Final

DIPLOMA CURRICULUM OF BIOTECHNOLOGY

(THIRD YEAR)
(5th Semester)

(To be implemented from 2026-27)

Prepared by;

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PROGRAMME TITLE: BIOTECHNOLOGY

SEMESTER – V

SL. No	Category of Course	Code No	Course Title	Teaching Scheme				Evaluation Scheme				Total Marks	Credits
				Pre-requisite	Contact Hours/ week			Theory		Practical			
					L	T	P	End Exam	Progressive Assessment	End Exam	Progressive Assessment		
1	Programme Core	BTPC301 TH:1	Bioreaction Engineering		3	0	0	70	30	-	-	100	3
2		BTPC303 TH:2	Basic Genetics		3	0	0	70	30	-	-	100	3
3		BTPC305 PR:1	Bioreaction Engineering Lab		0	0	4	-	-	15	35	50	2
4		BTPC307 PR:2	Genetic Engineering Lab		0	0	4	-	-	15	35	50	2
5		BTPC309 PR:3	Environmental Biotechnology Lab		0	0	4	-	-	15	35	50	2
6	Programme Elective	BTPE301 TH:3 (Any one)	(A)Food Biotechnology (B)Green Biotechnology (C)Fundamentals of Biological Engineering		3	0	0	70	30	-	-	100	3
7		BTPE303 TH:4 (Any one)	(A)Pharmacogenomics (B)Molecular Virology and Vaccine Production (C)Microbes		3	0	0	70	30	-	-	100	3
8	Open Elective	Open Elective – I OE301 (Any one) TH:5	(A)Universal Human Values (B)Leadership and Management Skills (C)Professional Skills		3	0	0	70	30	-	-	100	3
9	Summer Internship	SI301	SUMMER INTERNSHIP II*		0	0	0	-	-	15	35	50	2
10	Major Project	PR301 PR:4	MAJOR PROJECT (PHASE – I)		0	0	4	-	-	15	35	50	2
TOTAL					**15**	**0**	**16**	**350**	**150**	**75**	**175**	**750**	**25**

*3-4-weeks internship after 4th Semester

***The best of 2 IA conducted in a subject out of 20 marks to be considered. Assignment/ quiz etc. of 10 marks to be treated as part of IA. Besides this, Monthly Test to be conducted for each subject. Sessional Marks shall be total of the performance of individual different jobs/ experiments in a subject throughout the semester. Club/Innovation/ Idea Tinkering Activities etc. shall be encouraged to be performed by students beyond the above stipulated hours.**

CONTENT DETAILS OF SEMESTER - V

TH:1- BIOREACTION ENGINEERING

L	T	P		
3	0	0		**Course Code: BTPC301**
Total Contact Hours				**Theory Assessment**
Theory		: 45Hrs	**Total Marks: 100**	End Term Exam : 70
				Progressive Assessment : 30
Pre-Requisite		**: Nil**		
Credit		**: 3**		Category of Course: PC

RATIONALE:

Bioreaction Engineering bridges biology and chemical engineering principles to design and operate bioreactors effectively. This subject introduces diploma students to the fundamental concepts of reaction kinetics, reactor design, enzyme and microbial kinetics, and bioprocess optimization. It forms the basis for understanding large-scale production of biotechnological products in industries such as pharmaceuticals, food, and biofuels.

LEARNING OUTCOMES:

After completion of the course, the students will be able to

- Apply rate laws and reaction kinetics in biological systems.
- Explain the design and functioning of ideal chemical and biological reactors.
- Analyze enzyme immobilization and related diffusion limitations.
- Interpret microbial growth kinetics and modeling approaches.
- Compare batch, fed-batch, and continuous processes in microbial and enzyme-based systems.
- Apply basic principles of optimization and scale-up in bioreaction systems.

COURSE CONTENT DETAILS:

Unit No.	Topic/Sub-Topic	Allotted Time (Hours)
I	Reaction Kinetics and Rate Laws: Introduction to chemical and biochemical reactions, Rate laws: Definition and types, Zero-order and first-order reactions, Determination of reaction order and rate constants, Introduction to reaction rate in biological systems	**8**
II	Ideal Reactors and Their Applications: Ideal reactor types: Batch Reactor, Continuous Stirred Tank Reactor (CSTR/Mixed Flow), Plug Flow Reactor (PFR), Design equations for ideal reactors, Applications in biotechnology processes	**10**
III	Enzyme Immobilization and Diffusion Effects: Methods of enzyme immobilization, Diffusion in immobilized systems, Thiele modulus, Effectiveness factor, and Damkohler number, Impact on reactor performance	**10**
IV	Kinetics of Microbial Systems and Modeling: Kinetics of cell growth, substrate utilization, and product formation, Monod equation and growth-associated products, Introduction to structured and unstructured models, Concept of maintenance energy, Examples of modeling in microbial systems	**7**

V	Reactor Operations, Optimization, and Scale-Up: Types of reactor operation (Batch, Fed-batch, Continuous), Microbial and enzyme reactors: principles and examples, Basic concepts in optimization of bioprocess parameters, Introduction to scale-up of bioreactors	**10**
	Total	**45**

REFERENCES:

1.	Introduction to Biochemical Engineering by D G Rao. Publisher: McGraw Hill Education
2.	Biochemical Engineering Fundamentals by James Bailey, David Ollis. Publisher : McGraw Hill Education
3.	Bioreaction Engineering Principles by Villadsen John,Jens Nielsen,Gunnar Liden. Publisher: Springer

TH:2- BASIC GENETICS

L	T	P		
3	0	0		**Course Code: BTPC303**
Total Contact Hours				**Theory Assessment**
Theory		: 45Hrs	**Total Marks: 100**	End Term Exam : 70
				Progressive Assessment : 30
Pre-Requisite		**: Nil**		
Credit		**: 3**		Category of Course: PC

RATIONALE:

Genetics is the foundation of biological sciences, explaining how traits are inherited and how genetic variation occurs. This course introduces students to fundamental concepts of heredity, gene structure, mutations, and modern genetic technologies. Understanding genetics is crucial for fields such as biotechnology, medicine, and agriculture.

LEARNING OUTCOMES:

After completion of the course, the students will be able to

- Demonstrate the fundamental principles of genetics and inheritance.
- Explain the structure and function of genes, DNA, and chromosomes.
- Analyze Mendelian and non-Mendelian patterns of inheritance.
- Explain mutations and their effects on genetic traits.
- Discuss modern genetic techniques and their applications in research and industry.

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COURSE CONTENT DETAILS:

Unit No.	Topic/Sub-Topic	Allotted Time (Hours)
I	Introduction to Genetics: Definition and scope of genetics, History of genetics: From Mendel to modern genetics, Structure of DNA and RNA, Chromosomes and their organization, Central dogma of molecular biology (DNA → RNA → Protein)	**9**
II	Mendelian and Non-Mendelian Inheritance: Mendel's laws of inheritance (Law of Dominance, Segregation, and Independent Assortment), Monohybrid and dihybrid crosses with Punnett squares, Incomplete dominance, codominance, and multiple alleles, Polygenic inheritance and sex-linked inheritance	**9**
III	Genetic Variation and Mutation: Types of mutations: Point mutations, frameshift mutations, and chromosomal aberrations, Causes and effects of mutations, Genetic disorders and their inheritance patterns (e.g., sickle cell anemia, hemophilia), DNA repair mechanisms	**9**
IV	Gene Expression and Regulation: Transcription and translation processes, Regulation of gene expression in prokaryotes and eukaryotes, Operon concept: Lac and trp operons, Epigenetics and gene silencing	**9**

V	Modern Genetics and Applications: Genetic engineering and recombinant DNA technology, Polymerase Chain Reaction (PCR) and its applications, CRISPR-Cas9 and gene editing, Applications of genetics in medicine, agriculture, and forensic science, Ethical concerns in genetic research	**9**
	Total	**45**

REFERENCES:

1.	Principles of Genetics by Pranab Paul. Publisher: Mahaveer Publications
2.	Principles of Genetics by Robert H. Tamarin. Publisher : McGraw Hill Education
3.	Principles of Genetics Paperback by S N Pandey. Publisher: Ane Books Pvt. Ltd
4.	Fundamentals of Genetics by Dr. B. D. Singh. Publisher: Medtech Science Press
5	An Introduction to Genetic Engineering by Desmond S. T. Nicholl, Publisher: Cambridge University Press

PR:1- BIOREACTION ENGINEERING LAB

L	T	P		
0	0	4		**Course Code:** BTPC305
Total Contact Hours				**Practical Assessment**
Practical		: 60Hrs	**Total Marks: 50**	End Exam : 15
				Progressive Assessment : 35
Pre-Requisite		**: Nil**		
Credit		**: 2**		Category of Course: PC

RATIONALE:

The Bioreaction Engineering Lab is designed to provide diploma students with hands-on experience in biochemical reaction kinetics, bioreactor operation, and process analysis. Understanding how biological reactions are engineered at lab scale prepares students for industrial processes involving enzyme kinetics, microbial growth, and fermentation technologies. This course bridges the gap between theoretical concepts and real-world applications in bioprocess engineering.

LEARNINGOUTCOMES:

After completion of the course, the students will be able to

- Perform basic enzyme kinetics experiments.
- Measure microbial growth kinetics under batch conditions.
- Operate laboratory-scale bioreactors and analyze their performance.
- Apply principles of mass transfer and reactor design to bioprocesses.
- Collect, interpret, and present bioreactor data effectively.

LIST OF EXPERIMENTS:

Sl No.	Name of Experiments
1	Determination of specific growth rate (μ) of microorganisms in batch culture
2	Determination of Monod parameters
3	Enzyme activity assay
4	Effect of temperature on enzyme activity and determination of activation energy
5	Effect of pH on enzyme activity
6	Immobilization of enzyme using sodium alginate technique
7	Operation of a lab-scale stirred tank bioreactor: Monitoring pH, DO, and agitation
8	Batch fermentation for ethanol production using yeast
9	Preparation and calibration of DO and pH probes used in bioreactors

REFERENCES:

1.	Lab Manual
2.	Bioreactor Design and Bioprocesses by Mishra, R.K. Publisher: IK International Publishing House

PR:2- GENETIC ENGINEERING LAB

L	T	P		
0	0	4		**Course Code: BTPC307**
Total Contact Hours				**Practical Assessment**
Practical		: 60Hrs	**Total Marks: 50**	End Exam : 15
				Progressive Assessment : 35
Pre-Requisite		**: Nil**		
Credit		**: 2**		Category of Course: PC

RATIONALE:

The Genetic Engineering Laboratory is a vital component of biotechnology education that provides hands-on experience with molecular biology techniques fundamental to modern science and industry. This lab bridges theoretical knowledge with practical skills by training students in the manipulation of genetic material--an essential competency in areas such as healthcare, agriculture, environmental management, and industrial biotechnology. This lab fosters scientific thinking, precision, teamwork, and innovation, aligning with the broader goal of producing globally competent biotechnology professionals capable of contributing to sustainable and ethical biotechnological advancements.

LEARNINGOUTCOMES:

After completion of the course, the students will be able to

- Understand the basics of genetic engineering tools and techniques, including plasmid isolation, restriction digestion, ligation, and transformation.
- Operate and analyze essential molecular biology instruments, such as gel electrophoresis apparatus, UV transilluminator, and spectrophotometer.
- Isolate and quantify genetic material.
- Have a hands-on experience of SDS page and quantitative PCR

LIST OF EXPERIMENTS:

Sl No.	Name of Experiments
1	Introduction to Genetic Engineering Laboratory
2	To perform the Isolation of Genetic material.
3	To perform quantitative and qualitative analysis of extracted DNA.
4	To perform SDS of protein samples
5	To perform quantitative PCR
6	Restriction enzyme digestion of bacterial genomic DNA.
7	Amplification of DNA sample by PCR.
8	Isolation of plasmid DNA and estimation its size using agarose gel electrophoresis
9	To do gene Transfer: Preparation of competent cells, Transformation

REFERENCES:

1.	Green MR, Sambrook J,, *Molecular Cloning: A Laboratory Manual*,, Cold Spring Harbo Laboratory Press , ISBN: 978-1-621821-04-5
2.	Williams SA, Slatko BE, McCarrey JR,, *Laboratory Investigations in Molecular Biology*,, Jones and Bartlett Publishers, USA , ISBN-13:978-0-7637-3329-2

PR:3- ENVIRONMENTAL BIOTECHNOLOGY LAB

L	T	P		
0	0	4		**Course Code: BTPC309**
Total Contact Hours				**Practical Assessment**
Practical		: 60Hrs	**Total Marks: 50**	End Term Exam : 15
				Progressive Assessment : 35
Pre-Requisite		**: Nil**		
Credit		**: 2**		Category of Course: PC

RATIONALE:

The Environmental Biotechnology Laboratory equips students with practical knowledge and technical skills to address environmental challenges using biological systems. As environmental sustainability becomes a global priority, biotechnology offers innovative solutions for waste management, pollution control, resource recovery, and ecosystem restoration.

LEARNINGOUTCOMES:

After completion of the course, the students will be able to

- Perform accurate measurements of physical, chemical, and biological parameters in water, wastewater and soil samples.
- Isolate and characterize environmental microorganisms involved in biodegradation, composting, and nutrient cycling.
- Apply biosafety and environmental regulations during the handling and disposal of laboratory and environmental waste.
- Integrate biotechnological approaches to support environmental conservation and sustainable development.

LIST OF EXPERIMENTS:

Sl No.	Name of Experiments
1	Water analysis: Determination of pH, electrical conductivity, alkalinity, Hardness, total suspended solids (TSS) and total dissolved solids (TDS) in water samples.
2	Wastewater analysis: Determination of dissolved oxygen, biochemical oxygen demand, chemical oxygen demand in wastewater samples.
3	Soil analysis: Determination of organic matter, cation exchange capacity and acidity in soil samples.
4	Microorganisms for bioremediation: Isolation and molecular identification of bacteria for bioremediation, Characterization of microorganisms
5	Tolerance study: Determination of maximum tolerable concentration for given sample of bacteria
6	Biodegradation studies for the removal of toxic pollutants, Biosorption studies for the removal of heavy metals and dyes.
7	Bioleaching studies for the recovery of heavy metals and dyes.

REFERENCES:

1.	Pepper, Ian L., Charles P. Gerba, and Jeffrey W. Brendecke, *Environmental microbiology: a laboratory manual.*, Academic Press , 1995

TH:3(A)- FOOD BIOTECHNOLOGY

L	T	P		
3	0	0		**Course Code: BTPE301 (A)**
Total Contact Hours				**Theory Assessment**
Theory		: 45 Hrs	**Total Marks: 100**	End Term Exam : 70
				Progressive Assessment : 30
Pre-Requisite		**: Nil**		
Credit		**: 3**		Category of Course: PE

RATIONALE:

Food Biotechnology applies biological techniques to improve food quality, safety, and production. This course introduces students to the role of microorganisms, genetic engineering, and fermentation in food processing. It also covers the application of biotechnology in developing nutraceuticals and ensuring food safety.

LEARNING OUTCOMES:

After completion of the course, the students will be able to

- Understand the basic concepts of food biotechnology and its importance.
- Explain the role of microorganisms in food production and preservation.
- Describe the principles of food fermentation and enzyme technology.
- Explore genetic engineering applications in food biotechnology.
- Understand food safety regulations and the impact of biotechnology on human health.

COURSE CONTENT DETAILS:

Unit No.	Topic/Sub-Topic	Allotted Time (Hours)
UNIT-I	Introduction to Food Biotechnology: Definition and scope of food biotechnology, Historical developments in food biotechnology, Role of biotechnology in food processing and preservation, Advantages and concerns of genetically modified (GM) foods	**05**
UNIT-II	Microorganisms in Food Processing: Beneficial microorganisms in food (yeasts, bacteria, and molds), Fermented foods: Types and production processes (e.g., yogurt, cheese, and bread), Probiotics and prebiotics: Health benefits and applications, Spoilage microorganisms and foodborne pathogens	**10**
UNIT-III	Fermentation and Enzyme Technology: Basics of fermentation and types (batch, continuous, solid-state), Industrial production of fermented foods (e.g., beer, wine, vinegar), Enzymes in food biotechnology: Types, sources, and applications, Immobilized enzyme technology in food processing	**10**
UNIT-IV	Genetic Engineering in Food Biotechnology: Introduction to genetic modification in food, Techniques used in genetically modified organisms (GMOs), Applications of GMOs in agriculture and food production, Regulatory aspects and ethical concerns of GM foods	**10**
UNIT-V	Food Safety and Quality Control: HACCP (Hazard Analysis and Critical Control Points) in food biotechnology, Detection methods	**10**

	for GMOs in food products, Food allergens and safety regulations, Impact of biotechnology on food security and sustainability	
	Total	**45**

REFERENCES:

1.	Food Biotechnology by FOSTER GN. Publisher: CBS
2.	Fundamentals of Food Biotechnology by Lee B.H.Publisher : John Wiley
3.	Introduction to Food Biotechnology by SinoshSkariyachan, Abhilash M. CBS Publishers & Distributors.
4.	Food Biotechnology by Sahu Giriraj. Publisher: Crescent Publishing Corporation
5.	Fundamentals of Food Biotechnology by Byong H. Lee. Publisher: Wiley-Blackwell
6	Food process engineering and technology by Berk, Zeki, Publisher: Academic press

TH:3(B)- GREEN BIOTECHNOLOGY

L	T	P		
3	0	0		**Course Code: BTPE301 (B)**
Total Contact Hours				**Theory Assessment**
Theory		: 45 Hrs	**Total Marks: 100**	End Term Exam : 70
				Progressive Assessment : 30
Pre-Requisite		**: Nil**		
Credit		**: 3**		Category of Course: PE

RATIONALE:

Green Biotechnology involves the application of biotechnology to agriculture and environmental sustainability. This course introduces students to plant biotechnology, genetic engineering for crop improvement, sustainable agricultural practices, and the role of biotechnology in environmental conservation.

LEARNINGOUTCOMES:

After completion of the course, the students will be able to

- Explain the fundamentals of green biotechnology and its role in sustainable agriculture.
- Explain genetic engineering techniques used for crop improvement.
- Explore the applications of plant tissue culture in biotechnology.
- Analyze the role of biotechnology in biofertilizers, biopesticides, and biofuels.
- Assess the environmental and ethical concerns of biotechnology in agriculture.

COURSE CONTENT DETAILS:

Unit No.	Topic/Sub-Topic	Allotted Time (Hours)
UNIT-I	Introduction to Green Biotechnology: Definition, scope, and importance of green biotechnology, Difference between green, red, and white biotechnology, Applications in sustainable agriculture and environmental management, Role of biotechnology in climate-resilient agriculture	**8**
UNIT-II	Plant Genetic Engineering and Crop Improvement: Basics of plant genome organization, Techniques for gene transfer in plants (Agrobacterium-mediated and gene gun method), Development of genetically modified (GM) crops: Bt cotton, Golden rice, Benefits and risks of GM crops	**11**
UNIT-III	Plant Tissue Culture and Micropropagation: Basics of plant tissue culture and totipotency, Techniques of micropropagation (callus culture, organogenesis, somatic embryogenesis), Applications in agriculture: Disease-free plants, high-yield crops, Somaclonal variation and its role in crop improvement	**12**
UNIT-IV	Biofertilizers, Biopesticides, and Biofuels: Types and benefits of biofertilizers (Rhizobium, Azotobacter, Mycorrhiza), Biopesticides: Types and applications in pest control, Introduction	**6**

	to biofuels: Types, production methods, and advantages, Role of biotechnology in sustainable energy sources	
UNIT-V	Environmental and Ethical Considerations: Biosafety and regulatory frameworks for GMOs, Environmental impact of genetically modified crops, Ethical concerns in agricultural biotechnology, Future prospects of green biotechnology in sustainable development	**8**
	Total	**45**

REFERENCES:

1.	Green Biotechnologyby Anjani Singh Tomar. Publisher: Daya Pub. House
2.	Textbook of Green Biotechnologyby Pooja. Publisher: Discovery Publishing House Pvt. Ltd

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TH:3(C)- FUNDAMENTALS OF BIOLOGICAL ENGINEERING

L	T	P		
3	0	0		**Course Code: BTPE301 (C)**
Total Contact Hours				**Theory Assessment**
Theory		: 45 Hrs	**Total Marks: 100**	End Term Exam : 70
				Progressive Assessment : 30
Pre-Requisite		**: Nil**		
Credit		**: 3**		Category of Course: PE

RATIONALE:

Biological Engineering is an interdisciplinary field that applies engineering principles to biological systems for various applications, including biotechnology, healthcare, and environmental sciences. This course introduces fundamental concepts such as engineering principles in biological systems, thermodynamics, bioenergetics, and transport processes. The course aims to provide a foundational understanding of biological engineering to diploma students, preparing them for further studies or industrial applications.

LEARNINGOUTCOMES:

After completion of the course, the students will be able to

- Apply engineering concepts to biological and biochemical systems.
- Explain classical thermodynamics and bioenergetics in biological processes.
- Analyze transport processes in biological systems, including fluid flow, heat, and mass transfer.
- Develop problem-solving skills related to biological and biomedical engineering applications.

COURSE CONTENT DETAILS:

Unit No.	Topic/Sub-Topic	Allotted Time (Hours)
UNIT-I	Introduction to Biological Engineering: Overview of Biological Engineering, Relationship Between Biology and Engineering, Biological Systems and Their Engineering Applications, Fundamental Concepts in Bioengineering	**5**
UNIT-II	Engineering Principles Applied to Biological Systems: Engineering Mechanics in Biological Systems, Biomechanics and Bio-instrumentation Basics, Biochemical Reactions and Bioprocess Engineering, Applications of Biomaterials in Engineering	**10**
UNIT-III	Classical Thermodynamics and Bioenergetics: Laws of Thermodynamics and Their Applications in Biology, Energy Transformation in Biological Systems, Gibbs Free Energy, Enthalpy, and Entropy in Biochemical Reactions, Thermodynamics of Enzyme Catalysis and Metabolic Pathways	**10**
UNIT-IV	Transport Processes in Biological Systems: Fundamentals of Fluid Flow in Biological Systems, Heat Transfer in Biological and Biomedical Applications, Mass Transfer in Biological Systems (Diffusion, Osmosis, and Membrane Transport), Applications in Drug Delivery and Bioreactors	**10**

UNIT-V	Emerging Technologies and Applications in Biological Engineering: Biosensors and Bioelectronics, Genetic and Tissue Engineering Basics, Bioreactors and Industrial Applications, Environmental Biotechnology and Sustainable Bioengineering	**10**
	Total	**45**

REFERENCES:

1.	Biological Engineering by Suzy Hill Publisher: Callisto Reference, 2015
2.	Bioprocess Engineering: BasicConcepts by Michael L. Shuler and FikretKargi, publisher: Prentice Hall PTR

TH:4(A)- PHARMACOGENOMICS

L	T	P		
3	0	0		**Course Code: BTPE303 (A)**
Total Contact Hours				**Theory Assessment**
Theory		: 45 Hrs	**Total Marks: 100**	End Term Exam : 70
				Progressive Assessment : 30
Pre-Requisite		**: Nil**		
Credit		**: 3**		Category of Course: PE

RATIONALE:

Pharmacogenomics is the study of how genetic variations influence an individual's response to drugs. This course introduces students to the fundamentals of genetics, drug metabolism, and personalized medicine. Understanding pharmacogenomics is essential for improving drug safety and effectiveness in medical and pharmaceutical fields.

LEARNINGOUTCOMES:

After completion of the course, the students will be able to

- Explain the basic principles of pharmacogenomics and its importance in medicine.
- Explain the genetic basis of drug metabolism and response variability.
- Analyse how pharmacogenomic testing can improve drug safety and efficacy.
- Explore applications of pharmacogenomics in personalized medicine.
- Explain ethical, legal, and regulatory aspects of pharmacogenomics.

COURSE CONTENT DETAILS:

Unit No.	Topic/Sub-Topic	Allotted Time (Hours)
UNIT-I	Introduction to Pharmacogenomics: Definition, history, and scope of pharmacogenomics, Role of pharmacogenomics in drug discovery and development, Importance of personalized medicine in healthcare	**5**
UNIT-II	Genetic Basis of Drug Response: Overview of pharmacokinetics (ADME: Absorption, Distribution, Metabolism, Excretion), Genetic polymorphisms and their impact on drug metabolism, Cytochrome P450 enzymes and their role in drug metabolism, Examples of genetic variations affecting drug response	**10**
UNIT-III	Pharmacogenomic Testing and Biomarkers: Techniques for pharmacogenomic testing (PCR, microarrays, NGS), Identification of genetic biomarkers for drug efficacy and toxicity,	**10**
UNIT-IV	Applications of Pharmacogenomics: Pharmacogenomics in cancer therapy (targeted therapy), Role in psychiatric disorders and cardiovascular diseases, Impact on adverse drug reactions and drug repurposing, Pharmacogenomics in clinical trials and drug development	**10**

UNIT-V	Ethical, Legal, and Regulatory Aspects**:** Ethical concerns in pharmacogenomic research**,** FDA guidelines and regulatory policies on pharmacogenomics**,** Privacy and confidentiality in genetic data**,** Future trends in pharmacogenomics and precision medicine	**10**
	Total	**45**

REFERENCES:

1.	Principle of Pharmacogenetics and phatmacogenomics by David Flockhart,David B. Goldstein ,Russ B. Altman, publisher: Cambridge University Press
2.	Pharmacogenomics: Methods and Protocols by Innocenti, publisher: Springer

TH:4(B)- MOLECULAR VIROLOGY AND VACCINE PRODUCTION

L	T	P		
3	0	0		**Course Code: BTPE303 (B)**
Total Contact Hours				**Theory Assessment**
Theory		: 45 Hrs	**Total Marks: 100**	End Term Exam : 70
				Progressive Assessment : 30
Pre-Requisite		**: Nil**		
Credit		**: 3**		Category of Course: PE

RATIONALE:

This course provides an introduction to the fundamental aspects of molecular virology and vaccine production. Students will learn about virus structure, replication mechanisms, host interactions, and vaccine development strategies. The course is designed to provide basic theoretical and practical knowledge necessary for understanding virology and biotechnological applications in vaccine production.

LEARNINGOUTCOMES:

After completion of the course, the students will be able to

- Explain the basic structure and classification of viruses.
- Describe viral replication mechanisms and their interaction with host cells.
- Explain the principles of molecular diagnostics for viral infections.
- Explain the various types of vaccines and their production methods.
- Demonstrate an understanding of biosafety regulations and quality control in vaccine production.

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COURSE CONTENT DETAILS:

Unit No.	Topic/Sub-Topic	Allotted Time (Hours)
UNIT-I	Fundamentals of Virology: Introduction to Virology: Definition and Scope, Virus Classification and Taxonomy, Structure and Morphology of Viruses, Virus-Host Interactions and Pathogenesis	**5**
UNIT-II	Molecular Biology of Viruses: Viral Genome: DNA vs. RNA Viruses, Mechanisms of Viral Replication, Genetic Variability and Viral Mutations, Virus Evolution and Emerging Viruses	**10**
UNIT-III	Molecular Diagnostics and Antiviral Strategies: Techniques for Virus Detection (PCR, ELISA, RT-PCR), Serological and Molecular Approaches in Virology, Antiviral Drugs and Mechanisms of Action, Immune Response to Viral Infections	**10**
UNIT-IV	Vaccine Development and Production: Principles of Vaccination and Immunization, Types of Vaccines: Live-Attenuated, Inactivated, Recombinant, mRNA, and DNA Vaccines, Production	**10**

	Process of Vaccines: Cell Culture, Fermentation, and Purification, Adjuvants and Vaccine Formulations	
UNIT-V	Regulatory and Ethical Aspects in Vaccine Production: Good Manufacturing Practices (GMP) in Vaccine Industry, Biosafety Levels and Containment of Viruses, Quality Control and Quality Assurance in Vaccine Manufacturing, Ethical Issues in Vaccine Development and Distribution	**10**
	Total	**45**

REFERENCES:

1.	**Fields Virology** – David M. Knipe and Peter M. Howley
2.	**Principles of Virology** – S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka
3.	**Molecular Biology of the Cell** – Alberts et al.
4.	**Vaccinology: Principles and Practice** – Gregg N. Milligan and Alan D.T. Barrett
5.	**Textbook of Vaccines** – S. Plotkin, W. Orenstein, and P. Offit
6.	**Principle of Molecular Virology-** Alan J. Cann, Publisher:Academic Press

TH:4(C)- MICROBES

L	T	P		
3	0	0		**Course Code: BTPE303 (C)**
Total Contact Hours				**Theory Assessment**
Theory		: 45 Hrs	**Total Marks: 100**	End Term Exam : 70
				Progressive Assessment : 30
Pre-Requisite		**: Nil**		
Credit		**: 3**		Category of Course: PE

RATIONALE:

Microorganisms play a crucial role in various fields, including healthcare, food processing, industry, and environmental biotechnology. This course provides students with an introduction to microbial diversity, microbial applications in biotechnology, and their industrial relevance. The course will also cover large-scale microbial production processes, bioproduct purification, and screening strategies for novel microbial metabolites.

LEARNINGOUTCOMES:

After completion of the course, the students will be able to

- Explain microbial physiology and growth dynamics.
- Describe the production of microbial biomass, primary metabolites (e.g., ethanol, organic acids), and secondary metabolites (e.g., antibiotics).
- Discuss industrial applications of microbes (biofuels, bioplastics, enzymes).
- Analyze microbial roles in clinical diagnostics, food fermentation, and industrial processes.
- Apply screening strategies to isolate novel microbial strains and products.
- Demonstrate basic lab techniques in microbial cultivation and product extraction.

COURSE CONTENT DETAILS:

Unit No.	Topic/Sub-Topic	Allotted Time (Hours)
UNIT-I	Microbial Biomass & Primary Metabolites: Single-cell protein (SCP) production, Biofuels (ethanol, biodiesel, biogas), Organic acids (citric acid, lactic acid), Industrial enzymes (amylases, proteases, cellulases)	**9**
UNIT-II	Secondary Metabolites & High-Value Products: Antibiotics (penicillin, streptomycin), Bioplastics (PHA, PLA), Vitamins and amino acids, Pigments and biosurfactants	**9**
UNIT-III	Large-Scale Microbial Production: Fermentation technologies (submerged, solid-state), Bioreactor design and operation, Downstream processing (filtration, centrifugation, chromatography), Recombinant protein production (insulin, vaccines)	**9**
UNIT-IV	Clinical Microbiology: Pathogenic microbes and diagnostics, Antimicrobial resistance (AMR), Probiotics and microbiome engineering, Vaccines and therapeutic proteins	**9**

UNIT-V	Screening for Novel Microbial Products: Isolation and culture of environmental microbes, High-throughput screening methods, Genetic modification for strain improvement	**9**
	Total	**45**

REFERENCES:

1.	Microbiology by Pelczar, Chan, and Krieg (Indian Edition by Tata McGraw Hill)
2.	Environmental Microbiology by K. Vijaya Ramesh, publishers: MJP

TH:5(A)- UNIVERSAL HUMAN VALUES

L	T	P		
3	0	0		**Course Code: OE301A**
Total Contact Hours				**Theory Assessment**
Theory		: 45Hrs	**Total Marks: 100**	End Term Exam : 70
				Progressive Assessment : 30
Pre-Requisite		**: Nil**		
Credit		**: 3**		Category of Course: OE

RATIONALE:

The Universal Human Values (UHV) course is designed to help diploma students develop a strong ethical foundation, nurturing responsible individuals who contribute positively to society. In an era driven by rapid technological advancements, it is crucial for students not only to gain technical expertise but also to cultivate values that promote harmony, respect, and sustainability.

LEARNING OUTCOMES:

After completion of the course, the students will be able to:

- Identify fundamental human aspirations such as happiness and prosperity.
- Differentiate between the self and the body and understand their respective needs.
- Practice self-reflection to improve decision-making, emotional balance, and personal growth.
- Develop respectful and trustworthy relationships within family, friends, and society.
- Explain the role of values like trust, respect, and love in building strong social bonds.
- Promote cooperation and harmony within communities through ethical practices.

DETAILED COURSE CONTENTS:

Unit No.	Topic/Sub-Topic	Allotted Time (Hours)
I	**Introduction to Value Education and Human Values -** Concept and Need for Value Education - Understanding the importance of value education in personal and professional life, Differentiating between values and skills. Basic Human Aspirations - Exploring fundamental human aspirations: happiness and prosperity, Methods to achieve these aspirations through right understanding and relationships.	8
II	**Harmony in the Human Being -** Understanding the Self - Differentiating between the 'Self' (I) and the Body, Understanding the needs of the Self and the Body, Harmony of the Self with the Body - Ensuring the harmony of 'I' with the Body, Practices for mental and physical well-being.	8
III	**Harmony in the Family and Society -** Family as the Basic Unit of Society - Understanding values in human relationships, Trust and respect as the foundational values in relationships, Harmony in Society - The concept of an undivided society, Universal human order and world family.	8
IV	**Harmony in Nature and Existence -** Interconnectedness in Nature - Understanding the four orders of nature: material, plant, animal, and human, Mutual fulfillment among these orders, Co-existence in Existence - Holistic	8

	perception of harmony in existence, Role of human beings in maintaining environmental balance.	
V	**Professional Ethics -** Ethical Human Conduct - Integrating values into professional life, Concept of professional ethics and accountability, Case Studies in Professional Ethics - Analyzing real-life scenarios to understand ethical dilemmas, Developing solutions based on universal human values.	8
VI	**Personal Development and Social Responsibility -** Self-Reflection and Self-Exploration - Techniques for self-assessment and personal growth, Setting personal goals aligned with universal values, Social Responsibility - Understanding one's role in society, Participating in community service and social initiatives.	5
	Total	45

REFERENCES:

1.	R. R. Gaur, R. Asthana, G. P. Bagaria, A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019.
2.	R. R. Gaur, R. Asthana, G. P. Bagaria, Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019.
3.	A. Nagraj, JeevanVidya: EkParichaya, Amarkantak, 1999.
4.	A.N. Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004.
5.	Moral Thinking: An Introduction To Values And Ethics, VineetSahu, IIT Kanpur: https://onlinecourses.nptel.ac.in/noc23_hs89/preview

TH:5(B)- LEADERSHIP AND MANAGEMENT SKILLS

L	T	P		
3	0	0		**Course Code: OE301 (B)**
Total Contact Hours				**Theory Assessment**
Theory		: 45 Hrs.		End Term Exam : 70
Tutorial		: 0	**Total Marks: 100**	Progressive Assessment : 30
Pre-Requisite		**: Nil**		
Credit		**: 3**		Category of Course: OE

RATIONALE:

This course/subject on Leadership and Management Skills for students undergoing Diploma programmes is an exploration in leading and managing people, majorly in education based on sound and acceptable principles and theories for effective leadership. The leadership skills will enable them to take initiative, guide team efforts, motivate peers, and ensure effective collaboration. They'll learn how to delegate tasks, resolve conflicts, and foster a positive team environment. The management skills will help them in organizing tasks, setting timelines, and ensuring efficient workflow within a team.

It is expected that the students will be able to handle projects with better project outcomes and a earn a more productive learning experience. This will benefit their academic journey, future careers, and overall professional development:

LEARNING OUTCOMES:

After completion of the course, the students will be able to

- Explain the principles of management
- Collaborate across cultures for effective team work
- Communicate with people for a positive work culture
- Demonstrate personal dispositions, skills & abilities of a leader
- Undertake the process of change management
- Design training for staff development
- Adapt suitable leadership style for improved work efficiency.

DETAILED COURSE CONTENT:

Unit No.	Topic/Sub-Topic	Allotted Time (Hour)
I	**Leadership & Management, concept, principles.** • Definition of leadership, management • Leadership theories • Leadership characteristics • Principles of management • Managerial functions • Leader v/s Manager, Leader/Manager traits and character • Leadership Styles	10

II	**Human Resource Management in Organizations** • Human Resource Management: Meaning, Nature, Objectives, Scope • Job & Job analysis. • Staff Development: Need and Objectives of Staff Development, Approaches • Training & development • Organizational Development: Components of OD process. • Learning organization	10
III	**Personal disposition, skills & abilities of leaders** • Self-awareness • Leadership characteristics, traits • Leadership skills & abilities • Emotional intelligence & its components, importance in leadership • Communication skills for effective leadership, barriers to effective communication, Active Listening, Mindful listening. • Leading & Mentorship – Influencing & mentoring	09
IV	**Leader's role in Motivating, Inspiring and Transformative leadership, nurturing team-work** • Goal setting & leadership • Transformative Leadership, vision & envisioning • Motivational role of leader in people management • Group & team • Team dynamics • Conflict management, strategies in managing conflicts	08
V	**Change Management & Leadership** • Models of change • Forces driving change • Change Management – process, goal, importance • The process of change happening in an organization • Key aspects of leadership in change management – responsibilities of a change leader.	08

SUGGESTED ACTIVITIES:

- Group/individual presentation on the basic principles of leadership and management, Discussion on readings - Individual or group presentation of assigned topics in class on leadership and management principles and theories.
- Activities on Envisioning, Goal setting
- ACTION PLAN to be prepared

REFERENCES:

1.	Theories of Educational Leadership and Management (3rd ed.), by Bush, Tony (2003). SAGE Publications, Ltd.
2.	The inspiring leader: unlocking the secrets of how extraordinary leaders motivate. By Zenger, John, Joseph Folkman, and Scott Edinger (2009). New York: McGraw Hill Press.
3.	Knowing yourself. On becoming a leader: the leadership classic. By Bennis, Warren (2009). New York: Basic Books.
4.	Leading Change. By P. Kotter, Harvard Business, 2012.
5.	The Fifth Discipline. By Peter M. Senge, Crwon Currency, 2006.
6.	The Leadership Sutra: An Indian Approach to Power. By Devdutt Pattanaik, – Penguin Random House, 2017.
7.	Leadership and Management. By Dr. A. Chandra Mohan. Himalaya Publishing House, 2010.

TH:5(C)- PROFESSIONAL SKILLS

L	T	P		
3	0	0		**Course Code: OE301 (C)**
Total Contact Hours				**Theory Assessment**
Theory		: 45 Hrs.	**Total Marks: 100**	End Term Exam : 70
				Progressive Assessment : 30
Pre-Requisite		**: Nil**		
Credit		**: 3**		Category of Course: OE

RATIONALE:

The term, "Professional skills" carries significant weight in the job market and career development. This open elective course explores various types of professional skills, their significance, and how they can be cultivated and harnessed for career progression. By understanding the landscape of professional skills, student can better position himself or herself for success in the competitive job market. It is crucial to continuously update and adapt the professional skills to stay ahead in a rapidly changing work environment. By investing in professional development, one can enhance employability and open doors to new opportunities.

LEARNING OUTCOMES:

After completion of the course, the students will be able to

- Demonstrate Self-competency and Confidence
- Practice Emotional Competency
- Work in a team work or in collaboration
- Demonstrate problem solving and decision-making skills
- Apply time management strategies and techniques effectively
- Apply professional ethics and integrity in professional and personal life

UNIT NO.	CONTENT	ALLOTTED TIME (HOURS)
I Communication Skills:	• Active listening • Verbal and non-verbal communication • Written communication • Presentation skills • Conflict resolution	08
II Teamwork and Collaboration:	• Building trust within a team • Effective collaboration strategies • Role delegation and responsibility sharing • Conflict resolution within a team	08
III Problem-Solving:	• Identifying root causes of issues • Generating solutions and evaluating options	08

	• Decision-making under pressure • Critical thinking skills • Triple constraint issues	
IV Time Management:	• Prioritization and task management • Setting realistic deadlines • Effective time planning and organization	06
V Emotional Intelligence:	• Self-awareness and emotional regulation • Empathy and understanding others' emotions • Managing interpersonal relationships • Motivation • Social skills • Emotional Intelligence (EQ) • Stress management	08
VI Professional Ethics and Integrity:	• Workplace ethics and code of conduct • Confidentiality and data privacy • Professional accountability- • Important Considerations:	07

REFERENCES:

1. Dr. Vitthal Gore: Professional Skills for 21st Century: A Key to Success: Blue Rose- ACADEMIC
2. The ACE of Soft Skills: Attitude, Communication and Etiquette for Success: PEARSON
3. The essence of Leadership: S. Manikutty: Bloomsbury

SUMMER INTERNSHIP – II*

L	T	P		
0	0	0		**Course Code: SI301**
Total Contact Hours				**Internship Assessment**
Internship		: 3-4 weeks	**Total Marks: 50**	End Exam : 15
				Progressive Assessment : 35
Pre-Requisite		**: Nil**		
Credit		**: 2**		Category of Course: Internship

*3-4 weeks internship after 4th Semester

RATIONALE:

Summer Internship - II is to offer a structured and practical learning experience that prepares individuals for their future careers, helps them make informed career choices, and equips them with the skills and knowledge necessary to succeed in their chosen field. This course provides opportunities to students for hands-on industry experience.

LEARNING OUTCOMES:

After completion of the course, the students will be able to:

- Apply theoretical knowledge gained in their academic coursework to real-world situations.
- Develop and refine specific skills relevant to the field.
- Gains hands-on experience in a professional network by interacting with mentors and industry professionals.
- Learn to manage their time effectively.
- Clarify career goals.

DETAILED COURSE CONTENTS:

Unit No.	Topic/Sub-Topic
I	**Orientation:** • Introduction to the organization's mission, values, and culture. • Familiarization with workplace policies, procedures, and safety guidelines. • Orientation to the team and organizational structure.
II	**Project-Based Learning:** • Description of the main project or tasks the intern will be working on during the internship. • Detailed project goals and objectives. • Training and guidance on project-specific tools, technologies, or methodologies.

III	**Technical and Skill Development:** • Training sessions or workshops to enhance technical skills relevant to the internship role (e.g., programming languages, software tools, laboratory techniques). • Soft skills development, including communication, teamwork, problem solving, and time management
IV	**Mentorship and Supervision:** • Regular meetings with a designated mentor or supervisor for guidance, feedback, and support. • Mentorship objectives and expectations.
V	**Professional Development:** • Sessions on professional etiquette, networking, and building a personal brand • Resume writing and interview preparation workshops.
VI	**Industry and Field-Specific Knowledge:** • Lectures, seminars, or presentations on industry trends, best practices, and emerging technologies. • Guest speakers from the field to share insights and experiences.
VII	**Reporting and Documentation:** • Training on how to document project progress, results, and findings. • Practice in creating reports, presentations, or other deliverables.
VIII	**Ethics and Professionalism:** • Discussions on ethical considerations within the field. • Scenarios and case studies related to ethical decision-making
IX	**Feedback and Evaluation:** • Regular performance evaluations and feedback sessions. • Self-assessment and goal-setting exercises.
X	**Networking and Industry Exposure:** • Opportunities to attend industry conferences, webinars, or networking events. • Encouragement to connect with professionals in the field.

NOTE

As per AICTE guidelines, in Summer Internship-I, students are required to be involved in Inter/ Intra Institutional Activities viz;

- Training with higher Institutions;
- Soft skill training organized by Training and Placement Cell of the respective institutions;
- contribution at incubation/ innovation /entrepreneurship cell of the institute;
- participation in conferences/ workshops/ competitions etc.;

- Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop;
- Working for consultancy/ research project within the institutes and
- Participation in all the activities of Institute's Innovation Council for eg: IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.

PR:4- MAJOR PROJECT

L	T	P		
0	0	4		**Course Code: PR301**
Total Contact Hours				**Project Assessment**
Project		: 60Hrs	**Total Marks: 50**	End Exam : 15
				Progressive Assessment : 35
Pre-Requisite		**: Nil**		
Credit		**: 2**		Category of Course: PROJECT

RATIONALE:

A Major project generally requires a larger amount of effort and more independent work than that involved in a normal assignment. It requires students to undertake their own fact-finding and analysis. The students will select the topic, perform and design work. Major project is as preparation for the students to take on more responsibilities and bigger project in the future. It is a learning experience, which aims to provide students with the opportunity to synthesize knowledge from different areas of learning, and critically and creatively apply it to real life situations. The leadership quality, co-ordination of job and maintaining good communal harmony is an important factor of this type of activity.

LEARNING OUTCOMES:

After completion of the course, the students will be able to

1. Plan a Major Project
2. Execute a Major Project with team.
3. Implement hardware/software/analytical/numerical techniques, etc. based on project requirements.
4. Optimize time related works through sharing of work responsibility
5. Develop cost awareness and utilization of fund.
6. Prepare a technical report on the project.

GUIDELINES FOR MAJOR PROJECT

Unit No.	Topic/Sub-Topic
I	○ Minimum three and maximum five students can form a group for the minor project.
II	○ Project type can include • Development of a simple prototype system/product. • Investigation of performance of some systems using experimental method • Analysis of components/systems/devices using suitable software • Investigation of optimum process/material for product development using market survey. • Solution for society/industry problems

III	○ Project domain may not be limited to the specific area / discipline.
IV	○ Project report to be prepared and submitted by the students with following components: 1. Title 2. Objectives 3. Relevance and significance 4. Methodology 5. Analysis-Simulation/experimentation/survey/testing etc. 6. Result and Discussion 7. Conclusion