalism Everyday (Arrive on Time, Dress for Success, Work Smart, Manage and live up to Expectations, Lead by Example, Be Consistent)
- Time management, discipline and organizational skills
- Problem-solving and decision-making skills
- Teamwork and collaboration
- Leadership and interpersonal skills

Course Outcomes:
On completion of this course, the students will be able to

CO1 - Design and refine industry-tailored résumés using best practices for formatting and keyword optimization
CO2 - Leverage digital platforms, particularly LinkedIn, to build a consistent and attractive online presence.
CO3 - Excel in interviews by managing interview stress, presenting oneself with confidence and formulating effective responses.
CO4 - Participate effectively in group discussions on diverse topics
CO5 - Apply positive body language in professional contexts to create strong first impressions and command presence
CO6 - Integrate key soft skills such as time management, adaptability, workplace etiquette, leadership, and collaborative problem-solving into daily professional practice

Programme Outcomes (PO):
Upon successful completion of this three-semester programme, students will develop the following competencies:

PO1 - Professional Documentation and Career Readiness
PO2 - Excellence in Interviews and Group Discussions
PO3 - Resilience, adaptability and goal-setting strategies for continuous career growth
PO4 - Teamwork, problem-solving and decision-making skills essential for collaborative work environments
PO5 - Proficiency in verbal, non-verbal and written communication across academic and professional settings
PO6 - Mastery of Non-Verbal Communication and Professional Etiquette

Programme Specific Outcomes (PSO):
PSO1 - Craft ATS-friendly, professionally tailored résumés and cover letters for diverse industry roles
PSO2 - Demonstrate expertise in multiple interview formats
PSO3 - Articulate well-reasoned perspectives in group discussions, handling challenges with diplomacy and strategic thinking
PSO4 - Conduct personal SWOT analysis and goal-setting through self-reflection strategies
PSO5 - Utilize body language effectively to enhance professional presence and leadership communication
PSO6 - Adhere to business etiquette norms, ensuring professionalism in written and interpersonal Interactions

Correlation Matrix between CO and PO and CO and PSO:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO 1	3	3	1	1	2	2	3	2		1		2
CO 2	3	1	2	1	2	1	1					2
CO 3	2	3	1	2	3	3	2	3		1	3	3
CO 4	2	3	1	3	3	3			3	2	3	3
CO 5		3	2		3	3		3	3	1	3	1
CO 6	2	1	3	3		3		2	2	1		3

Degree of Correlation: 1 – low, 2 – medium, 3 – high

PG Curricular Structure with Coursework and Research
SEMESTER – III

BIT505	Advanced Plant and Animal Biotechnology	L	T	P	C
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	B SC in Biological Science				

Course Objectives:

1. **Understand** advanced concepts, principles, and techniques used in modern plant and animal biotechnology.
2. **Explore** the applications of genetic engineering, transgenics, and molecular tools for crop and animal products and healthcare improvement.
3. **Analyze** the role of tissue culture, stem cells, cloning, and genome editing in research and industry.
4. **Evaluate** ethical, regulatory, and biosafety concerns associated with plant and animal biotechnology.
5. **Develop** research aptitude for solving agricultural, environmental, and healthcare challenges using biotechnological approaches.

This course is aligned with SDG 2: Zero Hunger and SDG 3: Good Health and Well-Being.

Course Outcomes:

On completion of this course, the students will be able to

Recall and explain fundamental and advanced concepts of plant and animal biotechnology, including genetic engineering, tissue culture, transgenics, and genome editing.

Demonstrate and implement molecular, cellular, and bioprocessing techniques to solve practical problems in agriculture, environment, and health sciences.

Compare and differentiate experimental strategies, datasets, and case studies of genetically modified organisms, therapeutic models, and biotechnological interventions.

Critically assess and justify the scientific, ethical, regulatory, and biosafety dimensions of plant and animal biotechnology applications in real-world contexts.

Design and propose innovative research models, biotechnological products, or experimental protocols to address global challenges in food security, sustainability, and human health.

Catalogue Description

Advanced Plant and Animal Biotechnology is a challenging lecture course that covers a range of basic to applied topics. The course takes a broader approach and covers many aspects of conventional as well cutting-edge topics. Furthermore, the ethical issues regulatory concerns in plant and animal biotechnology would also be illuminated. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies using digital platforms. Students will be encouraged to actively take part in all group activities and to give an oral group presentation.

Course Content: Advanced Plant and Animal Biotechnology

Course Content: Advanced Plant and Animal Biotechnology

Unit I: Plant tissue culture

Scope and Importance of plant tissue culture- Media composition and types, hormones and growth regulators, Methods of sterilization, Different types of cultures - Shoot, callus cell suspension and protoplast cultures, Organogenesis Micropropagation, Somatic embryogenesis and synthetic seeds

Unit II: **Tissue culture techniques**

Embryo rescue techniques and importance of embryo culture. Production of haploid; Protoplast isolation and culture techniques, somatic hybridization and production of somatic hybrids and cybrids; in vitro production of secondary metabolites cell suspension, root and hairy root cultures,

Unit III: Stem cells and Tissue Engineering

Scope, embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences. Stem cells, iPSCs,

Unit IV: Ethics, Biosafety, and Future Perspectives

Ethical, legal, and social implications (ELSI) of plant and animal biotechnology, Biosafety guidelines, regulatory frameworks (national and international), Public perception and communication of GMOs

Unit V: Application of Advanced Plant and Animal Biotechnology:

Chloroplast transformation, protoplast transformation methods; Molecular Farming; therapeutic proteins, edible vaccines and antibiotics using transgenic technology. RNAi and antisense RNA technology; Gene therapy, IVF and Stem cell therapy. Tissue engineering, 3D bio printing

Tentative Lists of Practical

In vitro Micropropagation and Hardening of Plantlets
Quantitative Estimation of Plant Metabolites
Demonstration on Agrobacterium-Mediated Gene Transfer in Plants
Culture and maintenance of a cell line.
Staining and screening of cells
Application of AI in plant biotechnology

Text Books:

1. Plant Biotechnology: The Genetic Manipulation of Plants by Adrian Slater,2003
2. Biotechnology in Agriculture by Swaminathan,2009
3. Plant Tissue Culture: Propagation, Conservation and Crop Improvement Editors: **Anis**, Mohammad, **Ahmad**, Naseem (Eds.),2011.
4. Animal Cell Culture: Principles and Practice by Shalini Mani, Manisha Singh, Anil Kumar. Publisher : Springer International Publishing AG; 1st ed. 2023 edition (2 February 2024)
5. Textbook of Animal Biotechnology: By Carlos Wyatt, Publisher: Syrawood Publishing House

Reference Books

1. Plant Biotechnology by William G. Hopkins,2006
2. Plants, Biotechnology and Agriculture (Modular Texts) by Denis Murphy, 2011
3. An Introduction to Genetic Engineering by Desmond S.T. Nicholl,2012
4. Stem Cells: A Short Course by Rob Burgess,2015

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	*Recall and explain* fundamental and advanced concepts of plant and animal biotechnology, including genetic engineering, tissue culture, transgenics, and genome editing.	**PO1, PO2**
CO2	*Demonstrate and implement* molecular, cellular, and bioprocessing techniques to solve practical problems in agriculture, environment, and health sciences.	**PO1, PO2**
CO3	*Compare and differentiate* experimental strategies, datasets, and case studies of genetically modified	**PO1, PO2**
	organisms, therapeutic models, and biotechnological interventions.	
CO4	*Critically assess and justify* the scientific, ethical, regulatory, and biosafety dimensions of plant and animal biotechnology applications in real-world contexts.	**PO1, PO2, PO5, PO6**

CO 5	*Design and propose* innovative research models, biotechnological products, or experimental protocols to address global challenges in food security, sustainability, and human health.	**PO1, PO2, PO3, PO5, PO8**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**
CO4	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**
CO5	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Average	**3**	**2.6**	**2.2**	**2.8**	**2.6**	**3**	**2.8**	**2.8**	**2.6**	**2.6**	**2.2**	**2.6**

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT506	Bioprocess Technology	L	T	P	C
Version 1.0	Contact Hours - 75	2	1	1	**4**
Pre-requisites/Exposure	**B. Sc in Biology**				
Co-requisites	**Basic knowledge of 12th level Mathematics**				

Course Objectives

1. By the end of the course, students will be able to understand the fundamental principles of bioprocess engineering.
2. Analyze microbial growth kinetics and bioreactor operations.
3. Design and evaluate upstream and downstream processing steps.
4. Apply scale-up principles for industrial bioprocesses.
5. Integrate bioprocess strategies for production of bio-based products.

Course Outcomes

1. After successful completion, students will be able to demonstrate knowledge of microbial physiology in relation to fermentation.
2. Operate and optimize bioreactors for various production processes.
3. Analyze and interpret data from bioprocess operations.
4. Develop strategies for product recovery and purification.
5. Design a bioprocess considering technical and economic feasibility.

Course Content

Unit I: Introduction to Bioprocesses
History and scope of bioprocess technology; Components of a bioprocess: upstream, bioreaction, downstream; Microbial culture selection and strain improvement; Media formulation and sterilization techniques

Unit II: Kinetics of Microbial Growth and Product Formation

Phases of microbial growth, Monod kinetics, yield coefficients, Substrate-limited growth, maintenance energy, Models for product formation (growth-associated & non-growth associated)

Unit III: Bioreactor Design and Analysis
Types of bioreactors: stirred tank, airlift, packed bed, fluidized bed; Design and operation parameters: aeration, agitation, heat transfer; Batch, fed-batch, and continuous cultures; Scale-up and scale-down strategies

Unit IV: Downstream Processing
Cell disruption methods; Solid-liquid separation: centrifugation, filtration; Extraction and purification: chromatography, precipitation, ultrafiltration; Drying and formulation techniques

Unit V: Bioprocess Applications and Case Studies

Production of primary and secondary metabolites; Biopharmaceuticals: recombinant proteins, Biopolymers, biofuels, and enzyme production; Bioprocess economy.

Tentative list of practical:

1. Microbial growth curve analysis (optical density vs. time) and determination of biomass and product yield coefficients.
2. Effect of substrate concentration on microbial growth (Monod kinetics)
3. Bioreactor monitoring: pH, DO, temperature, agitation speed
4. Chromatographic separation (paper/thin layer or demo of column chromatography)
5. Operation of **fed-batch/continuous culture** in bench-scale fermenter for ethanol/antibiotic production
6. Media component optimization using Plackett–Burman or Taguchi design
7. Visit/report on a fermentation-based industry

Suggested Books

Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts., PEARSON EDUCATION; 2nd edition.
Doran, P. M. (2012). Bioprocess Engineering Principles. Academic Press Inc (3 April 1995); CBS PUBLISHERS AND DISTRIBUTORS PVT. LTD.
Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). Principles of Fermentation Technology., Butterworth-Heinemann; 3rd edition
Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals., , McGraw Hill Education; 2nd edition
Online MOOC materials (NPTEL, Coursera, etc.)

BIT553	Applied Food Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 75	3	1	0	4
Pre-requisites/Exposure	Basic Knowledge of basic Microbiology and Biochemistry at UG level				
Co-requisites	Basic knowledge of Food chemistry and techniques at UG level				

Course Objectives

1. Introduce modern food processing and preservation methods using biotechnology.
2. Examine food safety standards and regulatory bodies.
3. Explore intelligent packaging and emerging trends in food packaging.
4. Develop foundational skills in food toxicology and experimental optimization.

Course Outcomes

On completion of this course, the students will be able to

1 **Identify** and explain various food processing and preservation techniques.

2 **Apply** enzymatic and microbial biotechnology to food production processes.

3 **Analyze** national and global food safety regulations and food labeling norms.

4 **Evaluate** modern food packaging strategies and materials.

5 **Explain** the foodborne hazards and toxicology tests

Course Content

Unit 1: Food Processing and Preservation

Basic principles of food processing and preservation. Techniques: dehydration, chilling, freezing, pasteurization, sterilization, canning, non-thermal methods: high-pressure processing, irradiation, modified atmosphere packaging, and hurdle technology.

Unit 2: Food Biotechnology Applications

Fermentative production of enzymes, solid-state fermentation, enzyme recovery; applications in cheese and whey processing, fruit juice clarification, bioethanol production; role of enzymes in baking, meat processing, lipid modification, and oxygen-dependent catabolic reactions in foods.

Unit 3: Food Packaging Science and Technology

Functions of packaging; packaging materials (paper, plastic, metal, glass, composites); biodegradable and intelligent packaging; nanotechnology, active packaging; migration, barrier properties, and environmental impact.

Unit 4: Food Safety and Regulatory Affairs

Food safety regulators and labeling (FSSAI, CODEX, Organic, GM); food standardization and regulatory agencies in India; quality control systems including HACCP, ISO 22000, GMP, and AGMARK.

Unit 5: Food Toxicology

Foodborne hazards (microbial toxins, chemical residues, natural toxins, allergens); toxicology tests (LD_{50}, Ames test, animal models); food adulterants, additives, and contaminants (biological, chemical, physical).

Suggested Books:

1. Ray, B and Bhunia, A., "Fundaments of Food Microbiology" ISBN-13: 978-0815384311, 2017.
2. Sivasankar B, "Food Processing and Preservation", ISBN- 97881203-2086-4, 2009.
3. William C Frazier and Dennis C. Westoff, "Food Microbiology", ISBN-9780070667181, 2008.
4. Pometto, A., Shetty, K., Paliyath, G., & Levin, R. E. *Food Biotechnology* eBook ISBN: 9780429115394
5. Ravishankar Rai, V. *Advances in Food Biotechnology*. Wiley-Blackwell, ISBN: 9781118864555

BIT554	Industrial Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 75	3	1	**0**	**4**
Pre-requisites/Exposure	**B.Sc Biology discipline**				
Co-requisites	**-**				

Course Objectives:

1. To understand the role of microorganisms and bioprocesses in industrial production.
2. To explore various biotechnological products and processes used in industries.
3. To familiarize students with upstream and downstream process techniques.
4. To introduce students to industrially important enzymes, biofuels, and recombinant products.
5. To enable students to critically evaluate current trends, biosafety regulations, industrial applications of biotechnology.

Course outcome:

1. Explain the fundamental concepts of industrial biotechnology and describe the role of microorganisms in large-scale production systems.
2. Analyze and compare microbial processes involved in the production of organic acids, antibiotics, enzymes, and biofuels.
3. Demonstrate knowledge of bioreactor types, their operational parameters, and scale-up challenges in industrial settings.
4. Apply theoretical knowledge to assess enzyme technologies, biomolecule production, and applications in various industries.
5. Critically evaluate emerging biotechnological trends, industrial case studies, and regulatory frameworks governing industrial biotechnology.

Course content

Unit I: Introduction to Industrial Biotechnology

Scope and importance of industrial biotechnology, Historical development and current trends, Selection and screening of industrial microorganisms, Types of fermentations: batch, fed-batch, continuous, Concepts of upstream and downstream processing

Unit II: Industrial Microorganisms and Products

Strain improvement: mutagenesis, protoplast fusion, metabolic engineering, Production of Oxy Chemicals I: Tax and non-tax alcohol, Brewing industry, Microbial production of: Organic acids (e.g., citric acid, lactic acid), Amino acids (glutamic acid, lysine), Antibiotics (penicillin, streptomycin), Vitamins (B12, riboflavin), High fructose corn syrup, Cheese making, and Single cell production.

Unit III: Enzyme and Biomolecule Production

Industrial enzyme production and applications: Amylases, proteases, cellulases, lipases; Applications in textile, detergent, food, and pharmaceutical industries, Enzyme immobilization and stability, Biopolymers: PHB, PLA – production and applications, Bioplastics and biodegradable alternatives

Unit IV: Bioreactors and Process Engineering

Types of bioreactors: stirred tank, airlift, packed bed, fluidized bed, Bioreactor parameters and scale-up considerations, Monitoring and control of bioprocess parameters (pH, DO, temperature); Introduction to computer-aided bioprocess design and AI and ML application in industrial biotechnology.

Unit V: Industrial Applications and Emerging Trends

Biofuels: ethanol, biogas, biodiesel – microbial processes, Bioremediation and environmental applications, Recombinant product production (e.g., insulin, vaccines), Introduction to synthetic biology and cell factories, Regulatory and biosafety aspects in industrial biotechnology

Suggested Books

1. Industrial Microbiology by Samuel Cate Prescott and Cecil Gordon Dunn, Palgrave Macmillan; 4th edition
2. Biochemical Engineering Fundamentals by Bailey and Ollis, McGraw Hill Education; 2nd edition
3. Bioprocess Engineering Principles by Doran, Academic Press Inc (3 April 1995); CBS PUBLISHERS AND DISTRIBUTORS PVT. LTD.
4. Bioprocess Engineering Basic Concepts by Shular and Kargi, PEARSON EDUCATION; 2nd edition
5. Biochemical Engineering by Blanch and Clark, CRC Press; 2nd edition

BIT507	Project Proposal writing in Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 30	2	0	0	2
Pre-requisites/Exposure	Basic research training at UG level				
Co-requisites	Basic English writing				

Course Objectives

1. To develop knowledge and skills required for conceptualizing, structuring, and writing effective project proposals in biotechnology.
2. To provide hands-on experience in preparing funding-ready research and innovation proposals with clarity, feasibility, and impact.

Course Outcomes

On completion of this course, the students will be able to

CO1: Understand the essentials of research proposals, funding mechanisms, and components specific to biotechnology.

CO2: Formulate research problems, objectives, hypotheses, and review of literature relevant to biotechnology.

CO3: Design suitable research methodologies, work plans, and timelines for biotechnological projects.

CO4: Prepare budget estimates, resource requirements, and understand ethical/regulatory issues in biotech proposals.

CO5: Write, present, and defend complete project proposals with clarity and alignment to funding requirements.

Course Description

This course provides systematic training in the art and science of **project proposal writing with a focus on biotechnology**. It covers idea conceptualization, literature review, framing objectives, research design, budgeting, and ethical aspects. Students will engage in hands-on activities to prepare draft proposals suitable for academic, industrial, or funding agency submission. By the end, students will have a comprehensive understanding of how to develop high-quality proposals that address scientific, societal, and industrial needs.

Course Content

Unit I: Introduction to Project Proposal Writing

- Nature and scope of research projects in biotechnology
- Importance of project proposals in academia, industry, and funding agencies
- Types of proposals: academic research, industry collaboration, translational, and start-up innovation
- Structure of a typical project proposal (Title, Abstract, Objectives, Methodology, Outcomes, Budget)
- Overview of national and international funding agencies (DBT, DST, ICMR, BIRAC, NIH, EU Horizon)

Unit II: Problem Identification and Literature Review

- Identifying and defining research problems in biotechnology
- Sources of information: journals, patents, databases, reports
- Framing research questions, hypotheses, and objectives
- Writing a critical literature review (biological context, research gaps, justifications)
- Case examples of successful biotechnology projects

Unit III: Research Design and Methodology

- Choosing appropriate experimental designs for biotechnology research

- Methods in genomics, proteomics, molecular biology, fermentation, bioprocessing, etc.
- Designing workflow diagrams, Gantt charts, and milestones
- Risk assessment and contingency planning
- Pilot studies and preliminary data inclusion in proposals

Unit IV: Budgeting, Resources, and Ethical Considerations

- Preparing budget estimates (capital costs, consumables, manpower, equipment, travel, contingencies)
- Aligning budget with funding guidelines
- Institutional support and resource mobilization
- Ethical aspects: biosafety, bioethics, IPR, and regulatory frameworks in biotechnology research
- Sustainability and societal/industrial impact of biotech projects

Unit V: Writing, Presentation, and Evaluation of Proposals

- Drafting key sections: Title, Abstract, Objectives, Work plan, Expected outcomes
- Formatting guidelines as per funding agencies
- Common mistakes in project proposal writing and how to avoid them
- Preparing PowerPoint/project pitch for evaluation
- Peer review, faculty/mentor feedback, and final submission of proposals

Suggested Books:

1. Garg, B.L., Karadia, R., Agarwal, F., & Agarwal, U.K. An Introduction to Research Methodology. RBSA Publishers.
2. Trochim, W.M.K. & Donnelly, J.P. Research Methods: The Essential Knowledge Base. Cengage Learning.
3. Selected guidelines from DBT, DST, ICMR, BIRAC, NIH, and EU Horizon websites.

BIT508	Internship	L	T	P	C
Version 1.0	-	0	0	2	2
Pre-requisites/Exposure	Graduate level degree in biology or relevant area				
Co-requisites	--				

Course Objectives:

1. Students will have the opportunity to put content from the classroom into practice consistent with the standards of theindustry.
2. The primary goal of this course is to acquaint students with business or agency culture and to help them identify roles in that culture where scientific expertise in biotechnology is relevant.
3. Students will understand professional, ethical and social responsibilities and develop a respect for diversity and a knowledge of contemporary professional, societaland global issues of the need and an ability to engage in lifelonglearning,

Course Outcomes

On completion of this course, the students will be able to

CO1: **Illustrate** the operations of a biotechnology industry or research lab and the use of high-end instruments/software.

CO2: **Demonstrate** professional behavior, including conscientious performance and a collaborative work ethic.

CO3: **Apply** biotechnology knowledge and skills in industrial or research labs, appreciating ethical business principles and practices.

CO4: **Evaluate** technical information through written reports and oral presentations, focusing on observation, analysis, and results.

CO5: **Develop** knowledge of contemporary professional, societal, and global issues, and engage in lifelong learning.

Catalogue Description:

Students participate in research or applied biology outside this university. Students must contact and obtain approval of a supervising instructor at the off-campus location and the department internship coordinator in the term prior to registration. Students have the opportunity to put content from the classroom into practice consistent with the standards of the industry. Industry internships are a powerful way for students to experience biotechnology first-hand and set them up for future employment. Industrial internship of approximately two months duration is required, and typically in the second year of Master's degreecourse.

Course Content:

Student Notebook and Portfolio: A bound, paged notebook should serve as a reservoir of observations, results or conclusions about daily activities during the internship. Each date should be entered with a title of the activity in a form that can be listed in the table of contents, with appropriate page numbers. A brief concluding statement which suggests awareness of the purpose and important events or results acquired during the day should appear following any other observations or entries followed by the intern's signature. In addition, any interim projects or progress reports should be assembled or otherwise documented into a portfolio of products or findings arising from theinternship.

Written Presentation: At the conclusion of the assignment student will be required to submit a formal written progress report a summary of the important findings; and a statement regarding the impact of these findings on future operations or directions relative to the problem under investigation.

Oral Presentation: Each student is required to make a formal oral presentation on the experience. The presentations will summarize the findings and the overall experience, especially reflecting on the experience relative to the course goal and learning objectives.

CLL503	Advanced Soft Skills and Aptitude III	L	T	P	C
Version 1.0	**Contact Hours - 15**	1	0	0	1
Pre-requisites/Exposure					
Co-requisites	-				

Programme Educational Objectives (PEO)

The Three-Semester Soft Skills Programme aims to equip postgraduate students with the interpersonal, communication and professional competencies necessary for career success in academia and industry. The Programme Educational Objectives (PEO) are designed to ensure career and personal growth through structured skill development.

PEO1 – Impart skills required for employability and ensure career readiness
PEO2 – Instill professionalism and a sense of ethical work culture
PEO3 – Ensure proficiency in professional communication
PEO4 – Develop leadership skills and ability for effective teamwork
PEO5 – Encourage self-reflection, continuous learning and personal growth

Course Description

The third and final semester of the Soft Skills Programme focuses on advanced communication and professional development strategies. This semester is designed to fine-tune students' capabilities in interviews, group discussions, public speaking, professional correspondence and self-reflection. Through rigorous practice sessions, constructive feedback and structured learning approaches, students will develop a deep understanding of the nuances of persuasive communication, self-assessment techniques and effective career-building strategies.

Course Content

Module 1: Interview Skills
[4 hours]

- Types of Interviews:
  Behavioural Interview (STAR method of answering - Situation, Task, Answer, Result),
  Situational Interview, Panel Interview, Group Interview, Technical Interview,
  HR Interview, Case Interview, Stress Interview, Virtual Interview
- General Interview Questions:
  Discussion of questions asked in actual job interviews of senior university students
  Formulating responses to the questions
  Reviewing and refining answers
- Mock Interview Practice:
  Video-recording of the Interviews
  Structured feedback from Instructors using standardised rubrics

Module 2: Group Discussions [2 hours]

- Hands-on Sessions (Mock Group Discussions)
  Topics: Current Affairs / Business and Economics / Social Issues / Technology / Environmental Issues / Ethical Dilemmas / Abstract Concepts / Domain related
  Video-recording of the GDs with Peer and Instructor Evaluation using Rubrics

Module 3: Public Speaking [3 hours]

- Overcoming glossophobia and other psychological barriers
- Techniques for confidence building
- Content organization and story-telling techniques:
  Structuring a compelling speech (introduction, body, conclusion)
  Using rhetorical devices for persuasion and engagement
  Incorporating story-telling and humour effectively
- Persuasive Communication: Ethos, Pathos, Logos
- Analysis of a TED Talk for structure and appeal
- Individual student speeches (both prepared and extempore / impromptu) with constructive critique by faculty

Module 4: Handling official correspondence
[3 hours]

- Importance of professional tone, clarity and structure in official correspondence:
  Tone – direct vs. polite, positive framing
  Keeping emails concise and clear
  Key elements of an e-mail: subject line, salutation, body, closing and signature
- Email Etiquettes:
  Response time and digital courtesy
- Common Errors in email writing:
  Vague / Uninformative Subject Lines
  Forgotten Attachments
  Inappropriate “Reply All”
  (using "Reply All" when you only need to address a single person)
  Failing to review e-mails before sending them
  Sending emails to wrong recipients
  Use of ‘bcc’ without pre-thought
  Confusing homophones, grammatical errors, missed punctuation, redundancy
- Email Formatting - Good Practices:
  Allocating ample amount of white space so that recipients don’t have to squint their eyes
  If there are a list of things to do, presenting it in a list format
  No long paragraphs
  Legible font size and colour
  Using bold text for key points
- Hands-on practice with email writing exercises

Module 5: Self-Reflection and Self-Assessment [3 hours]

- Techniques for effective Self-Reflection:
  Journaling, thought exercises and guided introspection
  Johari Window – building self-awareness and trust
- Understanding self-assessment and its role in career success
- Conducting a personal SWOT Analysis
  (Strengths, Weaknesses, Opportunities, Threats)
- Developing a Self-Improvement Roadmap:
  Setting SMART goals (Specific, Measurable, Achievable, Relevant, Time-bound goals)
  Strategies for continuous growth and adaptability
  Building accountability for self-progress
  Managing Failures and learning from setbacks

Course Outcomes:

On completion of this course, the students will be able to

CO1 - Differentiate between various interview formats, structure responses effectively and refine
answers based on industry expectations.
CO2 - Participate in domain-specific and general topic group discussions, presenting arguments with
distinctness and self-assurance.
CO3 - Overcome fear of public speaking, build confidence and craft compelling speeches using
rhetorical and storytelling techniques.
CO4 - Draft professional emails with precision, clarity, and etiquette, avoiding common pitfalls and
formatting errors
CO5 - Utilize self-reflection methodologies and self-assessment frameworks to map personal growth
and career readiness.

Programme Outcomes (PO):

Upon successful completion of this three-semester programme, students will develop the following competencies:

PO1 - Professional Documentation and Career Readiness
PO2 - Excellence in Interviews and Group Discussions
PO3 - Resilience, adaptability and goal-setting strategies for continuous career growth
PO4 - Teamwork, problem-solving and decision-making skills essential for collaborative work environments
PO5 - Proficiency in verbal, non-verbal and written communication across academic and professional settings
PO6 - Mastery of Non-Verbal Communication and Professional Etiquette

Programme Specific Outcomes (PSO):

PSO1 - Craft ATS-friendly, professionally tailored résumés and cover letters for diverse industry roles
PSO2 - Demonstrate expertise in multiple interview formats
PSO3 - Articulate well-reasoned perspectives in group discussions, handling challenges with diplomacy
and strategic thinking
PSO4 - Conduct personal SWOT analysis and goal-setting through self-reflection strategies
PSO5 - Utilize body language effectively to enhance professional presence and leadership communication
PSO6 - Adhere to business etiquette norms, ensuring professionalism in written and interpersonal
Interactions

Correlation Matrix between CO and PO and CO and PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	2	2	3	3		3		2	3	3
CO2		3	2	2	3	3			3	2	3	3
CO3			2	1	3	3		2	2	2	3	3
CO4	2		1		3	2				1		3
CO5	3	2	3	2	1	1	1	2		3	2	2

Degree of Correlation: 1 – low, 2 – medium, 3 – high

BIT591	Dissertation Part I*	L	T	P	C
Version 1.0	-	0	0	6	6
Pre-requisites/Exposure	Graduate level degree in biology or relevant area				
Co-requisites	--				

Course Objectives

- To initiate students into independent research under faculty supervision.
- To develop skills in literature survey, hypothesis formulation, and research methodology.
- To provide hands-on exposure to laboratory/field/ computational work relevant to biotechnology.
- To train students in scientific writing, data organization, and progress reporting.

Course Outcomes (COs)

On completion of this course, the students will be able to:

- **CO1:** Identify and define a specific research problem in biotechnology.
- **CO2:** Conduct a comprehensive literature survey to recognize research gaps and establish study objectives.
- **CO3:** Formulate hypotheses, design methodology, and develop a work plan for dissertation research.
- **CO4:** Demonstrate experimental/computational skills and collect preliminary data.
- **CO5:** Prepare a dissertation progress report with clarity in writing, data presentation, and oral defense.

Course Description

This course marks the first phase of dissertation work, where students develop research questions, review relevant literature, and design their experimental/computational strategies. They work under faculty supervision to initiate data collection and analysis. Emphasis is on research planning, methodology standardization, and preliminary results. The course culminates in a mid-stage report and presentation for evaluation.

Course Content

Unit I: Introduction and Problem Identification

- Selection of research topic in biotechnology
- Identification of problem statements and formulation of objectives
- Scope, relevance, and expected impact of the dissertation work

Unit II: Literature Review

- Sources of information: journals, patents, databases, reports
- Critical analysis of existing studies
- Identification of research gaps and justification of study

Unit III: Research Design and Methodology

- Framing hypotheses and experimental strategies
- Selection of methods in biotechnology research (molecular biology, bioinformatics, bioprocessing, genomics, etc.)
- Preparation of detailed workflow and timelines (Gantt charts, milestones)
- Risk assessment and contingency plans

Unit IV: Preliminary Research Work

- Standardization of experimental techniques/methodologies
- Data collection and maintenance of research records
- Troubleshooting and optimization
- Ethical and biosafety considerations in research

Unit V: Progress Report and Presentation

- Compilation of dissertation Part I report (structure: Title, Abstract, Introduction, Literature Review, Objectives, Methodology, Preliminary Results, References)
- Preparation of figures, tables, and reference formatting
- Oral presentation and defense of research progress before committee

Suggested Readings

- Garg, B.L., Karadia, R., Agarwal, F., & Agarwal, U.K. *An Introduction to Research Methodology*. RBSA Publishers.
- Trochim, W.M.K. & Donnelly, J.P. *Research Methods: The Essential Knowledge Base*. Cengage Learning.
- Selected guidelines from DBT, DST, ICMR, BIRAC, NIH, and EU Horizon.
- Standard laboratory manuals and relevant peer-reviewed journals.

SEMESTER – IV

BIT509	Regulatory Affairs in Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 75	3	1	0	4
Pre-requisites/Exposure	**B. Sc Biology discipline**				
Co-requisites	**-**				

Course Objectives:

1. To introduce the principles and framework of regulatory systems applicable to biotechnology.
2. To familiarize students with national and international regulatory bodies and guidelines.
3. To explore the procedures for regulatory approval of drugs, biologics, and genetically modified organisms (GMOs).
4. To discuss intellectual property rights (IPR), biosafety, and bioethics.
5. To develop practical knowledge of documentation, compliance, and audits in biotech industries.

Course outcome:

1. Understand and interpret national and international regulatory frameworks governing biotechnology products, including drugs, biologics, diagnostics, and GMOs.
2. Demonstrate the ability to navigate and prepare regulatory documentation *such as* IND, NDA, and biosafety applications, in compliance with Indian (CDSCO, DBT, GEAC) and global (FDA, EMA, ICH) guidelines.
3. Critically evaluate ethical, legal, and biosafety issues related to clinical trials, biopharmaceuticals, gene therapies, and GM technologies.
4. Apply knowledge of intellectual property rights (IPR), patent filing procedures, and global agreements (e.g., TRIPS, WTO) in the context of biotechnology innovations.
5. Analyze real-world regulatory case studies and failures to assess compliance gaps and formulate appropriate strategies for regulatory approval and risk mitigation.

Course content:

Unit I: Introduction to Regulatory Affairs

- Role and scope of regulatory affairs in biotechnology
- Overview of the regulatory process
- Regulatory documentation and submission process (e.g., IND, NDA, ANDA, BLA)
- Regulatory strategy development

Unit II: National Regulatory Frameworks

- Indian regulatory bodies: CDSCO, DBT, DCGI, GEAC, ICMR, FSSAI
- Regulatory guidelines: Drugs and Cosmetics Act, Environmental Protection Act, Biodiversity Act
- Approval process for biotech products in India
- Biosafety levels and risk assessment guidelines

Unit III: International Regulatory Systems

- US FDA regulations and guidance documents
- EMA (European Medicines Agency) regulations
- WHO, OECD, ICH, and WTO guidelines
- International frameworks for GMOs and biosimilars
- Harmonization of regulatory standards

Unit IV: Regulatory Aspects of Biotech Products

- Biopharmaceuticals, vaccines, gene therapy products
- Diagnostics, medical devices, and tissue engineering
- Clinical trial regulations and Good Clinical Practices (GCP)
- Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP)
- Regulatory compliance for stem cells and regenerative medicine

Unit V: Intellectual Property, Biosafety & Bioethics

- Patent laws in biotechnology
- WTO-TRIPS and their relevance to biotech innovations
- Ethical, legal, and social issues (ELSI)
- Biosafety and risk management of GMOs and CRISPR-based products
- Case studies on regulatory failures and recalls

Tentative list of practical:

1. Preparation and Review of a Regulatory Dossier (IND/NDA Format) for biopharmaceutical product.
2. Clinical Trial Failure Case study.
3. Regulatory Filing Simulation for a Genetically Modified Crop in India.
4. Biosimilar Approval Process Case Study.
5. Patent Search and Analysis Using India Patent Database: Case study.

Suggested Books:

1. Regulatory Affairs for Biomaterials and Medical Devices – Stephen F. Amato, Robert M. Ezzell

2. Fundamentals of US Regulatory Affairs – Regulatory Affairs Professionals Society (RAPS)

3. Biotechnology and Safety Assessment – John A. Thomas, Roy L. Fuchs

4. Guidelines by CDSCO, WHO, FDA, EMA, and ICH (web resources and official portals)

BIT555	Agricultural Biotechnology	L	T	P	C
		3	1	0	4
Version 1.0	Contact Hours - 75				
Pre-requisites/Exposure	BSc in Biological Science				

Course Objectives:

1. To introduce students to the fundamental principles of agricultural biotechnology.
2. To understand the application of biotechnology tools in improving crop productivity, sustainability, and climate resilience.
3. To prepare students for academic, research, and industry roles in agri-biotech sectors.
4. **This course is aligned with SDG 2: Zero Hunger and SDG 13: Climate Action**

Course Outcomes:

On completion of this course, the students will be able to

CO1: Understand the fundamental principles, historical evolution, and global relevance of agricultural biotechnology, with emphasis on its role in food security and sustainable agricultural development.

CO2: Demonstrate knowledge of traditional and molecular plant breeding approaches, including hybridization, selection methods, and the integration of marker-assisted selection (MAS) in crop improvement.

CO3: Analyze and apply biotechnological strategies for developing climate-resilient crops, enhancing resource-use efficiency, and promoting sustainable agriculture.

CO4: Acquire practical understanding of biofertilizers and biopesticides, including their production, formulation, and role in integrated nutrient and pest management.

CO5: Evaluate recent agri-tech innovations such as precision agriculture, synthetic biology, and vertical farming, along with awareness of associated policy, IPR, and ethical considerations in modern agriculture.

Catalogue Description

Agriculture Biotechnology is a challenging lecture course that covers a range of basic to applied topics. The course takes a broader approach and covers many aspects of conventional as well cutting-edge topics. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies using digital platforms, such as analysis of video scenes and debates. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, videos, DVDs, and newspapers etc.

Course Content: Agricultural Biotechnology

Unit I: Introduction to Agricultural Biotechnology

Definition, scope, and importance**,** Historical developments and milestones**,** Conventional vs. modern agricultural practices**,** Global and Indian status of agricultural biotechnology**,** Role in food security and sustainable agriculture

Unit II: Introduction to Plant Breeding and Marker-Assisted Selection-

Role of plant breeding in food security and agri-business, Hybridization: types and purpose (inter-varietal, inter-specific, inter-generic), Selection methods: mass selection, pure line selection, Importance of maintaining genetic purity and seed certification; Marker-assisted breeding (MAB), Integration of MAS with traditional breeding.

Unit III: Climate-Smart and Sustainable Agriculture-

Developing abiotic stress-tolerant crops: drought, salinity, heat, flood**,** Role of biotechnology in carbon sequestration and soil health**,** Biotechnology for enhancing water-use and nutrient-use efficiency.

Unit IV: Biofertilizers and Biopesticides-

Nitrogen-fixing bacteria (Rhizobium, Azospirillum), phosphate-solubilizing microbes**,** Mycorrhizal associations and plant growth-promoting rhizobacteria (PGPR)**,** Microbial biopesticides: Bacillus thuringiensis, Trichoderma spp., neem extracts**,** Formulation, quality control, and commercialization**,** Role in integrated pest and nutrient management

Unit V: Agri tech Innovations and Future Directions

Precision agriculture: AI, drones, IoT in crop management**,** Synthetic biology and metabolic engineering in agriculture**,** Vertical farming and hydroponics/soilless cultivation**,** Edible vaccines and plant-made pharmaceuticals**,** Policy, IPR, regulatory frameworks, and ethical considerations

Text Books:

1. Slater, A., Scott, N., & Fowler, M.
Title: *Plant Biotechnology: The Genetic Manipulation of Plants*
Publisher: Oxford University Press
2. Biotechnology in Agriculture by Swaminathan,2009
3. Singh, B.D.
Title: *Plant Breeding: Principles and Methods*
Publisher: Kalyani Publishers
4. . Christou, P. & Klee, H. (Eds.)
Title: *Handbook of Plant Biotechnology* (Vol. I & II)
Publisher: Wiley

BIT556	Drug Design and Drug Development	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	Basic knowledge of Organic Chemistry and Protein Biochemistry and Engineering at UG level				
Co-requisites	Basic knowledge of Bioinformatics at UG level				

Course Objectives:

1. To provide foundational knowledge of drug sources, classification, mechanisms of action, and interaction with biological targets.
2. To explain the principles of pharmacokinetics and pharmacodynamics, including drug absorption, distribution, metabolism, elimination, and toxicity.
3. To introduce the process of drug discovery and development, including structure-activity relationships (SAR/QSAR), clinical trials, and regulatory considerations.

Course outcome:

The students will be able

1. **Understand** the historical evolution, sources, classification of drugs, and the molecular interactions involved in drug action, including identification of major drug targets like enzymes, receptors, and nucleic acids.
2. **Explain** the concepts of pharmacokinetics and pharmacodynamics, including drug administration routes, dosage forms, ADME processes, bioavailability, toxicity, and drug addiction.
3. **Analyze** the mechanisms of action of antibacterial, antiviral, antifungal, and antiparasitic drugs, and understand how they target different cellular components such as the cell wall, membrane, proteins, and nucleic acids.
4. **Describe** the mechanism and therapeutic applications of anticancer, cardiovascular, and gastrointestinal drugs, including their role in treating specific disorders and their chemical modes of action.
5. **Apply** the principles of drug discovery and design including SAR, QSAR, stereochemistry, and solubility; and understand the stages of drug development from preclinical to clinical trials, with emphasis on ethical and regulatory aspects.

Course Description:

This course offers an in-depth study of medicinal chemistry, focusing on the chemical and biological principles underlying drug action and development. It covers the historical background, sources, and classification of drugs, along with key terminologies in medicinal chemistry. Students will explore how drugs interact with biological targets such as enzymes, receptors, and nucleic acids. The course further delves into pharmacokinetics and pharmacodynamics, emphasizing drug absorption, distribution, metabolism, and elimination (ADME), as well as issues related to bioavailability, toxicity, and addiction. Mechanisms of action for various classes of drugs—antibacterial, antiviral, antifungal, antiparasitic, anticancer, cardiovascular, and gastrointestinal—are discussed. Additionally, students will learn the processes involved in modern drug discovery, including structure-activity relationships (SAR/QSAR), stereochemistry, clinical trial phases, regulatory frameworks, and ethical considerations.

Course Content:

UNIT I

Introduction to Drugs Historical background: Sources of Drugs, Classification of drugs- important terminologies used in medicinal Chemistry. Drug Action: role of intermolecular forces
- drug targets: lipids, carbohydrates, proteins (enzymes, receptor) and nucleic acids as drug targets.

UNIT II:

Pharmacokinetics and pharmacodynamics: Routs of drug administration, dosage forms. Fate of drugs in the body- absorption, distribution, metabolism, and elimination of drugs (ADME). Bioavailability of drugs, drug addiction and drug toxicity.

UNIT III:

Drugs and Their Mechanism of Action: Antibacterial agents-mechanism of action-antibacterial agents that act against cell metabolism (sulfonamides), inhibit cell wall synthesis (penicillins, cephalosporins), interact with plasma membrane (valinomycin and gramicidin A), drugs impair protein synthesis (tetracyclines, chloramphenicol) and drugs act on nucleic acids (quinolones and fluoroquinolones, rifamycins). Antiviral agents-general principles-nucleic acid synthesis inhibitors (HIV, HBV), host cell penetration inhibitors, inhibitors of viral protein synthesis. Antifungal agents-azoles, allyamines and phenols. Anti-protozoal drugs (antiamoebic, Giardia, Trichomoniasis, Leishmaniasis, Anthelimintics)

UNIT IV:

Anticancer drugs and their mechanism of action- role of antimetabolites, antisense drugs, alkylating agents and inter-chelating agents in cancer chemotherapy. Cardiovascular drugs: antiarrhythemic and antihypertension drugs. Gastro intestinal drugs; Peptic ulcer, gastroesophagal reflux disorders, laxatives, antidiarrhoeal

UNIT V:

Drug discovery, Design and Development Identification of diseases and corresponding targets, bioassays and leads. Stereochemistry and solubility issues in drug design. Structure activity relationships (SARs): changing size and shape-introduction of new substituents. Quantitative structure activity relationships (QSARs): lipophilicity-electronic and steric effects- Hansch Analysis-Topliss decision tree. Chemical and process development of drugs. Preclinical trials: pharmacology, toxicology, metabolism and stability studies-formulation. Clinical trials: phase I- IV studies ethical issues. Patent protection and regulation.

Suggested books

Keith Wilson & John Walker (Ed.), Principles & Techniques of practical Biochemistry, Cambridge University,Press.

Burtis & Ashwood W.B. (Ed.) Tietz Textbook of Clinical Chemistry, Saunders Company.

BIT557	CANCER BIOLOGY	L	T	P	C
Version 1.0	**Contact Hours-60**	3	1	0	4
Pre-requisites/Exposure	B.Sc. LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

- **To impart to the students a comprehensive understanding** of cancer biology, including cell signaling, apoptosis, cell cycle regulation, genetic mutations, oncogenes, tumor suppressor genes, hallmarks of cancer, and principles of carcinogenesis.
- **To equip students with the skills and ability** to analyze mechanisms of cancer progression, evaluate carcinogenic factors, and assess modern diagnostic and therapeutic strategies used in cancer detection and treatment.

Course Outcomes
On completion of this course, the students will be able to:

CO1: Describe the fundamental concepts of cancer biology, including cell signaling, apoptosis, and the regulation of the cell cycle.

CO2: Explain the molecular mechanisms of oncogene activation and tumor suppressor gene inactivation, with emphasis on mutations and key regulatory proteins such as p53 and pRB.

CO3: Analyze the hallmarks of cancer and relate them to the progression and behavior of malignant tumors.

CO4: Evaluate different carcinogenic agents and mechanisms of carcinogenesis, including chemical, physical, and viral factors.

CO5: Compare and assess various cancer detection and treatment modalities, and discuss recent advancements in therapeutic approaches.

Course Description

This course aims to provide a comprehensive understanding of cancer biology, covering fundamental concepts such as cell signaling, apoptosis, and cell cycle regulation, and how their dysregulation contributes to cancer development. It explores the genetic basis of cancer, including various types of mutations, oncogenes, and tumor suppressor genes like pRB and p53. Students will gain insight into the hallmarks of cancer and mechanisms underlying tumor progression, including angiogenesis, metastasis, and immune evasion. The course also examines the principles of carcinogenesis, emphasizing the roles of physical, chemical, and biological agents. Finally, it introduces modern diagnostic and therapeutic approaches, including chemotherapy, radiation therapy, and recent advances in cancer detection and treatment strategies.

Course Content
Cancer Biology

Unit I: Fundamentals of cancer biology
Cell signaling; Apoptosis; Regulation of Cell cycle; Modulation of cell cycle in cancer; Cancer-basic terminology; Neoplasia; Nomenclature of different forms of cancers.

Unit II: Mutations, Oncogenes, and Tumor suppressor genes
Nonsense, missense and point mutations, Frameshift mutations; Activation of oncogenes and dominant negative effect; Oncogenes as transcriptional activators; Viral oncogenes; Suppression of tumor suppressor genes; Tumor suppressor genes from humans: Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins.

Unit III: Hallmarks of cancer
Self-sufficiency in growth signals; Evasion of growth-inhibitory signals; Limitless replicative potential; Reprogramming of energy metabolism; Evasion of apoptosis; Angiogenesis; Invasion and metastasis; Tumor immunity.

Unit IV: Principles of carcinogenesis
Physical, chemical and biological mutagens/ carcinogens; Chemical Carcinogenesis, Targets of Chemical Carcinogens, Principles of Physical Carcinogenesis, X-Ray radiation – Mechanism of radiation carcinogenesis; Mechanisms of viral carcinogenesis.

Unit V: Cancer diagnosis and treatment modalities
Different forms of therapy, Chemotherapy, Radiation Therapy, Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection, Role of AI in cancer diagnosis , cancer drug discovery, and patient monitoring and care (SDG 3: good health and well-being).

Textbooks:

- The Biology of Cancer by Robert A. Weinberg, 3rd Edn., 2023.
- Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics by Lauren Pecorino, 5th Edn., 2021.

Reference books:

- Introduction to the Cellular and Molecular Biology of Cancer by Margaret A. Knowles, 2005.
- Molecular Biology of the Cell by Bruce Alberts, 7th Edn., 2024.

BIT510	Innovations and Entrepreneurship in Biotechnology	L	T	P	C
Version 1.0	**Contact Hours – 30**	2	0	0	2
Pre-requisites/Exposure	Basic knowledge of biotechnology and related applications. Awareness of research methodologies and industry practices.				
Co-requisites	Basic knowledge at UG level				

Course Objectives

- To familiarize students with innovation processes and their role in biotechnology.
- To understand the principles of entrepreneurship and start-up development in the biotech sector.
- To train students in intellectual property management, regulatory frameworks, and technology commercialization.
- To encourage entrepreneurial thinking by developing business models and innovation strategies.

Course Outcomes (COs)

On completion of this course, the students will be able to:

- **CO1:** Understand the role of innovation and entrepreneurship in biotechnology-based industries.
- **CO2:** Analyze the process of translating biotech research into marketable products.
- **CO3:** Demonstrate knowledge of intellectual property rights, regulatory compliance, and biosafety in biotech enterprises.
- **CO4:** Develop basic business plans, including financial, marketing, and operational strategies for biotech start-ups.
- **CO5:** Evaluate case studies of successful biotechnology innovations and entrepreneurial ventures.

Course Description

This course introduces the fundamental concepts of innovation and entrepreneurship in the context of biotechnology. It covers the processes of ideation, innovation management, intellectual property rights, regulatory considerations, and business plan development. The students will explore how biotechnology research leads to products, services, and enterprises with economic and societal impact. Case studies and interactive sessions will highlight the challenges and opportunities in the biotech start-up ecosystem.

Course Content

Unit I: Introduction to Biotechnology Innovation

- Innovation in life sciences and biotechnology
- Role of innovation in academia, industry, and healthcare
- Types of biotech innovations: product, process, and service innovations

- Case studies of global biotech innovations

Unit II: Entrepreneurship Basics

- Concept of entrepreneurship and entrepreneurial mindset
- Types of entrepreneurs and entrepreneurship models
- Idea generation, validation, and opportunity analysis in biotechnology
- Role of incubators, accelerators, and innovation hubs

Unit III: Intellectual Property Rights and Regulations

- Patents, copyrights, trademarks, and trade secrets in biotechnology
- Technology transfer and licensing
- Regulatory frameworks: biosafety, bioethics, FDA, EMA, DBT, CDSCO guidelines
- Challenges in biotech IP management

Unit IV: Business Plan Development

- Components of a business plan: executive summary, product description, market analysis, financial projections
- Market research and competitive analysis in biotech
- Funding sources: venture capital, angel investors, government schemes (BIRAC, DBT, DST, Start-up India)
- Risk assessment and mitigation strategies

Unit V: Commercialization and Case Studies

- Pathways from lab to market: translational research and commercialization
- Start-up ecosystem in biotechnology – Indian and global perspectives
- Case studies of biotech start-ups (pharma, agriculture, diagnostics, bioinformatics)
- Future trends in biotech innovation and entrepreneurship

Suggested Readings

- Hisrich, R.D., Peters, M.P., & Shepherd, D.A. *Entrepreneurship*. McGraw Hill.
- Kuckertz, A., Hinderer, S. *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Elsevier.
- BIRAC (Biotechnology Industry Research Assistance Council) guidelines and reports.
- Selected readings from DBT, DST, Start-up India, and global biotech innovation policies.

BIT592	Dissertation Part II**	L	T	P	C
Version 1.0	Contact Hours – 60	0	0	12	12
Pre-requisites/Exposure	Adequate training in research methodology and experimental skills.				
Co-requisites	Familiarity with advanced techniques and data analysis tools in biotechnology.				

Course Objectives

- To enable students to independently execute their planned research work.
- To train students in systematic data collection, statistical analysis, and interpretation.
- To prepare students for scientific writing and thesis/report preparation.
- To enhance oral presentation and defense skills in front of an evaluation committee.
- To inculcate research ethics, integrity, and scientific communication.

Course Outcomes (COs)

On completion of this course, the students will be able to:

- **CO1:** Execute dissertation research with appropriate experimental and computational approaches.
- **CO2:** Collect, analyze, and interpret experimental data using appropriate statistical and bioinformatics tools.
- **CO3:** Compile results into a structured dissertation report following academic guidelines.
- **CO4:** Demonstrate scientific writing skills for publications, reports, or patents.
- **CO5:** Defend their research outcomes through oral presentation and viva-voce before an expert committee.

Course Description

This course is the second and final phase of the dissertation work. Students will complete their research work, perform data analysis, and prepare the final dissertation report. Emphasis is on quality of results, originality of contribution, and clarity in presentation. The course culminates with submission of a bound thesis and oral defense (viva-voce) before an evaluation committee.

Course Content

Unit I: Execution of Research Work

- Completion of planned experiments/field studies/computational modeling
- Standardization and troubleshooting of techniques
- Maintenance of detailed research records and lab notebooks

Unit II: Data Collection and Analysis

- Systematic recording and organization of results
- Application of statistical and bioinformatics tools for data analysis

- Interpretation of results in light of existing literature

Unit III: Research Ethics and Publication

- Research integrity, plagiarism, and authorship issues
- Drafting manuscripts for peer-reviewed journals
- Filing of patents and intellectual property management
- Ethical compliance and biosafety documentation

Unit IV: Dissertation Report Writing

- Dissertation structure: Title, Abstract, Introduction, Literature Review, Materials & Methods, Results, Discussion, Conclusion, References, Appendices
- Preparation of figures, tables, charts, and supplementary data
- Formatting and referencing guidelines (APA/Harvard/Journal style)

Unit V: Presentation and Defense

- Preparation of PowerPoint presentations and posters
- Communicating research findings effectively to expert and non-expert audiences
- Viva-voce examination and defense before committee
- Feedback incorporation and final submission

Suggested Readings

- Garg, B.L., Karadia, R., Agarwal, F., & Agarwal, U.K. *An Introduction to Research Methodology*. RBSA Publishers.
- Day, R.A., & Gastel, B. *How to Write and Publish a Scientific Paper*. Cambridge University Press.
- Selected peer-reviewed journal articles relevant to dissertation topic.
- Guidelines from UGC/DBT/DST on dissertation and thesis preparation.

PG Curricular Structure with only Research

SEMESTER III

BIT505	Advanced Plant and Animal Biotechnology	L	T	P	C
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	B SC in Biological Science				

Course Objectives:

6. **Understand** advanced concepts, principles, and techniques used in modern plant and animal biotechnology.
7. **Explore** the applications of genetic engineering, transgenics, and molecular tools for crop and animal products and healthcare improvement.
8. **Analyze** the role of tissue culture, stem cells, cloning, and genome editing in research and industry.
9. **Evaluate** ethical, regulatory, and biosafety concerns associated with plant and animal biotechnology.
10. **Develop** research aptitude for solving agricultural, environmental, and healthcare challenges using biotechnological approaches.

This course is aligned with SDG 2: Zero Hunger and SDG 3: Good Health and Well-Being.

Course Outcomes:

On completion of this course, the students will be able to

Recall and explain fundamental and advanced concepts of plant and animal biotechnology, including genetic engineering, tissue culture, transgenics, and genome editing.

Demonstrate and implement molecular, cellular, and bioprocessing techniques to solve practical problems in agriculture, environment, and health sciences.

Compare and differentiate experimental strategies, datasets, and case studies of genetically modified organisms, therapeutic models, and biotechnological interventions.

Critically assess and justify the scientific, ethical, regulatory, and biosafety dimensions of plant and animal biotechnology applications in real-world contexts.

Design and propose innovative research models, biotechnological products, or experimental protocols to address global challenges in food security, sustainability, and human health.

Catalogue Description

Advanced Plant and Animal Biotechnology is a challenging lecture course that covers a range of basic to applied topics. The course takes a broader approach and covers many aspects of conventional as well cutting-edge topics. Furthermore, the ethical issues regulatory concerns in plant and animal biotechnology would also be illuminated. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies using digital platforms. Students will be encouraged to actively take part in all group activities and to give an oral group presentation.

Course Content: Advanced Plant and Animal Biotechnology

Unit I: Plant and Animal tissue culture

Scope and Importance of plant tissue culture- Media composition and types, hormones and growth regulators, explants for organogenesis, somaclonal variation and cell line selection, production of haploid plants and homozygous cell lines. Micro propagation, somatic embryogenesis, protoplast culture and somatic hybridization. Selection and maintenance of cell lines, cryopreservation, germplasm collection and conservation, plant tissue culture certification.

Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids; mechanism and manipulation of shikimate pathway.

Animal tissue culture, aseptic techniques media, cell cryopreservation

Unit II: GM Technology and Metabolic engineering of plants and animals

Mechanism of DNA transfer – *Agro bacterium* mediated gene transfer, Ti and Ri plasmids as vectors; Direct gene transfer methods-particle bombardment, electroporation and microinjection. Crop improvement, productivity, performance of agricultural products–Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Golden rice and transgenic sweet potato. Strategies for engineering stress tolerance. CRISPR/Cas9 and Genome Editing plant and animal biotechnology, Plant Synthetic Biology and Designer Crops. Animal Cloning, AWT

Unit III: Stem cells and Tissue Engineering

Scope, embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences. Stem cells, iPSCs,

Unit IV: Ethics, Biosafety, and Future Perspectives

Ethical, legal, and social implications (ELSI) of plant and animal biotechnology, Biosafety guidelines, regulatory frameworks (national and international), Public perception and communication of GMOs

Unit V: Application of Advanced Plant and Animal Biotechnology:

Molecular Farming: Plants and animals as Bio factories for production of Industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines and antibiotics using transgenic technology. RNAi and antisense RNA technology for extending shelf life of fruits and flowers

(ACC synthase gene and polygalactoronase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelons). Gene therapy, IVF and Stem cell therapy. Tissue engineering, 3D bio printing

Tentative Lists of Practical

In vitro Micropropagation and Hardening of Plantlets
Quantitative Estimation of Plant Metabolites
Demonstration on Agrobacterium-Mediated Gene Transfer in Plants
Culture and maintenance of a cell line.
Staining and screening of cells
Application of AI in plant biotechnology

Text Books:

6. Plant Biotechnology: The Genetic Manipulation of Plants by Adrian Slater,2003
7. Biotechnology in Agriculture by Swaminathan,2009
8. Plant Tissue Culture: Propagation, Conservation and Crop Improvement Editors: **Anis**, Mohammad, **Ahmad**, Naseem (Eds.),2011.
9. Animal Cell Culture: Principles and Practice by Shalini Mani, Manisha Singh, Anil Kumar. Publisher : Springer International Publishing AG; 1st ed. 2023 edition (2 February 2024)
10. Textbook of Animal Biotechnology: By Carlos Wyatt, Publisher: Syrawood Publishing House

Reference Books

5. Plant Biotechnology by William G. Hopkins,2006
6. Plants, Biotechnology and Agriculture (Modular Texts) by Denis Murphy, 2011
7. An Introduction to Genetic Engineering by Desmond S.T. Nicholl,2012
8. Stem Cells: A Short Course by Rob Burgess,2015

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	*Recall and explain* fundamental and advanced concepts of plant and animal biotechnology, including genetic engineering, tissue culture, transgenics, and genome editing.	**PO1, PO2**
CO2	*Demonstrate and implement* molecular, cellular, and bioprocessing techniques to solve practical problems in agriculture, environment, and health sciences.	**PO1, PO2**
CO3	*Compare and differentiate* experimental strategies, datasets, and case studies of genetically modified	**PO1, PO2**

	organisms, therapeutic models, and biotechnological interventions.	
CO4	*Critically assess and justify* the scientific, ethical, regulatory, and biosafety dimensions of plant and animal biotechnology applications in real-world contexts.	**PO1, PO2, PO5, PO6**
CO 5	*Design and propose* innovative research models, biotechnological products, or experimental protocols to address global challenges in food security, sustainability, and human health.	**PO1, PO2, PO3, PO5, PO8**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	3	3	3	3	3	2	2
CO2	3	3	2	3	2	3	2	2	2	2	2	2
CO3	3	3	2	3	3	3	3	3	2	2	2	3
CO4	3	2	2	3	3	3	3	3	3	3	2	3
CO5	3	2	2	2	3	3	3	3	3	3	3	3
Average	3	2.6	2.2	2.8	2.6	3	2.8	2.8	2.6	2.6	2.2	2.6

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT553	Applied Food Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 75	3	1	0	4
Pre-requisites/Exposure	Basic Knowledge of basic Microbiology and Biochemistry at UG level				
Co-requisites	Basic knowledge of Food chemistry and techniques at UG level				

Course Objectives

5. Introduce modern food processing and preservation methods using biotechnology.
6. Examine food safety standards and regulatory bodies.
7. Explore intelligent packaging and emerging trends in food packaging.
8. Develop foundational skills in food toxicology and experimental optimization.

Course Outcomes

On completion of this course, the students will be able to

1 **Identify** and explain various food processing and preservation techniques.

2 **Apply** enzymatic and microbial biotechnology to food production processes.

3 **Analyze** national and global food safety regulations and food labeling norms.

4 **Evaluate** modern food packaging strategies and materials.

5 **Explain** the foodborne hazards and toxicology tests

Course Content

Unit 1: Food Processing and Preservation

Basic principles of food processing and preservation. Techniques: dehydration, chilling, freezing, pasteurization, sterilization, canning, retorting. Introduction to non-thermal methods: high-pressure processing, irradiation, modified atmosphere packaging, and hurdle technology.

Unit 2: Food Biotechnology Applications

Fermentative production of enzymes, solid-state fermentation, and recovery of enzymes from natural sources. Applications in cheese and whey processing, fruit juice clarification, bioethanol production. Role of enzymes in baking, meat processing, and lipid modification and catabolic oxygen-dependent reactions in foods.

Unit 3: Food Packaging Science and Technology

Functions of food packaging. Packaging materials: paper, plastics, metal, glass, composites. Biodegradable and intelligent packaging. Nanotechnology and active packaging. Migration, barrier properties, and environmental impact.

Unit 4: Food Safety and Regulatory Affairs

Food safety regulators and their roles. Food labeling and certification (FSSAI, CODEX, Organic, GM). Food Standardization and regulatory agencies in India: Central and state food departments, State Food Laboratories / Food and Drug Administration, Bureau of Indian Standards, Food Corporation of India, Army Supply Corps and Central Insecticide Board Statutory Provisions for Quality Control: HACCP, ISO 22000, GMP, AGMARK,

Unit 5: Food Toxicology

Foodborne hazards: microbial toxins, chemical residues, natural toxins, allergens. Toxicology tests: LD_{50}, Ames, animal models. Food adulterants, additives, and contaminants (biological, chemical, physical).

Suggested Books:

1. Ray, B and Bhunia, A., "Fundaments of Food Microbiology" ISBN-13: 978-0815384311, 2017.
2. Sivasankar B, "Food Processing and Preservation", ISBN- 97881203-2086-4, 2009.
3. William C Frazier and Dennis C. Westoff, "Food Microbiology", ISBN-9780070667181, 2008.
4. Pometto, A., Shetty, K., Paliyath, G., & Levin, R. E. *Food Biotechnology* eBook ISBN: 9780429115394
5. Ravishankar Rai, V. *Advances in Food Biotechnology*. Wiley-Blackwell, ISBN: 9781118864555

BIT554	Industrial Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 75	3	1	**0**	**4**
Pre-requisites/Exposure	**B.Sc Biology discipline**				
Co-requisites	**-**				

Course Objectives:

6. To understand the role of microorganisms and bioprocesses in industrial production.
7. To explore various biotechnological products and processes used in industries.
8. To familiarize students with upstream and downstream process techniques.
9. To introduce students to industrially important enzymes, biofuels, and recombinant products.
10. To enable students to critically evaluate current trends, biosafety regulations, industrial applications of biotechnology.

Course outcome:

6. Explain the fundamental concepts of industrial biotechnology and describe the role of microorganisms in large-scale production systems.
7. Analyze and compare microbial processes involved in the production of organic acids, antibiotics, enzymes, and biofuels.
8. Demonstrate knowledge of bioreactor types, their operational parameters, and scale-up challenges in industrial settings.
9. Apply theoretical knowledge to assess enzyme technologies, biomolecule production, and applications in various industries.
10. Critically evaluate emerging biotechnological trends, industrial case studies, and regulatory frameworks governing industrial biotechnology.

Course content
Unit I: Introduction to Industrial Biotechnology

Scope and importance of industrial biotechnology, Historical development and current trends, Selection and screening of industrial microorganisms, Types of fermentations: batch, fed-batch, continuous, Concepts of upstream and downstream processing

Unit II: Industrial Microorganisms and Products

Strain improvement: mutagenesis, protoplast fusion, metabolic engineering, Production of Oxy Chemicals I: Tax and non-tax alcohol, Brewing industry, Microbial production of: Organic acids (e.g., citric acid, lactic acid), Amino acids (glutamic acid, lysine), Antibiotics (penicillin, streptomycin), Vitamins (B12, riboflavin), High fructose corn syrup, Cheese making, and Single cell production.

Unit III: Enzyme and Biomolecule Production

Industrial enzyme production and applications: Amylases, proteases, cellulases, lipases; Applications in textile, detergent, food, and pharmaceutical industries, Enzyme immobilization and stability, Biopolymers: PHB, PLA – production and applications, Bioplastics and biodegradable alternatives

Unit IV: Bioreactors and Process Engineering

Types of bioreactors: stirred tank, airlift, packed bed, fluidized bed, Bioreactor parameters and scale-up considerations, Monitoring and control of bioprocess parameters (pH, DO, temperature); Introduction to computer-aided bioprocess design and AI and ML application in industrial biotechnology.

Unit V: Industrial Applications and Emerging Trends

Biofuels: ethanol, biogas, biodiesel – microbial processes, Bioremediation and environmental applications, Recombinant product production (e.g., insulin, vaccines), Introduction to synthetic biology and cell factories, Regulatory and biosafety aspects in industrial biotechnology

Suggested Books

1. Industrial Microbiology by Samuel Cate Prescott and Cecil Gordon Dunn, Palgrave Macmillan; 4th edition
2. Biochemical Engineering Fundamentals by Bailey and Ollis, McGraw Hill Education; 2nd edition
3. Bioprocess Engineering Principles by Doran, Academic Press Inc (3 April 1995); CBS PUBLISHERS AND DISTRIBUTORS PVT. LTD.
4. Bioprocess Engineering Basic Concepts by Shular and Kargi, PEARSON EDUCATION; 2nd edition
5. Biochemical Engineering by Blanch and Clark, CRC Press; 2nd edition

BIT507	Project Proposal writing in Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 30	2	0	0	2
Pre-requisites/Exposure	Basic research training at UG level				
Co-requisites	Basic English writing				

Course Objectives

3. To develop knowledge and skills required for conceptualizing, structuring, and writing effective project proposals in biotechnology.
4. To provide hands-on experience in preparing funding-ready research and innovation proposals with clarity, feasibility, and impact.

Course Outcomes

On completion of this course, the students will be able to

CO1: Understand the essentials of research proposals, funding mechanisms, and components specific to biotechnology.

CO2: Formulate research problems, objectives, hypotheses, and review of literature relevant to biotechnology.

CO3: Design suitable research methodologies, work plans, and timelines for biotechnological projects.

CO4: Prepare budget estimates, resource requirements, and understand ethical/regulatory issues in biotech proposals.

CO5: Write, present, and defend complete project proposals with clarity and alignment to funding requirements.

Course Description

This course provides systematic training in the art and science of **project proposal writing with a focus on biotechnology**. It covers idea conceptualization, literature review, framing objectives, research design, budgeting, and ethical aspects. Students will engage in hands-on activities to prepare draft proposals suitable for academic, industrial, or funding agency submission. By the end, students will have a comprehensive understanding of how to develop high-quality proposals that address scientific, societal, and industrial needs.

Course Content

Unit I: Introduction to Project Proposal Writing

- Nature and scope of research projects in biotechnology
- Importance of project proposals in academia, industry, and funding agencies
- Types of proposals: academic research, industry collaboration, translational, and start-up innovation
- Structure of a typical project proposal (Title, Abstract, Objectives, Methodology, Outcomes, Budget)
- Overview of national and international funding agencies (DBT, DST, ICMR, BIRAC, NIH, EU Horizon)

Unit II: Problem Identification and Literature Review

- Identifying and defining research problems in biotechnology
- Sources of information: journals, patents, databases, reports
- Framing research questions, hypotheses, and objectives
- Writing a critical literature review (biological context, research gaps, justifications)
- Case examples of successful biotechnology projects

Unit III: Research Design and Methodology

- Choosing appropriate experimental designs for biotechnology research

- Methods in genomics, proteomics, molecular biology, fermentation, bioprocessing, etc.
- Designing workflow diagrams, Gantt charts, and milestones
- Risk assessment and contingency planning
- Pilot studies and preliminary data inclusion in proposals

Unit IV: Budgeting, Resources, and Ethical Considerations

- Preparing budget estimates (capital costs, consumables, manpower, equipment, travel, contingencies)
- Aligning budget with funding guidelines
- Institutional support and resource mobilization
- Ethical aspects: biosafety, bioethics, IPR, and regulatory frameworks in biotechnology research
- Sustainability and societal/industrial impact of biotech projects

Unit V: Writing, Presentation, and Evaluation of Proposals

- Drafting key sections: Title, Abstract, Objectives, Work plan, Expected outcomes
- Formatting guidelines as per funding agencies
- Common mistakes in project proposal writing and how to avoid them
- Preparing PowerPoint/project pitch for evaluation
- Peer review, faculty/mentor feedback, and final submission of proposals

Suggested Books:

4. Garg, B.L., Karadia, R., Agarwal, F., & Agarwal, U.K. An Introduction to Research Methodology. RBSA Publishers.
5. Trochim, W.M.K. & Donnelly, J.P. Research Methods: The Essential Knowledge Base. Cengage Learning.
6. Selected guidelines from DBT, DST, ICMR, BIRAC, NIH, and EU Horizon websites.

CLL503	Advanced Soft Skills and Aptitude III	L	T	P	C
Version 1.0	Contact Hours - 15	1	0	0	1
Pre-requisites/Exposure					
Co-requisites	-				

Programme Educational Objectives (PEO)

The Three-Semester Soft Skills Programme aims to equip postgraduate students with the interpersonal, communication and professional competencies necessary for career success in academia and industry. The Programme Educational Objectives (PEO) are designed to ensure career and personal growth through structured skill development.

PEO1 – Impart skills required for employability and ensure career readiness
PEO2 – Instill professionalism and a sense of ethical work culture
PEO3 – Ensure proficiency in professional communication
PEO4 – Develop leadership skills and ability for effective teamwork
PEO5 – Encourage self-reflection, continuous learning and personal growth

Course Description

The third and final semester of the Soft Skills Programme focuses on advanced communication and professional development strategies. This semester is designed to fine-tune students' capabilities in interviews, group discussions, public speaking, professional correspondence and self-reflection. Through rigorous practice sessions, constructive feedback and structured learning approaches, students will develop a deep understanding of the nuances of persuasive communication, self-assessment techniques and effective career-building strategies.

Course Content

Module 1: Interview Skills
[4 hours]

- Types of Interviews:
  Behavioural Interview (STAR method of answering - Situation, Task, Answer, Result),
  Situational Interview, Panel Interview, Group Interview, Technical Interview,
  HR Interview, Case Interview, Stress Interview, Virtual Interview
- General Interview Questions:
  Discussion of questions asked in actual job interviews of senior university students
  Formulating responses to the questions
  Reviewing and refining answers
- Mock Interview Practice:
  Video-recording of the Interviews
  Structured feedback from Instructors using standardised rubrics

Module 2: Group Discussions [2 hours]

- Hands-on Sessions (Mock Group Discussions)

Topics: Current Affairs / Business and Economics / Social Issues / Technology / Environmental Issues / Ethical Dilemmas / Abstract Concepts / Domain related
Video-recording of the GDs with Peer and Instructor Evaluation using Rubrics

Module 3: Public Speaking [3 hours]

- Overcoming glossophobia and other psychological barriers
- Techniques for confidence building
- Content organization and story-telling techniques:
  Structuring a compelling speech (introduction, body, conclusion)
  Using rhetorical devices for persuasion and engagement
  Incorporating story-telling and humour effectively
- Persuasive Communication: Ethos, Pathos, Logos
- Analysis of a TED Talk for structure and appeal
- Individual student speeches (both prepared and extempore / impromptu) with constructive critique by faculty

Module 4: Handling official correspondence [3 hours]

- Importance of professional tone, clarity and structure in official correspondence:
  Tone – direct vs. polite, positive framing
  Keeping emails concise and clear
  Key elements of an e-mail: subject line, salutation, body, closing and signature
- Email Etiquettes:
  Response time and digital courtesy
- Common Errors in email writing:
  Vague / Uninformative Subject Lines
  Forgotten Attachments
  Inappropriate “Reply All”
  (using "Reply All" when you only need to address a single person)
  Failing to review e-mails before sending them
  Sending emails to wrong recipients
  Use of ‘bcc’ without pre-thought
  Confusing homophones, grammatical errors, missed punctuation, redundancy
- Email Formatting - Good Practices:
  Allocating ample amount of white space so that recipients don’t have to squint their eyes
  If there are a list of things to do, presenting it in a list format
  No long paragraphs
  Legible font size and colour
  Using bold text for key points
- Hands-on practice with email writing exercises

Module 5: Self-Reflection and Self-Assessment [3 hours]

- Techniques for effective Self-Reflection:

Journaling, thought exercises and guided introspection
Johari Window – building self-awareness and trust

- Understanding self-assessment and its role in career success
- Conducting a personal SWOT Analysis
  (Strengths, Weaknesses, Opportunities, Threats)
- Developing a Self-Improvement Roadmap:
  Setting SMART goals (Specific, Measurable, Achievable, Relevant, Time-bound goals)
  Strategies for continuous growth and adaptability
  Building accountability for self-progress
  Managing Failures and learning from setbacks

Course Outcomes:

On completion of this course, the students will be able to

CO1 - Differentiate between various interview formats, structure responses effectively and refine
answers based on industry expectations.
CO2 - Participate in domain-specific and general topic group discussions, presenting arguments with
distinctness and self-assurance.
CO3 - Overcome fear of public speaking, build confidence and craft compelling speeches using
rhetorical and storytelling techniques.
CO4 - Draft professional emails with precision, clarity, and etiquette, avoiding common pitfalls and
formatting errors
CO5 - Utilize self-reflection methodologies and self-assessment frameworks to map personal growth
and career readiness.

Programme Outcomes (PO):

Upon successful completion of this three-semester programme, students will develop the following competencies:

PO1 - Professional Documentation and Career Readiness
PO2 - Excellence in Interviews and Group Discussions
PO3 - Resilience, adaptability and goal-setting strategies for continuous career growth
PO4 - Teamwork, problem-solving and decision-making skills essential for collaborative work environments
PO5 - Proficiency in verbal, non-verbal and written communication across academic and professional settings
PO6 - Mastery of Non-Verbal Communication and Professional Etiquette

Programme Specific Outcomes (PSO):

PSO1 - Craft ATS-friendly, professionally tailored résumés and cover letters for diverse industry roles
PSO2 - Demonstrate expertise in multiple interview formats

PSO3 - Articulate well-reasoned perspectives in group discussions, handling challenges with diplomacy
and strategic thinking
PSO4 - Conduct personal SWOT analysis and goal-setting through self-reflection strategies
PSO5 - Utilize body language effectively to enhance professional presence and leadership communication
PSO6 - Adhere to business etiquette norms, ensuring professionalism in written and interpersonal
Interactions

Correlation Matrix between CO and PO and CO and PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	2	2	3	3		3		2	3	3
CO2		3	2	2	3	3			3	2	3	3
CO3			2	1	3	3		2	2	2	3	3
CO4	2		1		3	2				1		3
CO5	3	2	3	2	1	1	1	2		3	2	2

Degree of Correlation: 1 – low, 2 – medium, 3 – high

BIT593	Research Project I*	L	T	P	C
Version 1.0	-	0	0	12	12
Pre-requisites/Exposure	Graduate level degree in biology or relevant area				
Co-requisites	--				

Course Objectives

- To initiate students into independent research under faculty supervision.
- To develop skills in literature survey, hypothesis formulation, and research methodology.
- To provide hands-on exposure to laboratory/field/ computational work relevant to biotechnology.
- To train students in scientific writing, data organization, and progress reporting.

Course Outcomes (COs)

On completion of this course, the students will be able to:

- **CO1:** Identify and define a specific research problem in biotechnology.
- **CO2:** Conduct a comprehensive literature survey to recognize research gaps and establish study objectives.
- **CO3:** Formulate hypotheses, design methodology, and develop a work plan for dissertation research.
- **CO4:** Demonstrate experimental/computational skills and collect preliminary data.
- **CO5:** Prepare a dissertation progress report with clarity in writing, data presentation, and oral defense.

Course Description

This course marks the first phase of dissertation work, where students develop research questions, review relevant literature, and design their experimental/computational strategies. They work under faculty supervision to initiate data collection and analysis. Emphasis is on research planning, methodology standardization, and preliminary results. The course culminates in a mid-stage report and presentation for evaluation.

Course Content

Unit I: Introduction and Problem Identification

- Selection of research topic in biotechnology
- Identification of problem statements and formulation of objectives
- Scope, relevance, and expected impact of the dissertation work

Unit II: Literature Review

- Sources of information: journals, patents, databases, reports
- Critical analysis of existing studies

- Identification of research gaps and justification of study

Unit III: Research Design and Methodology

- Framing hypotheses and experimental strategies
- Selection of methods in biotechnology research (molecular biology, bioinformatics, bioprocessing, genomics, etc.)
- Preparation of detailed workflow and timelines (Gantt charts, milestones)
- Risk assessment and contingency plans

Unit IV: Preliminary Research Work

- Standardization of experimental techniques/methodologies
- Data collection and maintenance of research records
- Troubleshooting and optimization
- Ethical and biosafety considerations in research

Unit V: Progress Report and Presentation

- Compilation of dissertation Part I report (structure: Title, Abstract, Introduction, Literature Review, Objectives, Methodology, Preliminary Results, References)
- Preparation of figures, tables, and reference formatting
- Oral presentation and defense of research progress before committee

Suggested Readings

- Garg, B.L., Karadia, R., Agarwal, F., & Agarwal, U.K. *An Introduction to Research Methodology*. RBSA Publishers.
- Trochim, W.M.K. & Donnelly, J.P. *Research Methods: The Essential Knowledge Base*. Cengage Learning.
- Selected guidelines from DBT, DST, ICMR, BIRAC, NIH, and EU Horizon.
- Standard laboratory manuals and relevant peer-reviewed journals.

SEMESTER – IV

BIT511	Field Project in Biotechnology	L	T	P	C
Version 1.0	Contact Hours – 60	0	0	2	2
Pre-requisites/Exposure	Basic understanding of biotechnology concepts and laboratory techniques. Prior exposure to research methodology or project proposal writing				
Co-requisites	Ability to apply theoretical knowledge in real-world or industrial/field settings.				

Course Objectives

- To provide practical exposure to biotechnology applications in industry, agriculture, healthcare, or environmental sectors.
- To train students in field/lab-based data collection, documentation, and analysis.
- To familiarize students with standard operating procedures (SOPs), regulatory practices, and biosafety in real-life settings.
- To develop teamwork, communication, and professional skills through project-based learning.
- To prepare students for careers in academia, industry, and applied biotechnology sectors.

Course Outcomes (COs)

On completion of this course, the students will be able to:

- **CO1:** Understand the practical applications of biotechnology in industrial/field settings.
- **CO2:** Demonstrate hands-on skills in fieldwork, data collection, and analysis.
- **CO3:** Apply theoretical concepts to solve practical problems in biotechnology.
- **CO4:** Prepare detailed project reports documenting methodologies, observations, and outcomes.
- **CO5:** Present and defend their project findings effectively through oral/poster presentations.

Course Description

This course emphasizes experiential learning by engaging students in biotechnology-related field or industry projects. The projects may include industrial training, agricultural biotechnology fieldwork, clinical/diagnostic studies, or environmental biotechnology applications. Students will document their work, analyze data, and submit a comprehensive field project report, followed by a presentation.

Course Content

Unit I: Introduction to Field/Industrial Projects

- Scope and significance of field projects in biotechnology
- Identifying project areas: agriculture, pharmaceuticals, bioinformatics, healthcare, food industry, environmental biotechnology
- Orientation on SOPs, regulatory, and biosafety compliance

Unit II: Project Planning and Data Collection

- Problem identification and objective setting
- Field visit/industrial training planning and scheduling
- Hands-on exposure to experimental protocols or field-based studies
- Systematic data recording and maintenance of field/lab notes

Unit III: Data Analysis and Interpretation

- Organizing and analyzing collected data
- Statistical and computational tools for data interpretation
- Comparing outcomes with published reports and industrial standards

Unit IV: Report Writing and Documentation

- Components of a field project report: Title, Abstract, Introduction, Objectives, Methodology, Observations, Results, Discussion, Conclusion, References
- Ethical and plagiarism checks in report writing
- Use of figures, tables, and graphical data representation

Unit V: Presentation and Evaluation

- Oral and poster presentation of field project outcomes
- Peer and faculty review of field project reports
- Viva-voce examination and defense of project work

Suggested Readings

- Selected standard operating manuals relevant to chosen project area.
- Research articles and case studies in applied biotechnology.
- DBT, DST, ICMR, and industry guidelines for field and industrial projects.
- Day, R.A., & Gastel, B. *How to Write and Publish a Scientific Paper*. Cambridge University Press.

BIT594	Research Project Part II**	L	T	P	C
Version 1.0	Contact Hours – 60	0	0	20	20
Pre-requisites/Exposure	Adequate training in research methodology and experimental skills.				
Co-requisites	Familiarity with advanced techniques and data analysis tools in biotechnology.				

Course Objectives

- To enable students to independently execute their planned research work.
- To train students in systematic data collection, statistical analysis, and interpretation.
- To prepare students for scientific writing and thesis/report preparation.
- To enhance oral presentation and defense skills in front of an evaluation committee.
- To inculcate research ethics, integrity, and scientific communication.

Course Outcomes (COs)

On completion of this course, the students will be able to:

- **CO1:** Execute dissertation research with appropriate experimental and computational approaches.
- **CO2:** Collect, analyze, and interpret experimental data using appropriate statistical and bioinformatics tools.
- **CO3:** Compile results into a structured dissertation report following academic guidelines.
- **CO4:** Demonstrate scientific writing skills for publications, reports, or patents.
- **CO5:** Defend their research outcomes through oral presentation and viva-voce before an expert committee.

Course Description

This course is the second and final phase of the dissertation work. Students will complete their research work, perform data analysis, and prepare the final dissertation report. Emphasis is on quality of results, originality of contribution, and clarity in presentation. The course culminates with submission of a bound thesis and oral defense (viva-voce) before an evaluation committee.

Course Content

Unit I: Execution of Research Work

- Completion of planned experiments/field studies/computational modeling
- Standardization and troubleshooting of techniques
- Maintenance of detailed research records and lab notebooks

Unit II: Data Collection and Analysis

- Systematic recording and organization of results
- Application of statistical and bioinformatics tools for data analysis
- Interpretation of results in light of existing literature

Unit III: Research Ethics and Publication

- Research integrity, plagiarism, and authorship issues
- Drafting manuscripts for peer-reviewed journals
- Filing of patents and intellectual property management
- Ethical compliance and biosafety documentation

Unit IV: Dissertation Report Writing

- Dissertation structure: Title, Abstract, Introduction, Literature Review, Materials & Methods, Results, Discussion, Conclusion, References, Appendices
- Preparation of figures, tables, charts, and supplementary data
- Formatting and referencing guidelines (APA/Harvard/Journal style)

Unit V: Presentation and Defense

- Preparation of PowerPoint presentations and posters
- Communicating research findings effectively to expert and non-expert audiences
- Viva-voce examination and defense before committee
- Feedback incorporation and final submission

Suggested Readings

- Garg, B.L., Karadia, R., Agarwal, F., & Agarwal, U.K. *An Introduction to Research Methodology*. RBSA Publishers.
- Day, R.A., & Gastel, B. *How to Write and Publish a Scientific Paper*. Cambridge University Press.
- Selected peer-reviewed journal articles relevant to dissertation topic.
- Guidelines from UGC/DBT/DST on dissertation and thesis preparation.