

# **CURRICULUM/ CREDIT FRAMEWORK**

*and*

## **SYLLABI OF COURSES**

for

### **M.Sc. Biological Sciences**

*(02 Year PG Program)*

**Applicable August 2025 Onwards**



**SCHOOL OF BIOLOGICAL SCIENCES**

**DOON UNIVERSITY**

## M.Sc. Biological Sciences Course Duration– 4 Semesters

### Distribution of credits

<b>Core Courses (DSC) [06]</b>	<b>Discipline Specific Elective (DSE) [06]</b>	<b>Generic Elective (GE) [3]</b>	<b>Project Seminar (PS) [4]</b>	<b>Dissertation/ Project (PD) [1]</b>	<b>Total Credits</b>
<b>24</b>	<b>24</b>	<b>12</b>	<b>8</b>	<b>20</b>	<b>88</b>

<b>SEMESTER</b>	<b>Total Credits</b>
<i>Semester – I</i>	22
<i>Semester – II</i>	22
<i>Semester – III</i>	22
<i>Semester – IV</i>	22
<b>Total</b>	<b>88</b>

**Nomenclature:** DSC: Discipline Specific Core; DSE: Discipline Specific Elective; GE: General Elective; PS: Project Seminar; PD: Project/ Dissertation

<b>SEMESTER</b>	<b>COURSE OPTED</b>	<b>COURSE NAME</b>	<b>CREDITS</b>
I (Total credits: 22)	Core course – I	Bioprocess Technology	4
	Core course – II	Cancer Biology	4
	GE/DSE*	Nanobiotechnology	4
		Environmental Biotechnology	4
		Research Methodology and Science Communication	4
Project Seminar – I		2	
II (Total credits: 22)	Core course – III	Bioinformatics	4
	Core course – IV	Genomics & Proteomics	4
	GE/DSE*	Industrial Microbiology	4
		Plant Biotechnology	4
		Intellectual Property Rights	4
Project Seminar – II		2	
III (Total credits: 22)	Core course – V	Animal Biotechnology	4
	Core course – VI	Genetic Engineering	4
	GE/DSE*	Virology	4
		Microbes in sustainable agriculture and development	4
		Entrepreneurship Development	4
Project Seminar – III		2	
IV (Total credits: 22)		Project/ Dissertation	20
	Project Seminar – IV	Seminar	2

## M.Sc. Biological Sciences

<b>First Semester</b>			
<b>Course Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Course Outcome (COC)</b>
Core	BSDSC1	Bioprocess Technology	<ul style="list-style-type: none"> <li>• Upon completing this course, students will possess a thorough understanding of bioprocess technology principles and their applications.</li> <li>• They will be adept at isolating, screening, and improving industrially significant microbes, and analyzing microbial growth kinetics in various bioreactor systems.</li> <li>• Students will be proficient in optimizing fermentation processes, including batch, fed-batch, and continuous modes, and will be able to design and operate diverse bioreactors.</li> <li>• Additionally, students will apply their knowledge of enzyme function and microbial processes to food production, including the development of fermented products, food ingredients, and the bioconversion of process wastes.</li> </ul>
Core	BSDSC2	Cancer Biology	<ul style="list-style-type: none"> <li>• Upon successful completion of this course, students will have a comprehensive understanding of the fundamental and advanced aspects of cancer biology.</li> <li>• They will be able to analyze the epidemiological, environmental, and genetic factors contributing to cancer, with a detailed understanding of the molecular mechanisms involved in carcinogenesis, oncogene regulation, and tumor suppression.</li> <li>• They will also acquire knowledge of current methodologies for cancer detection, such as biochemical assays and tumor markers, and other therapeutic approaches, including chemotherapy, radiation, immunotherapy, molecular-targeted therapy, and gene therapy.</li> <li>• Overall, students will be equipped with the theoretical foundation and analytical skills essential for pursuing research and innovation in cancer biology and therapeutics.</li> </ul>
DSE	BSDSE1	Nanobiotechnology	<ul style="list-style-type: none"> <li>• Understand the concepts in nanotechnology, nanomaterials, and its properties</li> <li>• Understand, apply, and analyze the role of nanomaterials and nanotechnology in healthcare and environment problem mitigations.</li> <li>• Explore the use of nanomaterials in various biotechnological applications such as drug delivery, diagnostics, tissue engineering, and therapeutics.</li> <li>• Examine the fabrication, modification, and application of nanomaterials in biomedical and environmental contexts.</li> <li>• Explore nanobiotechnology's ethical and regulatory challenges.</li> </ul>

DSE	BSDSE2	Environmental Biotechnology	<ul style="list-style-type: none"> <li>• Upon completion of this course, students will have a comprehensive understanding of environmental biotechnology applications, including advanced knowledge in wastewater treatment processes and technologies.</li> <li>• They will be proficient in assessing wastewater characteristics, conducting toxicity testing, and applying anaerobic digestion and composting techniques, including vermicomposting.</li> <li>• Students will be skilled in analyzing the biodegradation of organic pollutants and implementing bioremediation strategies for oil spills, heavy metals, and other contaminants.</li> <li>• The students will understand the role of microbial insecticides and biofertilizers in pest management and soil health, equipping them with List of Experiments skills for addressing environmental challenges through biotechnological solutions.</li> </ul>
GE	BSGE1	Research Methodology and Science Communication	<ul style="list-style-type: none"> <li>• Upon successful completion of this course, students will have the expertise to effectively formulate and plan research projects, including defining research problems, designing experiments, and employing advanced methodologies.</li> <li>• They will demonstrate proficiency in conducting comprehensive literature reviews, analyzing data using statistical methods and producing high-quality technical research articles.</li> <li>• Students will be well-versed in bioethics, understanding regulatory guidelines and ethical considerations relevant to biotechnology.</li> <li>• They will possess in-depth knowledge of biosafety practices, including containment levels, Good Laboratory Practices (GLP), and regulatory frameworks for GMOs, enabling them to manage and assess risks in research and industrial settings.</li> </ul>
<b>Second Semester</b>			
<b>Course Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Course Outcome (COC)</b>
Core	BSDSC3	Bioinformatics	<ul style="list-style-type: none"> <li>• Upon completion of this course, students will have developed a robust skill set in bioinformatics, enabling them to effectively utilize computational tools and databases for biological data analysis.</li> <li>• They will be proficient in navigating and leveraging various biological databases for sequence identification and analysis, including DNA and protein sequences.</li> <li>• They will be capable of conducting multiple sequence alignments and phylogenetic analyses using tools such as FASTA3 and CLUSTALW.</li> <li>• They will be skilled in evaluating protein structure predictions, constructing models, and applying in silico methods for drug design and protein function prediction.</li> </ul>

Core	BSDSC4	Genomics and Proteomics	<ul style="list-style-type: none"> <li>• Upon completing this course, students will have acquired a thorough understanding of both the structural and functional aspects of genomes and proteomes in prokaryotic and eukaryotic organisms.</li> <li>• They will understand genome mapping and sequencing techniques, capable of interpreting and utilizing data from significant genome projects like the Human Genome Project.</li> <li>• Students will be able to apply comparative genomics to classify organisms, understand evolutionary processes, and contribute to the development of new therapeutics.</li> <li>• The students will be well-versed in functional genomics, including gene expression analysis and chromosome characterization,</li> <li>• They will have foundational knowledge in emerging fields such as metabolomics, lipidomics, metagenomics, and systems biology.</li> </ul>
DSE	BSDSE3	Industrial Microbiology	<ul style="list-style-type: none"> <li>• Upon completing this course, students will understand the scope and applications of Industrial Microbiology, including the isolation, identification, and maintenance of industrially important microorganisms.</li> <li>• They will gain knowledge of fermenter design and operation for large-scale microbial cultivation and explore microbial roles in food production, pharmaceuticals, agriculture, and bioremediation.</li> <li>• Students will learn about biofertilizers, biopesticides, and the use of conventional and recombinant microbes for producing ethanol, amino acids, and organic acids.</li> <li>• They will also understand the sustainability of microbial applications in industrial and agricultural sectors.</li> </ul>
DSE	BSDSE4	Plant Biotechnology	<ul style="list-style-type: none"> <li>• Upon completion of this course, students will have acquired a robust understanding of plant tissue culture techniques and their applications in crop improvement, including the production of virus-free plants and somatic hybridization.</li> <li>• They will be proficient in the principles of genetic engineering, capable of developing genetically modified crops for both biotic and abiotic stress tolerance.</li> <li>• They will also gain expertise in manipulating plant secondary metabolites for industrial and therapeutic purposes.</li> <li>• They will also be proficient in applying advanced molecular breeding techniques such as RFLP, RAPD, STS, SCAR, QTL, and map-based cloning for the enhancement of crop traits.</li> </ul>
GE	BSGE2	Intellectual Property Rights	<ul style="list-style-type: none"> <li>• The students once they complete their academic projects, they get awareness of acquiring the patent.</li> <li>• They also learn to have copyrights, trademarks and trade secrets for their innovative works.</li> <li>• They also get the knowledge of plagiarism in their innovations which can be questioned legally.</li> </ul>

			<ul style="list-style-type: none"> <li>• They also learn the difference between traditional knowledge and the modern patent system.</li> </ul>
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<b>Third Semester</b>			
<b>Course Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Course Outcome (COC)</b>
Core	BSDSC5	Animal Biotechnology	<ul style="list-style-type: none"> <li>• Upon completing this course, students will possess a comprehensive understanding of animal biotechnology, including expertise in animal cell culture, reproductive biotechnology, and genomics.</li> <li>• They will be adept at using cell culture techniques, transfection methods, and stem cell applications.</li> <li>• Students will be skilled in genome characterization, gene knock-out technology, and cloning for conservation.</li> <li>• They will understand the mechanisms for producing vaccines, monoclonal antibodies, and pharmaceutical proteins, and proficient in immunological and nucleic acid-based identification methods.</li> </ul>
Core	BSDSC6	Genetic Engineering	<ul style="list-style-type: none"> <li>• Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical knowledge of this technology.</li> <li>• In conjunction with the List of Experiments in molecular biology &amp; genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.</li> <li>• Students know about various protein expression strategies and the use of enzymes in genetic engineering, explain gene cloning, transformation and transfection, and techniques used in genetic engineering.</li> <li>• Apply theoretical knowledge of genetic engineering for the development of new recombinant DNA molecules.</li> </ul>
DSE	BSDSE5	Virology	<ul style="list-style-type: none"> <li>• Understanding of viral structure, classification, replication mechanisms, and how viruses interact with host cells.</li> <li>• They will be able to explain how viruses cause diseases in humans, animals, and plants, and identify the factors influencing viral pathogenesis.</li> <li>• Understanding laboratory techniques for detecting and identifying viral infections, such as PCR, ELISA, or cell culture-based methods.</li> <li>• Understanding of Host-Virus Interactions the molecular and cellular interactions between viruses and their hosts, including immune responses and viral evasion strategies.</li> </ul>
DSE	BSDSE6	Microbes in sustainable agriculture and development	<ul style="list-style-type: none"> <li>• Upon completing this course, students will gain comprehensive knowledge of soil microbiology and its applications in agriculture and environmental sustainability.</li> <li>• They will understand the mechanisms by which microbes promote plant growth, suppress pathogens, and enhance nutrient acquisition.</li> <li>• Students will also be able to assess the impact of</li> </ul>

			<p>agricultural practices on microbial communities and apply biocontrol strategies and biofertilizers for improved crop productivity.</p> <ul style="list-style-type: none"> <li>• Furthermore, they will develop expertise in microbial composting, bioremediation, and sustainable practices to address agricultural and environmental challenges.</li> </ul>
GE	BSGE3	Entrepreneurship Development	<ul style="list-style-type: none"> <li>• Upon successful completion of this course, students will gain a comprehensive understanding of the fundamentals of entrepreneurship, including its types, key traits, and the socio-economic contributions of women entrepreneurs and Self-Help Groups.</li> <li>• They will be able to analyze trends and recognize business opportunities, while applying creative techniques such as brainstorming, focus groups, and customer-driven research to generate viable business ideas.</li> <li>• Students will develop the skills to identify and screen entrepreneurial opportunities through market, technical, and cost-benefit analysis, and assess the overall feasibility of projects.</li> <li>• Additionally, they will be equipped to design effective business plans, incorporating strategies for project formulation and implementation.</li> <li>• The course will also enable students to critically evaluate various sources of finance, including venture capital, angel investors, commercial banks, and government funding schemes, and apply suitable financial strategies to support new business ventures.</li> </ul>

<b>Fourth Semester</b>			
<b>Course Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Course Outcome (COC)</b>
	BSDP	Dissertation/ Project	
	BSPS- IV	Project Seminar	

**SEMESTER –I****Total Credits: 22**

<b>S. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L-T-P</b>	<b>Credits</b>	<b>Marks Distribution* M-F-A-P</b>
<b>1</b>	<b>BSDSC1</b>	<b>Bioprocess Technology</b>	<b>3-0-1</b>	<b>4</b>	<b>30-30-20-20</b>
<b>2</b>	<b>BSDSC2</b>	<b>Cancer Biology</b>	<b>3-1-0</b>	<b>4</b>	<b>30-50-20-00</b>
<b>3</b>	<b>BSDSE1</b>	<b>Nanobiotechnology</b>	<b>3-1-0</b>	<b>4</b>	<b>30-50-20-00</b>
<b>4</b>	<b>BSDSE2</b>	<b>Environmental Biotechnology</b>	<b>3-0-1</b>	<b>4</b>	<b>30-30-20-20</b>
<b>5</b>	<b>BSGE1</b>	<b>Research Methodology and Science Communication</b>	<b>3-1-0</b>	<b>4</b>	<b>30-50-20-00</b>
<b>6</b>	<b>BSPS1</b>	<b>Project Seminar</b>	<b>0-0-2</b>	<b>2</b>	<b>100</b>

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<b>Course Code</b>	<b>:</b>	<b>BSDSC1</b>
<b>Course Title</b>	<b>:</b>	<b>Bioprocess Technology</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3; Practical 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Practical 15</b>
<b>Semester</b>	<b>:</b>	<b>I</b>

### **Course Objectives:**

The objective of this course is to provide students with a comprehensive understanding of bioprocess technology, covering both theoretical principles and practical applications. It aims to familiarize students with fundamental concepts of bioprocess engineering, including microbial screening, strain improvement, and growth kinetics essential for optimizing industrial fermentation. The course explores various fermentation processes, reactor designs, and critical operational parameters such as aeration, agitation, and sterilization techniques. Additionally, students will gain insights into upstream and downstream processing, focusing on media formulation, scale-up strategies, biomass separation, product recovery, and purification methods. By the end of the course, students will have a strong foundation in bioprocess technology, enabling them to apply these principles to industrial and research-based biotechnological applications.

### **Course Outcome:**

- Upon successful completion of this course, students will be able to demonstrate a thorough understanding of bioprocess technology, encompassing key principles of microbial growth kinetics, strain improvement, and bioreactor operations.
  - They will be proficient in differentiating and optimizing various fermentation processes, including batch, fed-batch, and continuous modes, along with their respective reactor designs and process controls.
  - Students will develop practical expertise in upstream processing techniques such as media formulation, inoculum development, and bioprocess parameter monitoring, as well as downstream processing strategies for biomass separation, product extraction, purification, and concentration.
  - Furthermore, they will be equipped with the knowledge to scale up and scale down bioprocesses, ensuring efficiency in industrial applications.
  - This course will empower students with the analytical and technical skills necessary for careers in biotechnology, pharmaceuticals, and biochemical engineering industries.
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## **Course content (Bioprocess Technology):**

### **Unit I: Basic principles of Bioprocess Technology**

**No. of Hours: 10**

Introduction to concepts of bioprocess engineering, Overview of bioprocesses with their various components, Isolation, screening and maintenance of industrially important microbes; Strain improvement for increased yield and other desirable characteristics, Microbial growth and death kinetics with respect to fermenters, optimization of bioprocesses, yield coefficient, doubling time, specific growth rate, metabolic and biomass productivities, effect of temperature, pH and salt concentration on product formation.

### **Unit II: Concepts of basic mode of fermentation processes**

**No. of Hours: 10**

Bioreactor designs; Types of fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Solid substrate, surface and submerged fermentation; Fermentation media; Design and types of culture/production vessels- Batch, Fed batch, CSTBR, airlift, packed bed and bubble column fermenter; Impeller, Baffles, Sparger.

### **Unit III: Upstream processing:**

**No. of Hours: 13**

Media formulation; Inocula development and Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process. Modifying batch and continuous reactors, immobilization cell systems, active and passive immobilization.

### **Unit IV: Downstream processing**

**No. of Hours: 12**

Biomass separation by centrifugation, filtration, flocculation and other recent developments; Cell disintegration: Physical, chemical and enzymatic methods; Extraction (Solvent, two phase, liquid extraction, whole broth and aqueous multiphase extraction); Purification by different methods; Concentration by precipitation, ultra-filtration and reverse osmosis; Drying and crystallization.

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## **List of Experiments:**

1. Study the bacterial growth curve in shake flask and in bioreactor.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Study the production of enzyme.
4. Isolation of industrially important microorganism from natural resource.

## **Text and References:**

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
  2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition, Panima Publishing Co. New Delhi.
  3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
  4. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
  5. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
  6. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
  7. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
  8. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.
  9. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.
  10. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.
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<b>Course Code</b>	<b>:</b>	<b>BSDSC2</b>
<b>Course Title</b>	<b>:</b>	<b>Cancer Biology</b>
<b>Course Credits</b>	<b>:</b>	<b>4 (Theory 3; Tutorial 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Tutorial 15</b>
<b>Semester</b>	<b>:</b>	<b>I</b>

### **Course Objectives:**

The primary objective of this course is to provide students with a comprehensive understanding of cancer biology, encompassing its molecular, genetic, and environmental basis. The course aims to explore the mechanisms underlying carcinogenesis, the role of oncogenes, tumor suppressor genes, and epigenetics in tumor development, and the progression of cancer at the cellular and biochemical levels. Additionally, students will gain insights into cutting-edge approaches for cancer detection, diagnostics, and therapeutic strategies, including chemotherapy, radiation therapy, immunotherapy, molecular therapy, and gene therapy. By the end of the course, learners will be equipped with the foundational knowledge and analytical skills necessary for advancing cancer research and developing innovative treatments.

### **Course Outcome:**

- Upon successful completion of this course, students will have a comprehensive understanding of the fundamental and advanced aspects of cancer biology.
  - They will be able to analyze the epidemiological, environmental, and genetic factors contributing to cancer, with a detailed understanding of the molecular mechanisms involved in carcinogenesis, oncogene regulation, and tumor suppression.
  - Students will gain expertise in the biological processes driving tumor progression, including cell cycle dysregulation, chromosomal instability, angiogenesis, metastasis, and the role of epigenetic modifications.
  - They will also acquire knowledge of current methodologies for cancer detection, such as biochemical assays and tumor markers, and other therapeutic approaches, including chemotherapy, radiation, immunotherapy, molecular-targeted therapy, and gene therapy.
  - Overall, students will be equipped with the theoretical foundation and analytical skills essential for pursuing research and innovation in cancer biology and therapeutics.
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## **Course content (Cancer Biology):**

### **Unit I: Fundamentals of cancer biology**

**No. of Hours: 15**

Epidemiology of cancer: Environmental factors, Viruses, Life style habits, Mutations and DNA repair. Regulation of cell cycle, Modulation of cell cycle in cancer: pRb, p53. Classification of cancer forms and hallmarks of cancers, characteristics of benign and malignant neoplasms, grading and staging of cancer, biology of tumor growth, invasion and metastasis, carcinogens and cancer.

### **Unit II: Principles of carcinogenesis**

**No. of Hours: 10**

Theory of carcinogenesis, Chemical carcinogenesis, Physical carcinogenesis; X-ray radiation: mechanisms of radiation carcinogenesis. Mutations that cause changes in signal molecules. Genetic basis of cancer: DNA repair.

### **Unit III: Oncogene regulations and diseases**

**No. of Hours: 15**

General idea of Oncogenes and Tumor suppressor genes, Molecular mechanisms of tumorigenesis Cell cycle check-point defects, Tumor specific markers, Chromosomal basis of Cancer, Philadelphia chromosome, Retinoblastoma, Burkitt's lymphoma, Oncogene amplification (HSR & DM), Aneuploidy in neoplasia, Epigenetic Mechanisms: Methylation, Acetylation, Histone modification, Epigenetics and Cancer, Epigenetic inheritance and gene expression, Epigenetic regulation in cancer

### **Unit IV: Cancer Genetics**

**No. of Hours: 10**

Mutagenesis & Mutation, Types & origin, Mechanisms, Detection and isolation, DNA damage and repair mechanisms, Chromosomal Instability and DNA damage response, Cancer Biology, Cancer & environment, Biochemical & structural Changes in cancer cells, Tumor progression: angiogenesis & metastasis.

### **Unit V: Cancer Detection and Therapy**

**No. of Hours: 10**

Cancer screening and early detection, Detection using biochemical assays, Tumor markers. Advances in cancer detection. Different forms of therapy- Chemotherapy, Radiation therapy, Immunotherapy, Molecular therapy, Use of signal targets towards therapy of cancer; Gene therapy.

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## **List of Experiments:**

1. Study of permanent slides of various tissue-types (e.g., epithelial, connective, blood, muscle, nervous, etc.); cancer cytogenetics, etc.
2. Electron micrographs & Photomicrographs related to cellular structures, etc.
3. Methods of histology & histochemistry for localization of biomolecules.
4. Experiments related to cell structure and function (Apoptosis, Signaling, cancer, etc.)

## **Text and References:**

1. Molecular Biology of the Cell, 4th Ed., Alberts et al, Garland, 2002
  2. Molecular Cell Biology, 6th Ed., Lodish et al, Freeman & Co. 2008
  3. Cell and Molecular Biology, Karp, Wiley, 2002
  4. Developmental Biology, 8th Ed., Gilbert, Sinauer, 2006
  5. Essential Cell Biology Alberts et al Garland 1998
  6. Cell and Molecular Biology, 8th Ed., De Robertis, Lea &Febiger, 1987.
  7. The Cell, Cooper, ASM Press, 2004.
  8. Stella Pelengaris, Michael Khan, "The Molecular Biology of Cancer", Blackwell Publishing 1st edition, 2006.
  9. Robert A. Weinberg, "The Biology of Cancer", Garland Science, 2nd edition, 2014.
  10. R. W. Ruddon, "Cancer Biology", Oxford, Oxford University Press, 2007.
  11. C. Athena Aktipis, Randolph M Nesse, "Evolutionary foundations for cancer biology", Evol Appl. 2013 January; 6(1): 144–159.
  12. Molecular Biology of the Cell, 4th Ed., Alberts et al, Garland, 2002
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<b>Course Code</b>	<b>:</b>	<b>BSDSE1</b>
<b>Course Title</b>	<b>:</b>	<b>Nanobiotechnology</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3; Tutorial 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Tutorial 15</b>
<b>Semester</b>	<b>:</b>	<b>I</b>

### **Course Objectives:**

This course provides a comprehensive overview of nanobiotechnology, covering the fundamentals, synthesis, characterization, applications, and safety of nanomaterials. It explores various nanostructures, their properties, and synthesis approaches, including top-down and bottom-up methods. Advanced characterization techniques such as microscopy, spectroscopy, and diffraction methods are introduced for material analysis. The course examines applications in medicine, agriculture, and the environment, focusing on drug delivery, theranostics, and nanosensors. Through this course, students will gain essential knowledge of nanobiotechnology and its diverse applications.

### **Course Outcome:**

- Upon successful completion of this course, students will have a comprehensive understanding of nanobiotechnology, including its fundamental concepts, historical development, and the diverse properties and types of nanomaterials.
  - They will gain knowledge of various synthesis techniques, including top-down and bottom-up approaches, and develop an understanding of advanced fabrication methods.
  - Students will acquire proficiency in key characterization techniques such as microscopy, spectroscopy, and diffraction methods, enabling them to analyze and evaluate nanomaterials effectively.
  - Furthermore, they will explore cutting-edge applications of nanotechnology in diagnostics, drug delivery, agriculture, and environmental science while also understanding the principles of nanotoxicity and safety assessments.
  - The students will be well-equipped with the theoretical and practical knowledge to contribute to research and industry applications in nanobiotechnology.
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## **Course content (Nanobiotechnology):**

### **Unit I: Introduction to Nanobiotechnology**

**No. of Hours: 17**

Introduction, Concepts, historical perspective of Nanobiotechnology, Cellular Nanostructures, Nanopores, Bio-inspired Nanostructures, Properties of nanomaterials: Structural, chemical and physical properties. Classification of nanomaterials, 3D, 2D, 1D, and zero-dimensional nanomaterials. Carbon nanotubes, Graphene, Carbon dots, metal nanoparticles, metal Oxide-based nanomaterials, semiconductor nanomaterials, quantum dots, hybrid nanoparticles, Bio-nanomaterials, polymer nanoparticles, lipid nanoparticles etc. Nanofilms, Colloidal nanostructures, Nanovesicles; Nanospheres; Nano capsules.

### **Unit II: Synthesis of Nanomaterials**

**No. of Hours: 13**

Top down and bottom-up approaches for nanomaterial synthesis, Physical methods: equipment for mechanical alloying, ball milling method, Electro-spinning, Sputtering method, Laser ablation method, Thermal decomposition method, arc discharge method; Chemical Approach: Solgel method, Spray pyrolysis, Chemical vapor deposition (CVD) method, Electro spraying and spin coating routes; Templating methods- Hard-template method, Soft-template method, and Colloidal-template method. Biosynthesis of Nanoparticles- Bacterial, algal, fungal and plant based synthesis of nanoparticles

### **Unit III: Characterization techniques**

**No. of Hours: 13**

Characterization of various parameters of nanomaterials such as size, composition, surface morphology, surface charges, crystallinity, etc using different modern technologies- Microscopy-Optical, SEM, TEM, AFM, High Resolution Imaging Techniques, Physicochemical Characterization, Spectroscopy-Raman, Microwave, Atomic and IR, NMR, DLS, Diffraction methods- DLS, XRD.

### **Unit IV: Applications and Nanotoxicity**

**No. of Hours: 17**

Nanoparticles for diagnostics and imaging (theranostic), Nanonutraceuticals and pharmaceuticals, Targeted Drug Delivery, Nanodevices. Nanoscaffolds, Nanobots, Sensors, Nanotechnology in agriculture and environment. Nanotechnology based tools to enhance agricultural productivity, Nano Based Agri and Food Products, Nano pesticides and Nanofertilizers. Nanotoxicity: Introduction to safety of nanomaterials, basics of nanotoxicity, Models and assays for nanotoxicity assessment.

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## Text and References:

1. Nanotechnology: Principles and Practices by Sulabha K. Kulkarni
  2. Akçan R, Aydoğan HC, Yildirim MŞ, Taştekin B, Sağlam N. (2020) Nanotoxicity: a challenge for future medicine.
  3. Balls, M., Combes, R. D., & Bhogal, N. (2012, March 22). *New Technologies for Toxicity Testing*. Springer Science & Business Media.
  4. Cao, G., & Wang, Y. (2011, January 1). *Nanostructures and Nanomaterials*. World Scientific.
  5. Chen, Y., Lai, Z., Zhang, X., Fan, Z., He, Q., Tan, C., & Zhang, H. (2020). Phase engineering of nanomaterials. *Nature Reviews Chemistry*,
  6. Goodsell, D. S. (2004, April 16). *Bio nanotechnology*. John Wiley & Sons.
  7. *Multilayer Thin Films: Sequential Assembly* by Gero Decher, Joseph B. Schlenoff, 2003
  8. Neelina H. Malsch, *Biomedical Nanotechnology*, CRC Press
  9. Niemeyer, C. M., & Mirkin, C. A. (2006, March 6). *Nanobiotechnology*. John Wiley & Sons.
  10. Pedrero, M., Gamella, M. and Serafin, V. (2022) *Nanomachines and Nanorobotics: Improving cancer diagnosis and therapy, The Detection of Biomarkers*,
  11. Rao, C. N. R., Govindaraj, A., & Panchakarla, L. S. (2021, October 27). *Nanotubes and Nanowires*. Royal Society of chemistry.
  12. Sahu, S. C., & Casciano, D. A. (2014, April 22). *Handbook of Nanotoxicology, Nanomedicine and Stem Cell Use in Toxicology*. John Wiley & Sons.
  13. Sutariya, V. B., & Pathak, Y. (2014, July 29). *Bio interactions of Nanomaterials*. CRC Press.
  14. Wavhale, R.D. et al. (2021) Water-powered self-propelled magnetic nanobot for rapid and highly efficient capture of circulating tumor cells, *Communications Chemistry*, 4(1).
  15. Zhang, Y., Li, M., Gao, X., Chen, Y. and Liu, T., 2019. Nanotechnology in cancer diagnosis: progress, challenges and opportunities. *Journal of Hematology & Oncology*, 12(1).
  16. Zhao, Y., Zhang, Z., & Feng, W. (2016, December 12). *Toxicology of Nanomaterials*. John Wiley & S
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<b>Course Code</b>	<b>:</b>	<b>BSDSE2</b>
<b>Course Title</b>	<b>:</b>	<b>Environmental Biotechnology</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3;Practical 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Practical 15</b>
<b>Semester</b>	<b>:</b>	<b>I</b>

### **Course Objectives:**

This course explores the principles and applications of environmental biotechnology, focusing on wastewater treatment, bioremediation, and biogeotechnology. It covers wastewater characterization, treatment processes, and microbial roles in nutrient removal. Students will learn about anaerobic digestion, composting, and their applications in waste management. The course delves into the biodegradation of organic pollutants, bioremediation strategies for oil spills and heavy metals, and the use of GMOs in pollution control. Additionally, it examines bioleaching, biodesulfurization, microbial insecticides, and biofertilizers, highlighting their industrial and environmental significance. Through this course, students will gain essential knowledge of sustainable biotechnological solutions for environmental challenges.

### **Course Outcome:**

- Upon completing this course, students will develop a deep understanding of environmental biotechnology, its scope, and its significance in sustainable waste management and pollution control.
  - They will gain expertise in wastewater treatment processes, including primary, secondary, and tertiary treatments, along with both suspended and fixed-film technologies for biological treatment.
  - Additionally, they will explore the mechanisms of biodegradation and bioremediation for organic pollutants, oil spills, and heavy metals, along with advanced strategies such as phytoremediation and genetically modified organisms (GMOs) in bioremediation.
  - Furthermore, they will understand the principles of biogeotechnology, including bioleaching, biomining, microbial insecticides, and biofertilizers, enabling them to apply biotechnological solutions for environmental sustainability and industrial applications.
  - This course will equip students with the theoretical and practical skills necessary for careers in environmental biotechnology, waste management, and bioremediation research.
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## **Course content (Environmental Biotechnology):**

### **Unit I**

**No. of Hours: 12**

Issues and scopes of environmental biotechnology. Wastewater treatment: Wastewater characterization and its significance: COD, BOD, Inorganic constituents, solids, biological components. Primary, secondary and tertiary treatment of waste water. Principles and aims of biological wastewater treatment processes. Biochemistry and microbiology of inorganic phosphorus and nitrogen removal. Introduction of suspended growth technologies: Activated sludge, oxidation ditches, waste stabilization ponds. Introduction of fixed film technologies: Trickling filters, rotating biological contactors, fluidized bed and submerged aerated filters.

### **Unit II**

**No. of Hours: 10**

Toxicity testing in waste water treatment plants using microorganisms. Anaerobic digestion: microbiological and biochemical fundamentals, factors influencing anaerobic digestion. Anaerobic waste water treatment systems: RBC, UASB, anaerobic filters. Merits and demerits of anaerobic treatment of waste. Composting: Objectives, fundamentals, microbiology, factors influencing composting and composting systems. Compost quality and uses. Vermicomposting.

### **Unit III**

**No. of Hours: 13**

Biodegradation of organic pollutants: Mechanisms and factors affecting biodegradation. Pollution problems and biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azo dyes, lignin and pesticides. Bioremediation: Intrinsic bioremediation, Biostimulator and Bioaugmentation. In situ and ex situ bioremediation technologies. Bioremediation of oil spills. Bioremediation of heavy metal pollution, Phytoremediation. Use of GMO in bioremediation. Biological treatment of waste gas (polluted air): biofilters, bio scrubbers, membrane bioreactors, biotrickling filters.

### **Unit IV**

**No. of Hours: 10**

Biogeotechnology- Bioleaching of metals: Characteristics of commercially important microbes, mechanisms of bioleaching, factors affecting bioleaching and current biomining processes. Biobeneficiation of gold ores. Microbially enhanced oil recovery. Biodesulfurization of coal: Removal of organic and inorganic sulphur from coal. Microbial Insecticides: Bacterial, fungal and viral insecticides in pest management. Biofertilizers: Nitrogen fixing and phosphate solubilizing biofertilizers.

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## **List of experiments:**

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Determination of alkalinity and hardness of water/wastewater samples.
3. Determination of BOD of water sample.
4. Determination of COD of water sample.
5. Estimation of bacterial contamination of water by MPN Method.

## **Text and References:**

1. Murray Moo Young. Comprehensive Biotechnology Vol-4.
  2. Rehm and Reid. Biotechnology.
  3. G. Bitton. Waste water microbiology
  4. M. Alexander. Biodegradation and bioremediation
  5. Arceivala. Waste water treatment for pollution control, 2nd edition.
  6. H. Jordening and Josef Winter. Environmental Biotechnology.
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<b>Course Code</b>	<b>:</b>	<b>BSGE1</b>
<b>Course Title</b>	<b>:</b>	<b>Research Methodology and Science Communication</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3;Tutorial 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Tutorial 15</b>
<b>Semester</b>	<b>:</b>	<b>I</b>

### **Course Objectives:**

This course provides a comprehensive understanding of research methodology, data analysis, bioethics, and biosafety in biotechnology. It covers formulating research problems, experimental planning, literature surveys, and effective scientific communication. Students will gain insights into data collection, sampling techniques, probability, and statistical methods, including ANOVA, for biological assays. The course also explores bioethics principles, regulations, and ethical concerns related to molecular technologies and GMOs. Additionally, it emphasizes biosafety, containment levels, GLP, GMP, and regulatory frameworks for GMOs and LMOs. By the end, students will be equipped with essential skills for conducting responsible and effective scientific research.

### **Course Outcome:**

- Upon completion of this course, students will be able to formulate research problems, design experimental plans, and effectively communicate scientific findings.
  - They will develop skills in data collection, statistical analysis, and experimental design, including probability concepts and ANOVA.
  - The students will gain an understanding of bioethics, covering national and international guidelines, ethical concerns in biotechnology, and regulations on GMOs and recombinant drugs.
  - The course also provides essential knowledge of biosafety principles, containment strategies, biosafety levels, and regulatory frameworks for GMOs and biohazards.
  - The students will be prepared for responsible and ethical research in biotechnology and life sciences.
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## **Course content (Research Methodology and Science Communication):**

### **Unit I: Formulating research problem and effective research communication      No. of Hours: 18**

Formulating research problem and experimental planning selection of an area for research; Importance and need of research in that field; Literature survey; Planning of experimental work: Importance and designing of the problem to be undertaken, Defining the aim and objectives of the research work planned, Importance of prior collection of protocols, Time bound frame of work plan, Designing of experimental protocol; Description of strategies to meet the objectives using state-of-the-art techniques and proper citation of standard procedures. Types of research articles and technical writing skills.

### **Unit II: 1. Data Collection and Analysis      No. of Hours: 12**

Understand the basics of data types, sampling techniques, and data analysis. Probability: Grasp the basic concepts of probability and their application. Statistical Basis of Biological Assay. Learn the statistical methods used in biological assays. Analysis of Variance (ANOVA) Understand principles of experimental design and variance analysis.

### **Unit III: Bioethics      No. of Hours: 12**

Introduction and historical background, terminology, and regulations, Bioethics Guidelines, different paradigms of Bioethics – National & International standards, A brief account of bioethics in Biotechnology, Rules and regulations, Necessity of Bioethics. Ethical issues against molecular technologies. Release of Genetically modified Organisms and Recombinant drugs, Regulating Agencies regarding ethical committees.

### **Unit IV: Biosafety      No. of Hours: 18**

Importance of biosafety in biotechnology, Health hazards related to biotechnology). Concept of containment levels, Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP). Evolution of biosafety practices, Biological Safety Cabinets: purpose and types. Primary containment methods for biohazards, Understanding different Biosafety Levels (BSL), Specific biosafety levels for various microorganisms. Biosafety guidelines by the Government of India, Recommended biosafety levels for infectious agents and animals. Definitions of GMOs and Living Modified Organisms (LMOs), Roles of Institutional Biosafety Committee, RCGM, GEAC in GMO regulation. Environmental release of GMOs, Risk Analysis: assessment, management, and communication.

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## **Text and References:**

1. Bhattacharyya, D.K. Research methodology. Excel Books, New Delhi.
  2. Kumar, R. Research methodology: A step-by-step guide for beginners. SAGE Publications, California.
  3. Singh, Y.K. Research methodology. APH Publishing Corporation, New Delhi.
  4. Khan, J.A. Research methodology. APH Publishing Corporation, New Delhi.
  5. Gupta, S. Research methodology and statistical techniques. Deep and Deep Publications, New Delhi.
  6. Khanzode, V.V. Research methodology. APH Publishing Corporation, New Delhi.
  7. Goddard, W. and Melville, S. Research methodology: An introduction. Juta and Company Limited, Landsdown.
  8. Dawson, C. Practical research methods: A user-friendly guide to mastering research techniques and projects. How to Books Limited, London.
  9. Daniel, P.S. and Sam, A.G. Research methodology. Gyan Publishing House, New Delhi.
  10. Murray, R. How to write a thesis. McGraw-Hill, New York.
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**SEMESTER –II****Total Credits: 22**

<b>S. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L-T-P</b>	<b>Credits</b>	<b>Marks distribution* M-F-A-P</b>
<b>1</b>	<b>BSDSC3</b>	<b>Bioinformatics</b>	<b>3-0-1</b>	<b>4</b>	<b>30-30-20-20</b>
<b>2</b>	<b>BSDSC4</b>	<b>Genomics and Proteomics</b>	<b>3-1-0</b>	<b>4</b>	<b>30-50-20-00</b>
<b>3</b>	<b>BSDSE3</b>	<b>Industrial Microbiology</b>	<b>3-0-1</b>	<b>4</b>	<b>30-30-20-20</b>
<b>4</b>	<b>BSDSE4</b>	<b>Plant Biotechnology</b>	<b>3-0-1</b>	<b>4</b>	<b>30-30-20-20</b>
<b>5</b>	<b>BSGE2</b>	<b>Intellectual Property Rights</b>	<b>3-1-0</b>	<b>4</b>	<b>30-50-20-00</b>
<b>6</b>	<b>BSPS2</b>	<b>Project Seminar</b>	<b>0-0-2</b>	<b>2</b>	<b>100</b>

<b>Course Code</b>	<b>:</b>	<b>BSDSC3</b>
<b>Course Title</b>	<b>:</b>	<b>Bioinformatics</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3; Practical 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Practical 15</b>
<b>Semester</b>	<b>:</b>	<b>II</b>

### **Course Objective:**

This course provides a foundational understanding of bioinformatics, focusing on biological databases, sequence analysis, and computational tools for gene and protein prediction. It introduces the scope and applications of bioinformatics, covering genomic, protein, and transcriptome data. Students will explore key biological databases, including NCBI, UniProt, and PDB, along with sequence retrieval tools like BLAST and FASTA. The course delves into sequence alignment techniques, scoring matrices, and multiple sequence alignment algorithms. Additionally, it covers gene prediction methods, protein structure modeling, molecular docking, and functional annotation, with an introduction to Next-Generation Sequencing (NGS). By the end, students will be equipped with essential bioinformatics skills for data analysis and interpretation in biological research.

### **Course Outcome:**

- Upon completing this course, students will gain foundational knowledge of bioinformatics, its applications, and the role of computational tools in biology and medicine.
  - They will develop proficiency in utilizing biological databases such as NCBI, UniProt, and PDB for data retrieval and analysis.
  - Students will understand sequence alignment techniques, including pairwise and multiple sequence alignments using tools like BLAST and ClustalW.
  - Additionally, they will learn gene and protein prediction methods, protein structure analysis, and molecular docking techniques.
  - The course also provides insights into functional annotation, pathway analysis, and Next-Generation Sequencing (NGS), equipping students with essential bioinformatics skills for research and industry applications.
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## **Course content (Bioinformatics):**

### **Unit I: Bioinformatics basics**

**No. of Hours: 10**

Bioinformatics: Introduction, scope and application, Computers in biology and medicine, type of data (Genomic, protein, transcriptome), Databases: Protein and nucleic acid data bases; Structural databases, Literature databases.

### **Unit II: Introduction to Biological Databases**

**No. of Hours: 10**

Types and categories of databases (sequence databases, structure databases, expression databases, etc.). NCBI (GenBank, PubMed) EMBL, UniProt, PDB (Protein Data Bank), Gene Ontology (GO), Ensembl, UCSC Genome Browser, Database Searching and Retrieval: BLAST, FASTA, and sequence alignment tools.

### **Unit III: Sequence analysis**

**No. of Hours: 13**

Pair wise Sequence Alignment: Basic concepts, scoring matrices, Needleman-Wunsch (global) and Smith-Waterman (local) algorithms. Multiple Sequence Alignment: Algorithms such as ClustalW, CLUSTALX, MUSCLE, and MAFFT. BLAST and Other Alignment Tools: Usage and optimization of BLAST (Basic Local Alignment Search Tool) for sequence alignment.

### **Unit IV: Gene and Protein prediction**

**No. of Hours: 12**

Gene Prediction Methods: Identification of genes, coding regions, promoters, introns, and exons. Protein Structure Prediction: Tools and methods to predict protein secondary and tertiary structures, including homology modelling. Protein-Protein Interactions: Tools to study protein interactions (e.g., STRING). Molecular Docking: Predicting protein-ligand binding. Functional Annotation of Genes: Gene ontology, pathway analysis. Overview of Next Generation Sequencing (NGS).

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## List of experiments:

1. Understanding the use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR).
2. Pair wise sequence alignment using BLAST
3. Multiple sequence alignment (MSA) using various tools (ClustalW, BioEdit, MEGA).
4. Protein structure visualization using various tools (Eg. PyMOL)

## Text and References:

1. Lesk, A. M. (2014). Introduction to Bioinformatics. Oxford: Oxford University Press.
  2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
  3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
  4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ: Wiley-Blackwell.
  5. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
  6. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press
  7. JinXiong (2006). Essential Bioinformatics, Cambridge University Press.
  8. Primrose SB, Twyman RM, Blackwell Science (2002). Principles of Genome analysis and genomics.
  9. Teresa Attwood, David Parry-Smith, (2016). Introduction to Bioinformatics. Addison Wesley Longman ltd.
  10. Bryan Bergeron. Bioinformatics Computing, Publisher: Prentice Hall PTR.
  11. Rastogi, Mendritta and Rastogi (2013). Bioinformatics: Methods and Applications. PHI earnin publishers.
  12. Des Higgins, Willie Taylor, (2000). Bioinformatics: Sequence, Structure and Databanks: A Practical Approach (The Practical Approach Series, 236), Oxford Univ Press.
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<b>Course Code</b>	<b>:</b>	<b>BSDSC4</b>
<b>Course Title</b>	<b>:</b>	<b>Genomics and Proteomics</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3; Tutorial 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Tutorial 15</b>
<b>Semester</b>	<b>:</b>	<b>II</b>

## Course Objectives:

The objective of this course is to equip students with a deep and integrated understanding of genomics and proteomics, emphasizing both foundational concepts and advanced analytical approaches. The course describes about the organization of prokaryotic and eukaryotic genomes, including extrachromosomal elements such as plasmids and organellar DNA. It aims to develop knowledge of genetic and physical mapping techniques, cytogenetic tools, and linkage analysis, with applications in major genome sequencing projects such as the Human Genome Project. Students will explore comparative genomics to understand evolutionary relationships, track pathogens, and identify genes through molecular markers. The course also focuses on the methodologies, strategies, and challenges in proteomics, including protein separation, identification, and interaction studies using techniques such as mass spectrometry and yeast two-hybrid systems. Finally, it covers the principles of functional genomics and proteomics through gene expression analysis, gene function studies, and omics technologies, preparing students for applications in biomedical research, diagnostics, drug discovery, and systems biology.

## Course Outcomes:

- Upon successful completion of this course, students will be able to demonstrate a solid understanding of genome organization in prokaryotes and eukaryotes, including extrachromosomal elements.
  - They will be proficient in various genome mapping and sequencing techniques and capable of interpreting data from major genome projects. Students will gain the ability to apply comparative genomics tools for species classification, evolutionary studies, and disease surveillance.
  - They will also acquire practical knowledge of proteomic technologies for analyzing protein expression, interactions, and functions.
  - Additionally, students will be able to understand advance applications such as protein chips, metagenomics, and systems biology, preparing them for roles in research, diagnostics, and biotechnological innovation.
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## **Course content (Genomics and Proteomics):**

**CREDITS: 4**

### **Unit I: Basics of genomics and proteomics**

**No. of Hours: 10**

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.

### **Unit II: Genome mapping & Genome sequencing projects**

**No. of Hours: 15**

Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, in situ hybridization, comparative gene mapping. Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.

### **Unit III: Comparative genomics**

**No. of Hours: 10**

Identification and classification of organisms using molecular markers-16S rRNA typing/ sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.

### **Unit IV: Proteomics**

**No. of Hours: 10**

Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.

### **Unit V: Functional genomics and proteomics**

**No. of Hours: 15**

Transcriptome analysis for identification and functional annotation of gene, PCR, Gene expression analysis (relative quantitation and absolute quantitation using qRT PCR), Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function-forward and reverse genetics, gene ethics; Protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.

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## List of Experiments:

1. Isolation of genomic DNA from various biological samples.
2. PCR Amplification of specific DNA sequences.
3. Gel Electrophoresis analysis of DNA fragments
4. DNA Sequencing- Sanger sequencing or Next-Generation Sequencing (NGS).
5. Quantitative PCR (qPCR) quantification of DNA or RNA in samples.
6. Protein Extraction and Quantification: Isolation and measurement of protein concentration.
7. SDS-PAGE: Separation of proteins based on molecular weight.
8. 2D Gel Electrophoresis: Separation of proteins by isoelectric point and molecular weight.

## Text and References:

1. Gene Cloning and DNA Analysis – An introduction (Fourth Edition), T.A. Brown
  2. Database Annotation in Molecular Biology: Principles and Practice, Arthur M. Lesk
  3. Lesk, A. M. (2010) Introduction to Protein Science: Architecture, Function and Genomics. Oxford University Press, UK.
  4. Branden, C. I. and Tooze, T. (1999) Introduction to Protein Structure. Garland Publishing, USA.
  5. Introduction to proteomics: Tools for new biology by Daniel C. Liebler, Humana Press.
  6. Protein array, Biochips and Proteomics by Smith and Albala (Eds), Marcel Dekkar, New York.
  7. Recombinant DNA (Second Edition), James D. Watson and Mark Zoller
  8. Bioinformatics: Sequence and genomic analysis by D. W. Mount, Cold Spring Harbour Laboratory Press.
  9. T.A. Brown. Gene Cloning and DNA Analysis – An introduction (Fourth Edition).
  10. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
  11. Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.
  12. Arthur M. Lesk. Database Annotation in Molecular Biology: Principles and Practice
  13. Lesk, A. M. (2010) Introduction to Protein Science: Architecture, Function and Genomics. Oxford University Press, UK.
  14. Branden, C. I. and Tooze, T. (1999) Introduction to Protein Structure. Garland Publishing, USA.
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<b>Course Code</b>	<b>:</b>	<b>BSDSE3</b>
<b>Course Title</b>	<b>:</b>	<b>Industrial Microbiology</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3;Practical 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Practical 15</b>
<b>Semester</b>	<b>:</b>	<b>II</b>

### **Course Objectives:**

This course provides an in-depth understanding of industrial microbiology, covering its historical development, key microorganisms, and applications in various industries. It explores the isolation, identification, and maintenance of industrially important bacteria, fungi, actinomycetes, microalgae, and viruses, including GRAS microorganisms and strain improvement techniques. Students will study microbial applications in food production, pharmaceuticals, agriculture, bioremediation, and dairy industries, focusing on the production of antibiotics, enzymes, biofertilizers, and biopesticides. Additionally, the course examines fermentation media, including crude and synthetic sources such as molasses and corn-steep liquor. By the end, students will gain essential knowledge of microbial applications in industrial processes.

### **Course Outcomes:**

- Upon completing this course, students will gain a comprehensive understanding of industrial microbiology, including its historical development and scope.
  - They will learn about industrially important microorganisms, their isolation, identification, and maintenance, as well as strain improvement techniques.
  - The course will equip students with knowledge of microbial applications in food production, pharmaceuticals, agriculture, and bioremediation.
  - Additionally, they will understand the role of microorganisms in dairy and industrial fermentation, including the use of conventional and recombinant strains.
  - Students will also develop insights into the formulation of industrial fermentation media using crude and synthetic ingredients, preparing them for careers in biotechnology, fermentation technology, and microbial industries.
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## **Course content (Industrial Microbiology):**

### **Unit I**

**No. of Hours: 8**

Definition and scope of Industrial Microbiology – Historical development – chronological order of outstanding scientific achievements, concepts and practices of microbiology proceeded to Industrial Microbiology.

### **Unit II**

**No. of Hours: 15**

Industrially important microorganisms – Introduction to industrially important microorganisms – Bacteria, fungi, actinomycetes, microalgae, viruses – culture techniques, collection isolation, identification, maintenance of microorganisms. Generally regarded as safe (GRAS) microorganism, Yeasts, Filamentous fungi, Industrial strains, improvement of strains and study of strain stability.

### **Unit III**

**No. of Hours: 15**

Production of Food – yeast, mushroom, microalgae and food spoilage organisms. Pharmaceuticals – production of amino acids, antibiotics, enzymes, and vaccines. Production in agriculture – Biofertilizers, biopesticides, biocontrol of microbial pathogens. Bioremediation-pesticides, fungicides, preservatives, waste recycling, industrial effluent treatment. Dairy – important microbes. Conventional and recombinants microorganisms involved in the production of ethanol, amino acids, organic acids.

### **Unit IV**

**No. of Hours: 7**

Media and ingredients for industrial fermentations: Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.

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## **List of Experiments:**

1. Microbial (Bacterial and Fungal) fermentations for the production and estimation of:
  - (a) Enzymes: Amylase and Protease
  - (b) Alcohol: Ethanol
  - (c) Organic acid: Citric acid
  - (d) Amino acid: Glutamic acid

## **Text and References:**

1. Industrial Microbiology. 2001. M.J. Waites et al., Blackwell Science.
  2. Industrial Microbiology. 1999. L.E. Casida, Jr. New Age International Publ.
  3. Industrial Microbiology. B.M. Miller and W. Litsky.
  4. Industrial Microbiology. 1984. A.H. Patel. Macmilan India Limited.
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<b>Course Code</b>	<b>:</b>	<b>BSDSE4</b>
<b>Course Title</b>	<b>:</b>	<b>Plant Biotechnology</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3;Practical 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Practical 15</b>
<b>Semester</b>	<b>:</b>	<b>II</b>

### **Course Objectives:**

This course provides a comprehensive understanding of plant biotechnology, focusing on tissue culture, genetic engineering, and molecular breeding for crop improvement. It covers key techniques such as somatic hybridization, protoplast culture, and meristem culture for virus-free plant production. Students will explore tumor formation, Ti plasmid-mediated gene transfer, and the development of genetically modified crops for biotic and abiotic stress tolerance. The course delves into molecular breeding, marker-assisted selection, and transgenic applications for enhancing nutritional quality. Additionally, it examines plant secondary metabolites, industrial enzyme production, biodegradable plastics, and greenhouse technology. By the end, students will gain expertise in advanced plant biotechnology applications.

### **Course Outcome:**

- Upon completing this course, students will gain expertise in plant tissue culture techniques, including totipotency, somatic hybridization, and virus-free plant production.
  - They will understand tumor formation, genetic transformation using Ti plasmids, and the development of genetically modified crops for biotic and abiotic stress tolerance.
  - The course will also cover genetic improvement for nutritional enhancement, molecular breeding, and marker-assisted selection.
  - Additionally, students will explore the biosynthesis and manipulation of plant secondary metabolites, industrial enzymes, biodegradable plastics, and therapeutic proteins.
  - This knowledge will prepare them for careers in agricultural biotechnology, plant genetics, and bioengineering.
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## **Course content (Plant Biotechnology):**

### **Unit I**

**No. of Hours: 10**

Introduction to the techniques of plant tissue culture, Cellular totipotency, Single cell culture, Somoclonal variation, Embryogenesis, protoplast isolation and culture, Somatic hybridization, cybrid production and their application in crop improvement, production of virus free plants using meristem culture.

### **Unit II**

**No. of Hours: 10**

Basic of tumor formation, Ti and Ri plasmids, hairy root culture, mechanisms of DNA transfer and use of vectors, Genetically modified crops, plants and Genetic engineering for biotic stress tolerance (insects, fungi, bacteria, virus and fungi) Genetic engineering for abiotic stress (Drought, flooding, salt and temperature).

### **Unit III**

**No. of Hours: 15**

Genetic improvement for quality improvement of proteins, lipids, carbohydrates, vitamins and mineral nutrients, plants as bioreactor, molecular breeding, constructing molecular maps, molecular tagging of traits, Marker assisted selection of Qualitative and quantitative traits, physical maps of chromosomes and concept of map-based cloning and their use in transgenics.

### **Unit IV**

**No. of Hours: 10**

Plant secondary metabolites: Control mechanisms and manipulation of metabolites and enzymes (Shikimate and PHA pathway), production of therapeutic proteins and edible vaccines, Green house technology.

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## List of Experiments:

1. Organizing Plant tissue culture Laboratory
2. Preparation of Tissue Culture Media
3. Callus Induction
4. Shoot tip culture
5. Embryo / Endosperm Culture
6. Somatic Embryogenesis
7. Hardening and Planting infield
8. Isolation of protoplasts
9. Cell suspension culture
10. Economics of micropropagation project

## Text and References:

1. Hamish A Collin, Sue Edwards (1998). Plant Cell Culture
  2. Chawla H S, Introduction to Plant Biotechnology by, Oxford & IBH publishing Co. Pvt. Ltd., NewDelhi, 3rd Ed., ISBN- 9788120417328.
  3. Gupta P K, 2004. Biotechnology and Genomics.
  4. Primrose and Twyman. Principles of Gene Manipulation & Genomics (7th Ed.).
  5. Singh BD and Shekhawat NS, 2018. Molecular Plant Breeding, Scientific Pub.
  6. RastogiSmita and Pathak Neelam (2009) Genetic Engineering, 1st Ed. Oxford.
  7. John H Dodds; Lorin W Roberts, 3<sup>rd</sup> edition, 2004. Experiments in Plant tissue Culture
  8. Plant tissue culture by MK Razdan& SS Bhojwani(1996) Elsevier.
  9. Robert H Smith, 3<sup>rd</sup> edition. Plant Tissue Experiments
  10. Plant physiology by L Tiaz& E Zeiger 4th edition (2006) Sinauer Associates Inc publishers.
  11. Plant Biotechnology and transgenic plants, Edited by KirsiMarjaOksman-Caldentey, Wolfgang Barz Marcel Dekker 2002.
  12. Plant tissue culture concepts and laboratory exercises, Second edition, Robert N Trigiano, Dennis J Gray, CRC Press November 1999.
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<b>Course Code</b>	<b>:</b>	<b>BSGE2</b>
<b>Course Title</b>	<b>:</b>	<b>Intellectual Property Rights</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3;Tutorial 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Tutorial 15</b>
<b>Semester</b>	<b>:</b>	<b>II</b>

### **Course Objectives:**

This course provides a comprehensive understanding of Intellectual Property Rights (IPR), covering key concepts, legal frameworks, and applications. It introduces the nature and significance of IPR, including patents, copyrights, trademarks, trade secrets, geographical indications, and traditional knowledge, along with an overview of TRIPS and WTO agreements. Students will explore patent rights, their registration, infringement issues, and legal remedies. The course also delves into copyright laws, piracy, and software-related copyrights. Additionally, it examines trademark registration, infringement, and domain name protection in cyberspace. The final unit covers design rights, semiconductor layout designs, and the IT Act 2000, emphasizing e-commerce and digital governance.

### **Course Outcome:**

- Upon completing this course, students will gain a comprehensive understanding of Intellectual Property Rights (IPR), including patents, copyrights, trademarks, trade secrets, and designs.
  - They will develop knowledge of international agreements such as TRIPS and WTO and their impact on intellectual property.
  - The course will provide insights into patent laws, registration processes, infringement issues, and legal remedies.
  - Students will also explore copyright laws, particularly in software, as well as trademark regulations and cyber-related trademark concerns.
  - Additionally, they will understand design registration, semiconductor layout design laws, and key aspects of the Information Technology Act, preparing them for careers in legal, technological, and business domains related to intellectual property.
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## **Course content (Intellectual Property Rights):**

### **Unit I: Introduction**

**No. of Hours: 12**

Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights, Introduction to TRIPS and WTO, Kinds of Intellectual property rights-Copy Right, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge

### **Unit II: Patent Rights and Copy Rights**

**No. of Hours: 12**

Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties.

### **Unit III: Copy Rights**

**No. of Hours: 12**

Copy Right- Origin, Definition & Types of Copy Right, Registration procedure, Assignment & license, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with special reference to software

### **Unit IV: Trademarks**

**No. of Hours: 12**

TRADE MARKS-Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties. Domain Names on cyber space.

### **Unit 5: Design**

**No. of Hours: 12**

DESIGN- Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention on design, functions of Design. Semiconductor Integrated circuits and layout design Act-2000. Basic Tenants of Information Technology Act-2000 – IT Act – Introduction E-Commerce and legal provisions E- Governance and legal provisions Digital signature

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## **List of Experiments:**

1. Proxy filing of Indian Product patent.
2. Proxy filing of Indian Process patent.
3. Case study on turmeric and other Indian traditional-based patents.
4. Case study on medical errors and negligence.
5. Case study on handling and disposal of radioactive waste.

## **Text and References:**

1. Intellectual Property Rights by Brigitte Anderson, Edward Elgar Publishing
  2. Intellectual Property Rights and the Life Sciences Industries by Graham Dutfield, Ashgate Publishing
  3. WIPO Intellectual Property Handbook
  4. Intellectual Property Rights by William Rodolph Cornish, David Clewelyn
  5. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
  6. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers
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**SEMESTER IX****Total Credit: 22**

<b>S. No.</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L-T-P</b>	<b>Credits</b>	<b>Marks distribution* M-F-A-P</b>
<b>1.</b>	<b>BSDSC5</b>	<b>Animal Biotechnology</b>	<b>3-0-1</b>	<b>4</b>	<b>30-30-20-20</b>
<b>2.</b>	<b>BSDSC6</b>	<b>Genetic Engineering</b>	<b>3-0-1</b>	<b>4</b>	<b>30-30-20-20</b>
<b>3.</b>	<b>BSDSE5</b>	<b>Virology</b>	<b>3-1-0</b>	<b>4</b>	<b>30-50-20-00</b>
<b>4.</b>	<b>BSDSE6</b>	<b>Microbes in sustainable agriculture and development</b>	<b>3-0-1</b>	<b>4</b>	<b>30-30-20-20</b>
<b>5.</b>	<b>BSGE3</b>	<b>Entrepreneurship Development</b>	<b>3-1-0</b>	<b>4</b>	<b>30-50-20-00</b>
<b>6.</b>	<b>BSPS3</b>	<b>Project Seminar</b>		<b>2</b>	<b>100</b>

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<b>Course Code</b>	<b>:</b>	<b>BSDSC5</b>
<b>Course Title</b>	<b>:</b>	<b>Animal Biotechnology</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3; Practical 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Practical 15</b>
<b>Semester</b>	<b>:</b>	<b>III</b>

### **Course Objectives:**

The course provides an in-depth understanding of modern animal biotechnology with a strong emphasis on cellular, reproductive, genetic, and molecular approaches. It aims to equip students with foundational knowledge in animal cell culture, including media preparation, culture techniques, and the use of stem cells and induced pluripotent cells. It explores advanced reproductive biotechnologies such as artificial insemination, embryo transfer, cryopreservation, and the creation of transgenic animals through various gene transfer techniques. The course further delves into animal genomics, emphasizing genome characterization methods, molecular markers, disease resistance genetics, and cloning, particularly for conservation. Students will also learn about the production of biologics through animal cell cultures, including vaccines, monoclonal antibodies, and recombinant proteins. Finally, the course highlights the practical applications of biotechnology in areas such as species identification, food safety, and forensic analysis using molecular tools like DNA barcoding and nucleic acid-based detection methods.

### **Course Outcomes:**

- Upon successful completion of this course, students will be able to demonstrate a comprehensive understanding of animal cell culture techniques, including media formulation, maintenance of cell lines, and applications of stem cells in biotechnology.
  - They will gain practical insights into reproductive biotechnologies such as cryopreservation, in vitro fertilization, and the development of transgenic animals through various gene transfer methods.
  - Students will be equipped to analyze and interpret genomic data using molecular markers and omics technologies, and understand their relevance in disease resistance and animal cloning.
  - Additionally, they will develop proficiency in utilizing animal cell cultures for the production of vaccines, therapeutic proteins, and monoclonal antibodies.
  - The course will also enable students to apply molecular and biochemical techniques for species identification, detection of adulteration in food products, and conservation biology, thereby preparing them for advanced research and professional roles in animal biotechnology and related industries.
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## **Course Content (Animal Biotechnology):**

### **Unit I: Animal cell culture**

**No. of Hours: 5**

History; Basic requirements; Cell culture media and reagents; Animal cell, tissue and organ cultures; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Transfection and transformation of cells; Stem cells and their application; Induced Pluripotency.

### **Unit II: Animal reproductive biotechnology**

**No. of Hours: 10**

Structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; embryo recovery and in vitro fertilization; cryopreservation of embryos; embryo transfer technology. Transgenic Animals: applications of transgenic animal technology; Techniques of gene transfer: Microinjection, Lipofection, Electroporation, Chemical based transformation, Viral Vectors.

### **Unit III: Animal Genomics**

**No. of Hours: 10**

Introduction to animal genomics; Different methods for characterization of animal genomes, SNP, STR, RFLP, RAPD, proteomics, metabolomics; Genetic basis for disease resistance; Gene knock out technology and animal models for human genetic disorders. Animal cloning - basic concept, cloning for conservation for conservation endangered species

### **Unit IV: Animal Cell Cultures**

**No. of Hours: 10**

Cell Culture based products, Vaccines, Hybridoma technology, Monoclonal antibodies, In vitro testing of drugs; Production of pharmaceutical proteins; Stem Cells and their Use, Using Animals Cells for heterologous gene expression. Introduction to the concept of vaccines, conventional methods of animal vaccine production.

### **Unit V: Applications**

**No. of Hours: 10**

Immunological, Biochemical and molecular based applications, Immunological and nucleic acid based methods for identification of animal species; DNA Barcoding; Detection of adulteration in meat using DNA based methods; Detection of food/ feed adulteration with animal protein; Identification of wild animal species using DNA based methods.

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## **List of Experiments:**

1. Sterilization techniques and biosafety
2. Cell counting using hemocytometer
3. Preparation of media for animal cell culture.
4. Prerequisites for starting animal cell culture lab.
5. Peripheral blood lymphocyte culture
6. Nuclear and Mitochondrial staining of cells
7. Passaging of cultured cells.
8. Determination of viable cells by trypanblue test or MTT Assay
9. Observation of permanent slides- CHO Cells, BHK, Vero, HEK, SP2/0-Ag14.
10. Effect of drugs on cell culture
11. Growth kinetics of animal cells

## **Text and References:**

1. T. A. Brown. (2020) Gene Cloning and DNA Analysis: An Introduction, 8th Edition. Wiley-Blackwell
  2. Primrose S.B. (2014) Principles of Gene Manipulation and Genomics, 7th Edn. John Wiley Blackwell
  3. SmitaRastogi ,Neelam Pathak. (2009). Genetic Engineering. Oxford University Press.
  4. Razdan M.K. "Introduction to Plant Tissue Culture", Science Publishers, Third Edition (2005).
  5. Slater A, Scott N.W and Fowler M.R. "Plant Biotechnology: The Genetic Manipulation of Plants", Oxford University Press, Third Edition (2008).
  6. Gelvin S (2003) Agrobacterium-Mediated Plant Transformation: The Biology behind the Gene-Jockeying Tool, Microbiology and Molecular Biology Reviews, 67: 16-37.
  7. Voytas D.F and Gao C (2014) Precision Genome Engineering and Agriculture: Opportunities and Regulatory Challenges, Plos One. 12, e1001877.
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<b>Course Code</b>	<b>:</b>	<b>BSDSC6</b>
<b>Course Title</b>	<b>:</b>	<b>Genetic Engineering</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3;Practical 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Practical 15</b>
<b>Semester</b>	<b>:</b>	<b>III</b>

### **Course Objective:**

The objective of this course is to provide students with a comprehensive foundation in the principles, tools, and applications of genetic engineering across various biological systems. It aims to familiarize students with the structure and function of genes, the genetic code, and the regulatory elements involved in gene expression, while tracing the historical milestones and addressing biosafety and ethical considerations surrounding genetically modified organisms (GMOs). The course is designed to build technical competence in the use of essential molecular tools such as restriction enzymes, cloning vectors, and expression systems, as well as in advanced techniques like PCR, gene tagging, and DNA labeling. It further seeks to equip students with a working knowledge of gene transfer methods in animals, plants, and microbial systems, including modern genome editing techniques such as CRISPR-Cas. Through the exploration of real-world applications, the course emphasizes the role of genetic engineering in medicine, agriculture, food production, and environmental biotechnology, laying a strong conceptual and practical groundwork for future research and innovation in the life sciences.

### **Course Outcomes:**

- Upon completion of this course, students will possess a thorough understanding of the principles and practices of genetic engineering, including the structure and function of genes, regulatory elements, and the molecular mechanisms that govern gene expression.
  - They will gain knowledge of the historical advancements and biosafety guidelines surrounding GMOs and their applications in agriculture, medicine, and industry.
  - Students will be skilled in the use of molecular tools such as restriction enzymes, vectors, and tagging systems for DNA manipulation and cloning, as well as techniques like PCR and various methods of DNA labeling.
  - They will also acquire hands-on knowledge of gene transfer techniques across model systems, including microinjection, viral-mediated transfer, and CRISPR-Cas genome editing.
  - Furthermore, the course will enable students to critically assess the real-world applications of genetic engineering in pharmaceuticals, food technology, agriculture, and environmental restoration, preparing them to contribute to innovations in biotechnology while considering ethical and regulatory frameworks.
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## **Course content (Genetic Engineering):**

### **Unit I: Introduction of genetic engineering**

**No. of Hours: 10**

Basics of Genetic Engineering: Role of genes within cells, genetic code, genetic elements that control gene expression, Milestones in Genetic Engineering, GMOs, Biosafety issues – Genetic engineering guidelines. Molecular Tools in Genetic Engineering, Plant and Animal Genetic Engineering. Transgenic animals (knockout mice) and plants (FlavrSavr tomato), Genetic Engineering in Biopharmaceutical industries, and Biotech products from GMOs.

### **Unit II: Tools & Techniques of genetic engineering**

**No. of Hours: 15**

General requirements for performing a genetic engineering experiment; enzymes in genetic engineering; ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, Plasmids; Bacteriophages; M13 mp vectors, phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); expression vectors; Protein purification; His-tag; GST-tag; MBP-tag etc, mammalian expression and replicating vectors; Baculovirus and Pichia vectors system, plant-based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors. PCR analysis and its applications, PCR-based cloning.

### **Unit III: Transfection of DNA into different model**

**No. of Hours: 10**

Gene Transfer methods in Animals – Gene cloning, Techniques for genetic engineering, Gene transfer and expression of induced genes, Microinjection, Embryonic stem cells Transfer, Retrovirus and Genetransfer, Xenografting, Gene silencing techniques, introduction to methods of genetic manipulation in different model systems; Transgenics - gene replacement; gene targeting; introduction to genome editing by CRISPR-CAS.

### **Unit IV: Applications of genetic engineering**

**No. of Hours: 10**

Genetic engineering in pharmaceutical industries and medicines like insulin, human growth hormone, and vaccines, supplements such as tryptophan, gene therapy (in vitro and in vivo methods), Genetic engineering in food industries- Genetically modified food, aid in the production of food (chymosin in cheese making); In agriculture like pest resistance, fungal and virus-resistant crops, GM crops and genetic engineering for crop improvement, disadvantages. Genetic engineering in environment restoration.

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## **List of Experiments:**

1. Cloning of PCR product in vector using T/A cloning strategy.
2. Preparation of competent cells and its transformation with PCR product ligated in vector.
3. Screening of recombinant transformants using blue white selection and confirmation of clone.
4. PCR amplification of Gene of Interest
5. Miniprep isolation of plasmid DNA
6. Restriction digestion of plasmid DNA and Agarose gel electrophoresis of restriction digests and PCR products
7. Cloning of PCR product into the isolated plasmid and transformation
8. Identification and characterization of transformed colonies
9. Study of gene expression using blotting or RT-PCR.

## **Text and References:**

1. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Oxford: Blackwell Scientific Publications.
  2. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
  3. Brown, T. A. (2006). Genomes (3rd ed.). New York: Garland Science Pub.
  4. Selected papers from scientific journals, particularly Nature & Science.
  5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.
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<b>Course Code</b>	<b>:</b>	<b>BSDSE5</b>
<b>Course Title</b>	<b>:</b>	<b>Virology</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3;Tutorial 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Tutorial 15</b>
<b>Semester</b>	<b>:</b>	<b>III</b>

### **Course Objective:**

The course objective of virology typically revolves around providing students with a comprehensive understanding of viruses, their structure, replication, and their roles in human, animal, and plant diseases. Understanding the different types of viruses, their structural components, and classified based on various factors like genetic material and morphology. The processes of viral replication, including entry into host cells, genome replication, protein synthesis, assembly, and release. It also explore viruses interact with their host cells, including the immune responses triggered by viral infections and how viruses evade host defense mechanisms. Students gain knowledge about how viruses cause disease, the factors influencing virulence, and the clinical manifestations of viral infections. The course introduce methods used to diagnose viral infections, as well as current and emerging antiviral treatments, including vaccines. Understanding the spread of viral infections, outbreaks, and public health strategies for prevention and control.

### **Course Outcomes:**

- Understanding of viral structure, classification, replication mechanisms, and how viruses interact with host cells. They will be able to explain how viruses cause diseases in humans, animals, and plants, and identify the factors influencing viral pathogenesis.
  - Understanding laboratory techniques for detecting and identifying viral infections, such as PCR, ELISA, or cell culture-based methods.
  - Understanding of Host-Virus Interactions the molecular and cellular interactions between viruses and their hosts, including immune responses and viral evasion strategies.
  - Understanding the epidemiological aspects of viral infections and the strategies used to prevent and control viral outbreaks, including vaccination and antiviral therapies.
  - Application of Virology in Public Health to assess the impact of viral diseases on public health, including outbreak management and viral surveillance.
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## **Course content (Virology):**

### **Unit I: Nature and Properties of Viruses Introduction**

**No. of Hours: 15**

Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Isolation, purification and cultivation of viruses. Viral taxonomy: Classification and nomenclature of different groups of viruses.

### **Unit II: Bacteriophages**

**No. of Hours: 12**

Bacteriophages: Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage.

### **Unit III: Viral Transmission, Salient features of viral nucleic acids**

**No. of Hours: 20**

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal. Salient features of viral Nucleic acid : Unusual bases (TMV, T4 phage), overlapping genes ( $\phi$ X174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV). Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification ( $\phi$  X 174, Retroviridae, Vaccinia, Picorna), Assembly with example of Polio virus and T4 phage, maturation and release of virions

### **Unit IV: Prevention and control of viral diseases**

**No. of Hours: 13**

Antiviral compounds and their mode of action. Interferon and their mode of action. General principles of viral vaccination. Use of viral vectors in cloning and expression, Gene therapy, Phage display and phage therapy.

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## List of Experiments:

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo, hepatitis B and retroviruses) using electron micrographs.
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs.
3. Study of the structure of important bacterial viruses ( $\phi$ X 174, T4,  $\lambda$ ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique.
5. Studying isolation and propagation of animal viruses by chick embryo technique by photographs.
6. Study of cytopathic effects of viruses using photographs.
7. Performing local lesion technique for assaying plant viruses.

## Text and References:

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
  2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
  3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
  4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
  5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
  6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
  7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
  8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
  9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.
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<b>Course Code</b>	<b>:</b>	<b>BSDSE6</b>
<b>Course Title</b>	<b>:</b>	<b>Microbes in sustainable agriculture and development</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3;Practical 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Practical 15</b>
<b>Semester</b>	<b>:</b>	<b>III</b>

## Course Objective

This course aims to provide an in-depth understanding of soil as a dynamic microbial habitat and the diverse microbial communities that thrive within it. Students will explore the roles of soil microorganisms, including bacteria, fungi, actinomycetes, and protozoa, in ecosystem functioning. The course will focus on microbial interactions, factors influencing microbial populations, and their involvement in critical processes such as cellulose, hemicellulose, and lignin decomposition. Additionally, the course will emphasize microbial contributions to nutrient cycling, including nitrogen fixation, phosphorus solubilization, and sulphur transformations, and their importance in sustainable agriculture.

## Course Outcomes

- Upon completing this course, students will gain comprehensive knowledge of soil microbiology and its applications in agriculture and environmental sustainability.
  - They will understand the mechanisms by which microbes promote plant growth, suppress pathogens, and enhance nutrient acquisition.
  - Students will also be able to assess the impact of agricultural practices on microbial communities and apply biocontrol strategies and biofertilizers for improved crop productivity.
  - Furthermore, they will develop expertise in microbial composting, bioremediation, and sustainable practices to address agricultural and environmental challenges, fostering innovative solutions for ecological balance.
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## **Course content (Microbes in sustainable agriculture and development):**

### **Unit I**

**No. of hours: 15**

Soil as Microbial Habitat, Soil formation. Types of soil microbes (bacteria, fungi, actinomycetes, protozoa), Microbial interactions in soil ecosystems (symbiosis, competition), Factors affecting microbial populations (soil pH, moisture, temperature). Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus.

### **Unit II**

**No. of hours: 7**

Nitrogen fixation by rhizobia and free-living bacteria, Phosphorus solubilization by fungi and bacteria, Sulphur cycling and microbial transformations

### **Unit III**

**No. of hours: 13**

Microbial antagonism against plant pathogens, Development and application of biocontrol agents (fungi, bacteria, viruses), biofertilizers. Mechanisms of plant growth promotion (phytohormone production, nutrient uptake enhancement), Beneficial bacterial genera (e.g., Pseudomonas, Bacillus, Azotobacter), Mycorrhizal fungi and their role in nutrient acquisition, biofuels.

### **Unit IV**

**No. of hours: 10**

Microbial processes involved in composting, Key microbial groups involved in organic matter decomposition, Impact of agricultural practices on soil microbial communities. Bioremediation of agricultural pollutants using microbes. Sustainability aspects of microbial applications in agriculture. Microbial culture collection centres.

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## **List of Experiments:**

1. Isolation of bacteria using serial dilution technique.
2. Isolation of fungi using given soil sample.
3. Isolate phosphorus-solubilizing bacteria using Pikovskaya's agar.
4. Quantification of phosphate solubilizing activity.

## **Text and References:**

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
  2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
  3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
  4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition.
  5. Benjamin/Cummings Science Publishing, USA
  6. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic
  7. Press
  8. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
  9. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
  10. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
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<b>Course Code</b>	<b>:</b>	<b>BSGE3</b>
<b>Course Title</b>	<b>:</b>	<b>Entrepreneurship Development</b>
<b>Total Credits</b>	<b>:</b>	<b>4 (Theory 3;Tutorial 1)</b>
<b>Total Hours</b>	<b>:</b>	<b>Theory 45; Tutorial 15</b>
<b>Semester</b>	<b>:</b>	<b>III</b>

### **Course Objectives:**

The course aims to provide students with a comprehensive understanding of bioentrepreneurship by exploring innovation strategies in biotech companies, biotechnology-based products and services, licensing, and protection, alongside the intricacies of IPR issues and biosafety. It delves into the concepts and theories of entrepreneurship, the importance of entrepreneurial traits and motivation, and examines government schemes for technology commercialization. The course covers funding mechanisms for biotech businesses in India, support systems for entrepreneurship, challenges faced, organizations supporting biotech growth, and biotech policy initiatives. Additionally, it provides insights into setting up and managing biotech enterprises of various scales, including quality control, location considerations, and exploring export possibilities. Students will also gain proficiency in financial analysis, including ratio analysis, investment processes, break-even analysis, profitability analysis, and budgeting and planning.

### **Course Outcome:**

- Upon completing this course, students will be able to develop and implement innovation strategies in biotech companies, effectively navigate licensing, protection, and IPR issues, and address biosafety concerns.
  - They will understand key entrepreneurial concepts, traits, and motivations, and utilize government schemes for technology commercialization.
  - Students will secure funding for biotech businesses, leverage support systems, identify challenges, and utilize organizations and policy initiatives for biotech growth in India.
  - They will be equipped to set up and manage biotech enterprises of various scales, ensure quality control, select strategic locations, and explore export opportunities.
  - The students will also be proficient in financial analysis, including ratio analysis, investment processes, break-even analysis, profitability analysis, and budgeting and planning, ensuring the financial sustainability of biotech ventures.
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## **Course content (Bioentrepreneurship Development):**

### **Unit I: Entrepreneurship**

**No. of Hours: 15**

Entrepreneurship: Meaning and types of Entrepreneurship, Traits of entrepreneurship, Factors promoting entrepreneurship, Barriers to entrepreneurship, the entrepreneurial culture, Stages in entrepreneurial process, Women entrepreneurship and economic development- SHG

### **Unit II: Developing Successful Business Ideas**

**No. of Hours: 15**

Recognizing opportunities, trend analysis, generating ideas, Brainstorming, Focus Groups, Surveys, Customer advisory boards, Day in the life research, encouraging focal point for ideas and creativity at a firm level, Protecting ideas from being lost or stolen, Patents and IPR

### **Unit III: Opportunity Identification**

**No. of Hours: 15**

Identification and product/ service selection, Generation and screening the project ideas, Market analysis, Technical analysis, Cost benefit analysis and network analysis, Project formulation, Assessment of project feasibility, Dealing with basic and initial problems of setting up of Enterprises.

### **Unit IV: Business Planning Process & Funding**

**No. of Hours: 15**

Meaning of business plan- Business plan process- Advantages of business planning- preparing a model project report for starting a new venture (Team-based project work), Sources of Finance- Venture capital- Venture capital process- Business angles- Commercial banks- Government Grants and Schemes

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## **Text and References:**

1. Barringer, B., Entrepreneurship: Successfully Launching New Ventures, 3rd Edition, Pearson, 2011.
  2. Bessant, J., and Tidd, J., Innovation and Entrepreneurship, 2nd Edition, John Wiley & Sons, 2011.
  3. Desai, V., Small Scale Industries and Entrepreneurship, Himalaya Publishing House, 2011.
  4. Donald, F.K., Entrepreneurship- Theory, Process and Practice, 9th Edition, Cengage Learning, 2014.
  5. Hirsch, R.D., Peters, M. and Shepherd, D., Entrepreneurship, 6th Edition, Tata McGraw-Hill Education Pvt.Ltd., 2006.
  6. Mathew, J.M., Entrepreneurship Theory at Cross Roads: Paradigms and Praxis, 2nd Edition, Dream Tech, 2006.
  7. Reddy, Entrepreneurship: Text & Cases - Cengage, New Delhi.
  8. Kuratko/rao, Entrepreneurship: a south asian perspective.- Cengage, New Delhi.
  9. Leach/Melicher, Entrepreneurial Finance – Cengage, New Delhi.
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