KANNUR UNIVERSITY

FYUGP -2024 ADMISSION ONWARDS

MAJOR AND MINOR PATHWAY COURSES IN BIOTECHNOLOGY

PROGRAMME STRUCTURE

KANNUR UNIVERSITY VISION AND MISSION STATEMENTS

Vision: To establish a teaching, residential and affiliating University and to provide equitable and just access to quality higher education involving the generation, dissemination, and a critical application of knowledge with special focus on the development of higher education in Kasargod and Kannur Revenue Districts and the Mananthavady Taluk of Wayanad Revenue District.

Mission: To produce and disseminate new knowledge and to find novel avenues for application of such knowledge.

- To adopt critical pedagogic practices which uphold scientific temper, the uncompromised spirit of enquiry and the right to dissent.

- To uphold democratic, multicultural, secular, environmental and gender sensitive values as the foundational principles of higher education and to cater to the modern notions of equity, social justice, and merit in all educational endeavors.
- To affiliate colleges and other institutions of higher learning and to monitor academic, ethical, administrative, and infrastructural standards in such institutions.
- To build stronger community networks based on the values and principles of higher education and to ensure the region's intellectual integration with national vision and international standards.
- To associate with the local self-governing bodies and other statutory as well as non- governmental organizations for continuing education and for building public awareness on important social, cultural, and other policy issues.

ELIGIBILITY FOR THE BSc BIOTECHNOLOGYPROGRAM:
THE STUDENT SHOULD HAVE COMPLETED SCIENCE STREAM AT THE PLUS TWO LEVEL OF SCHOOLING

PREFACE

Bachelor of Science in Biotechnology with honors is a four-year undergraduate program offered in tune with the UGC-NEP and the rules laid out by the KSHEC. The students have a choice of taking up a 3-year program or 4-year honors program or 4-year honors with research. The whole program is divided into six semesters / eight semesters with each semester having a duration of about five months. The curriculum has been revised in tune with the concept of 'Outcome Based Education'. Outcome Based Education is an approach, in which decisions about the curriculum and instruction are driven by the learning outcome. 'Learning outcome' is the ability the students are expected to acquire at the end of a program or a course.

The syllabus of the BSc Biotechnology program has been designed to give a basic understanding of Biotechnology, a fast-developing interdisciplinary area in science with emphasis on hands-on training. It is revised after evaluating the existing syllabus and in consultation with teachers who are experts and well experienced in the subject.

Several courses are offered in the B.Sc. Biotechnology program. The syllabus of each course has been divided into instructional units. The program specific outcome and course outcomes are explicitly stated in the syllabus. Details such as the semester in which the course is offered, credit for the course, books for study/reference and the pattern of evaluation are also given in the syllabus.

Chairperson
Board of Studies, Biotechnology (Cd) Kannur University

KANNUR UNIVERSITY PROGRAMME OUTCOMES (PO)

PO 1. Critical Thinking:

1.1. Acquire the ability to apply the basic tenets of logic and science to thoughts, actions and interventions.
1.2. Develop the ability to chart out a progressive direction for actions and interventions by learning to recognize the presence of hegemonic ideology within certain dominant notions.
1.3 Develop self-critical abilities and the ability to view positions, problems, and social issues from multiple perspectives.

PO 2. Effective Citizenship:

2.1. Learn to participate in nation building by adhering to the principles of sovereignty of the nation, socialism, secularism, democracy, and the values that guide a republic.
2.2. Develop and practice gender sensitive attitudes, environmental awareness, empathetic social awareness about various kinds of marginalisation and the ability to understand and resist various kinds of discrimination.
2.3. Internalise certain highlights of the history of the region, especially of the freedom movement, the renaissance within native societies and the project of modernisation of the post- colonial society.

PO 3. Effective Communication:

3.1. Acquire the ability to speak, write, read, and listen clearly in person and through electronic media in both English and in one Modern Indian Language

3.2. Learn to articulate, analyze, synthesize, and evaluate ideas and situations in a well- informed manner.

3.3. Generate hypotheses and articulate assent or dissent by employing both reason and creative thinking.

PO 4. Interdisciplinarity:

4.1. Perceive knowledge as an organic, comprehensive, interrelated, and integrated faculty of the human mind.

4.2. Understand the issues of environmental contexts and sustainable development as a basic interdisciplinary concern of all disciplines.

4.3. Develop aesthetic, social, humanistic, and artistic sensibilities for problem solving and evolving a comprehensive perspective.

<u>Programme Specific Outcomes of B.Sc. Biotechnology Programme</u>

PSO1	Understand the organization, structure and functions of living cells, cell organelles, biological macromolecules, and interaction of an organism with its surroundings.
PSO2	Understand the genes, heredity, flow of genetic information and reaction pathways in the biological system.
PSO3	Understand the methods of modification of genes and biological macromolecules and large-scale production of useful products by making use of cell/tissue culture, microbes, plants, and animals.
PSO4	Perform laboratory experiments that help to understand the biological processes, manipulation and the production and isolation of useful products.
PSO5	Understand the requirements of bio entrepreneurship, product design, basic management techniques, entrepreneurial skills, and funding agencies.
PSO6	Understand the various mechanisms enzyme kinetics, inhibition and regulation Apply enzyme technology in various fields
PSO7	Understand molecular basis of human genetic diseases, diagnostic and therapeutic procedures

PROGRAM OUTLAY FOR THE FOUR-YEAR UNDERGRADUATE PROGRAM IN BIOTECHNOLOGY

In the Eighth semester there is a choice to take up 3 courses or a project for 12 credits.

Level of the course	Semester	Course Code	Name of the Course	CREDITS			Whether the course is offered as Minor also
				Theory	Practical	Total	
Foundation level 100-199	I	KU 1 DSC BTC101	WORLD OF BIOTECHNOLOGY	4		4	Yes
	I	KU 1 DSC BTC102	FOOD BIOTECHNOLOGY	3	1	4	Yes
	I	KU 1 DSC BTC103	MICROBIOLOGY FOR BIOTECHNOLOGY	3	1	4	
	II	KU 2 DSC BTC104	BASIC CELL BIOLOGY	3	1	4	Yes
	II	KU 2 DSC BTC105	BIOCHEMISTRY FOR BIOTECHNOLOGY	3	1	4	
	II	KU 2 DSC BTC 106	BIOPHYSICS	4		4	
Intermediate level 200-299	III	KU 3 DSC BTC 201	EMBRYOLOGY AND DEVELOPMENTAL BIOLOGY	4		4	
	III	KU 3 DSC BTC 202	GENETICS	3	1	4	Yes
	IV	KU 4 DSC BTC 203	MARINE BIOTECHNOLOGY	3	1	4	Yes
	IV	KU 4 DSC BTC 204	MOLECULAR BIOLOGY	3	1	4	
	IV	KU 4 DSC BTC 205	BIOSTATISTICS	4		4	
	V	KU 5 DSC BTC 301	IMMUNOLOGY	4		4	
	V	KU 5 DSC BTC 302	GENETIC ENGINEERING	3	1	4	Yes

Higher level 300-399	V	KU 5 DSC BTC 303	PLANT BIOTECHNOLOGY	3	1	4	Yes
	V	KU 5 DSC BTC 304	ANIMAL BIOTECHNOLOGY	4		4	Yes
	V	KU 5 DSE BTC 301	FORENSIC BIOTECHNOLOGY	4		4	
	V	KU 5 DSE BTC 302	INTERMEDIARY METABOLISM	4		4	
	VI	KU 6 DSC BTC 305	ECOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY	3	1	4	Yes
	VI	KU 6 DSC BTC 306	BASIC BIOINFORMATICS	3	1	4	
	VI	KU 6 DSC BTC 307	BIOPROCESS AND INDUSTRIAL BIOTECHNOLOGY	3	1	4	Yes
	VI	KU 6 DSC BTC 308	MEDICAL BIOTECHNOLOGY	4		4	Yes
	VI	KU 6 DSE BTC 303	VACCINE BIOTECHNOLOGY	4		4	
	VI	KU 6 DSE BTC 304	PHARMACEUTICAL BIOTECHNOLOGY	4		4	
	VI	KU 6 DSC BTC 309	INTERNSHIP			2	
Capstone / Advanced level 400-499	VII	KU 7 DSC BTC 401	MOLECULAR IMMUNOLOGY	3	1	4	Yes
	VII	KU 7 DSC BTC 402	OMICS AND BIOINFORMATICS	3	1	4	Yes
	VII	KU 7 DSC BTC 403	MOLECULAR CELL BIOLOGY	3	1	4	
	VII	KU 7 DSC BTC 404	INTELLECTUAL PROPERTY RIGHTS	4		4	
	VII	KU 7 DSE BTC 401	BIOENTREPRENEURSHIP	4		4	Yes
	VII	KU 7 DSE BTC 402	BIOINSTRUMENTATION	4		4	
	VII	KU 7 DSE BTC 403	BIOTECHNOLOGY IN PHARMACOGNOSY & ETHNOMEDICINE	3	1	4	Yes
	VIII	KU 8 DSC BTC 405	RESEARCH METHODOLOGY	4		4	
	VIII	KU 8 DSC BTC 406	NANOBIOTECHNOLOGY	4		4	

	VIII	KU 8 DSC BTC 407	MOLECULAR DIAGNOSTICS	3	1	4	Yes
	VIII	KU 8 DSC BTC 408	PROJECT	12		12	
	VIII	KU 8 DSE BTC404	PRINCIPLES OF DRUG DESIGN AND DEVELOPMENT	4		4	Yes
	VIII	KU 8 DSE BTC 405	ENZYMOLOGY	4		4	
	VIII	KU 8 DSE BTC 406	STEM CELL AND NEUROBIOLOGY	4		4	Yes
	VIII	KU 8 DSE BTC 407	ONLINE /MOOC COURSE I	4		4	
	VIII	KU 8 DSE BTC 408	ONLINE/MOOC COURSE II	4		4	
	VIII	KU 8 DSE BTC 409	ONLINE/MOOC COURSE III	4		4	

MINOR PATHWAY COURSES: BIOTECHNOLOGY						
				CREDITS		
Level of the course	**Semester**	**Course Code**	**Name of the Course**	**Theory**	**Practical**	**Total**
Foundation level 100-199	I	KU 1 DSC BTC101	WORLD OF BIOTECHNOLOGY	4		4
	I	KU 1 DSC BTC102	FOOD BIOTECHNOLOGY	3	1	4
	II	KU 2 DSC BTC103	BASIC CELL BIOLOGY	3	1	4
	II	KU 2 DSC BTC105	ANIMAL CELL BIOTECHNOLOGY (OM)*	4		4
	III	KU 2 DSC BTC 208	PLANT TISSUE CULTURE AND CROP IMPROVEMENT(OM)*	3	1	4
	III	KU 3 DSC BTC 202	GENETICS	3	1	4
	IV	KU 4 DSC BTC 204	MARINE BIOTECHNOLOGY	3	1	4

	V	KU 5 DSC BTC 302	GENETIC ENGINEERING	3	1	4
	V	KU 5 DSC BTC 303	PLANT BIOTECHNOLOGY	3	1	4
	V	KU 5 DSC BTC 304	ANIMAL BIOTECHNOLOGY	4		4
	VI	KU 6 DSC BTC 305	ECOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY	3	1	4
	VI	KU 6 DSC BTC 307	BIOPROCESS AND INDUSTRIAL BIOTECHNOLOGY	3	1	4
	VI	KU 6 DSC BTC 308	MEDICAL BIOTECHNOLOGY	4		4
Capstone / Advanced level 400-499	VII	KU 7 DSC BTC 401	MOLECULAR IMMUNOLOGY	3	1	4
	VII	KU 7 DSC BTC 402	OMICS AND BIOINFORMATICS	3	1	4
	VII	KU 7 DSE BTC 401	BIOENTREPRENEURSHIP	4		4
	VII	KU 7 DSE BTC 403	BIOTECHNOLOGY IN PHARMACOGNOSY & ETHNOMEDICINE	3	1	4
	VIII	KU 8 DSC BTC 407	MOLECULAR DIAGNOSTICS	3	1	4
	VIII	KU 8 DSE BTC404	PRINCIPLES OF DRUG DESIGN AND DEVELOPMENT	4		4
	VIII	KU 8 DSE BTC 406	STEM CELL AND NEUROBIOLOGY	4		4

(OM)* Only offered for Minor pathway in the particular semester

GENERAL FOUNDATION COURSES: BIOTECHNOLOGY

SKILL ENHANCEMENT COURSES (SEC)

Semester	Course Code	Name of the course	Credits		
			Theory	Practical	Total
IV	KU 4 SEC BTC 101	BIOFERTILIZERS, BIOPESTICIDES AND BIOFUELS	1	2	3
V	KU 5 SEC BTC 102	VERMICOMPOSTING AND MUSHROOM CULTIVATION	1	2	3
VI	KU 6 SEC BTC 103	SKILL DEVELOPMENT COURSE IN BIOTECHNOLOGY	1	2	3

VALUE ADDED COURSES (VAC)

Semester	Course code	Name of the course	Credits		
			Theory	Practical	Total
III	KU 3 VAC BTC 101	BIOTECHNOLOGY IN SUSTAINABLE DEVELOPMENT	3		3
IV	KU 4 VAC BTC 102	HEALTH CARE BIOTECHNOLOGY	3		3
IV	KU 4 VAC BTC 103	ETHICS IN BIOTECHNOLOGY	3		3

MULTIDISCIPLINARY COURSES (MDC)

Semester	Course code	Name of the course	Credits		
			Theory	Practical	Total
I	KU 1 MDC BTC 101	BIOTECHNOLOGY AND BUSINESS	3		3
II	KU 2 MDC BTC 102	APPLIED BIOTECHNOLOGY	3		3

COURSES OFFERED IN THE FIRST SEMESTER 4YR UGP BSC BIOTECHNOLOGY PROGRAM

KU 1DSC BTC 101: WORLD OF BIOTECHNOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours / week
I	DSC	Foundation	KU 1 DSC BTC 101	4	4

Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
Lecture	Practical	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

Course Description:

The World of Biotechnology course introduces the fundamental principles and applications of biotechnology. Students will be able to explore the core concepts underlying the manipulation of living organisms for various purposes, including healthcare, agriculture, environment, and industry. The course covers basic tools in biotechnology, offering a foundation for further studies in this rapidly evolving field.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the basics of biotechnology	U
2	Understand agricultural and aquatic biotechnology	U
3	Apply Biotechnology in medicine and forensics	A
4	Understand the concept of fermentation, food biotechnology and bio entrepreneurship	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

	PSO1	PSO2	PSO3	PSO4	PSO 5	PSO 6	PSO 7
CO1	√						
CO2			√				
CO3			√				
CO4				√			

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**BIOTECHNOLOGY FOUNDATION**	
	1	The Biotechnology century and its workforce	3
	2	An introduction to genes and genomes	4
	3	Recombinant DNA technology and genomics	5
	4	Proteins as products	3
2		**GREEN AND BLUE BIOTECHNOLOGY (Brief Overview)**	
	1	Plant Biotechnology	4
	2	Animal Biotechnology	4
	3	Bioremediation	4
	4	Aquatic Biotechnology	3
3		**RED AND GOLD BIOTECHNOLOGY (Brief Overview)**	
	1	Medical Biotechnology	4
	2	Pharmaceutical Biotechnology	4
	3	Nano Biotechnology	4
	4	DNA fingerprinting and forensic analysis	3

4	**WHITE AND YELLOW BIOTECHNOLOGY (Brief Overview)**		
	1	Bioprocess Technology	5
	2	Food Biotechnology	4
	3	Microbial Biotechnology	4
	4	Bio entrepreneurship	2

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. T.A Brown (2020) Gene Cloning and DNA analysis (8th edition) Wiley-Blackwell publishing.
2. Bernard R Glick (2017) Molecular Biotechnology (5th edition)-ASM press.
3. Benjamin A Pierce (2012) Genetics: A conceptual approach (4th edition). W.H Freeman and Company.
4. Holger Patzelt and Thomas Brenner (2008). "Handbook of Bio entrepreneurship," Springer publications.
5. A.H Emrey and S Malcolm (1995). Recombinant DNA (2nd edition)- John Wiley & Sons.
6. David E Burns, Edward R. Ashwood, Carl A Burtis (2013). Fundamental of Molecular Diagnostics (5th edition)- Saunders Group.
7. V Sreekrishna (2011). Comprehensive nanobiotechnology- Ist edition - New Age international (P) Ltd; ISBN 978-81-224- 3082-0.

JOURNALS

8. "Cell" - A peer-reviewed scientific journal.
9. "Nature Biotechnology" - A leading journal in the field.
10. “Journal of Biotechnology”
11. “Trends in Biotechnology”

WEBSITES

12. Genetic Science Learning Center (GSLC) - https://learn.genetics.utah.edu/
13. World Health Organization (WHO) - https://www.who.int/ -
14. National Center for Biotechnology Information (NCBI) - https://www.ncbi.nlm.nih.gov/

Reference Distribution:

Module	Unit	Reference No.
1	1	2
	2	1
	3	1
	4	1
2	1	15
	2	17
	3	21
	4	21

3	1	5
	2	20
	3	7
	4	16
4	1	18
	2	19
	3	18
	4	4

Suggested Readings:

1. Kalyan Kumar De (1997)-Plant cell and tissue culture-New Central Book Agency
2. Lincoln P.J and Thomson. J (1998). Forensic DNA profiling protocols- 1st edition, Humana Press.
3. R Ian Freshney (2021). Culture of Animal Cells-John Wiley & Sons
4. Stanbury PF, A Whitaker and S J Hall (2013). Principles of fermentation technology- Elsevier
5. S. N Tripathy (2004). Food Biotechnology- Dominant publications
6. Patrick, Graham L (2017). Introduction to Medicinal Chemistry - Oxford University Press
7. Agarwal S.K (1999). Environmental Biotechnology- APH Publishing corporation

JOURNALS

1. Biotechnology Advances
2. Biotechnology Journal

WEBSITES

1. Biotechnology Innovation Organization (BIO) - https://www.bio.org/
2. National Institute of General Medical Sciences (NIGMS) - Biomedical Beat - https://biobeat.nigms.nih.gov/

Assessment Rubrics:

Evaluation Type		Marks (%)
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

- **Employability for the Course:**
- Biopharmaceutical Industry: Bioprocess engineer, research scientist, regulatory affairs specialist.
- Biotechnology Research Institutions: Research assistant, research associate, laboratory technician.
- Agri-Biotech Companies: Genetic engineer, crop scientist, research associate in plant biotechnology.

- Medical Diagnostics and Imaging: Clinical research associate, laboratory technologist, medical researcher.
- Government Agencies and Regulatory Bodies: Regulatory affairs specialist, policy analyst, inspector.
- Pharmaceutical Companies: Formulation scientist, pharmaceutical researcher, quality control analyst.
- Academia: Lecturer, academic researcher.
- Clinical Trials and Pharmacovigilance: Clinical research associate, pharmacovigilance specialist.
- Forensic Biotechnology: Forensic scientist, DNA analyst.

KU 1 DSC BTC 102: FOOD BIOTECHNOLOGY

Semester	Course Type	Course Level	Course Code	Credits		Total Hours / week
I	DSC	Foundation	KU 1 DSC BTC 102	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
	Lecture	Practical	Tutorial	CE	ESE	Total	
Modules 1, 2, and 3	3			30	70	100	2
Module 4		2		40	60	100	2

Course Description:

1. Food biotechnology is a process used to enhance the production, nutritional value, safety, and taste of foods. Food Biotechnology emphasizes modern techniques in food microbiology, biotechnology, and food analysis. Other areas of strong

interest are fermentation to improve foods, food ingredients, functional foods, and food waste remediation. Food Biotechnology is beneficial to develop an in-depth knowledge of food science, and food processing and composition, focusing on biotechnology applied to food. Can have jobs in food processing companies where they work in different sections like Production, Quality Assurance, R&D (Research and Development), etc. Can work as a Sensory scientist or Quality controller to monitor organic properties like aroma, flavor, quality, hygiene, and more. Students will be able to understand how biotechnology can be utilized for improving the nutritional content of foods.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Gain detailed knowledge of the role of microorganisms in food production.	U
2	Demonstrate competence in basic fermentation techniques.	R
3	Understand the principle of food preservation and food preservation techniques.	U
4	Understand food spoilage and food borne illness and HACCP.	U

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7
CO 1				√			
CO 2				√			
CO 3	√						
CO 4	√						

COURSE CONTENT

MODULE	UNIT	DESCRIPTION	HOURS
1	**INTRODUCTION TO FERMENTATION AND FERMENTED BEVERAGES**		
	1	Food fermentation, Primary and secondary fermentation.	3
	2	Fermented beverages-Wines and different types of Wines.	3
	3	Brewing- steps involved in Beer production.	4
	4	Distilled liquors (Whisky, Brandy, Rum, Vodka, Tequila, Gin).	5

2	**FERMENTED FOOD PRODUCTS**		
	1	Fermented milk products - Cheese, Butter, Yoghurt and Kefir.	5
	2	Fermented vegetables – Sauerkraut and Kimchi.	3
	3	Bread and other indigenous fermented foods (Idly).	3
	4	Single cell protein - Spirulina.	4

	1	Principles of food preservation - high temperature and low 5 temperature storage, drying, food additives, chemicals, irradiation and Pascalization.	5
	2	Preservation of milk, meat, fish, fruits, and vegetables.	2
	3	Food spoilage - Spoilage of milk, canned food, fruits and vegetables.	4
	4	Hazard Analysis Critical Control Points (HACCP). FSSAI.	4
4	**LABORATORY EXPERIMENTS**		
	1	Production and characterization of wine.	8
	2	Production of beer.	7
	3	Production of cheese	5
	4	Production of yoghurt	5
	5	Production of sauerkraut.	5
3	**FOOD PRESERVATION AND SPOILAGE**		
5	**Teacher Specific Module**		**5**
	Directions		

Essential Readings:

1. Industrial microbiology. A H Patel. MacMillian (2008)
2. Food Biotechnology- S.N Tripathy - Dominant pu (2004)
3. Bioprocess technology. P T Kalaichelvan, I ArunPandi. MJP publishers (2021)

Reference Distribution:

Module	Unit	Reference No.
1	1	2
	2	1
	3	2
	4	2
2	1	5
	2	6
	3	1
	4	2
3	1	2
	2	2
	3	2
	4	2
4	1	2
	2	4
	3	5
	4	6

Suggested Readings:

1. Principles of fermentation technology. Stanbury PF, A Whitaker, and S J Hall. Elsevier (2013)
2. Biotechnology. A textbook of Industrial Microbiology. Wulf Crueger and Annelies Crueger. 3rd edn-Medtech (2017)
3. Industrial Microbiology. L E Casida. 2nd edn- NEW AGE International Publications (2019)

Assessment Rubrics:

	Evaluation Type		Marks (%)
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate	**5**
		Assignment	**5**
		Product development	**10**
	End Semester Evaluation		**70**
	Total		**100**

	Evaluation Type		Marks (%)
Practical Part	**Continuous Evaluation**	**Lab performance**	**60**
	End Semester Evaluation	**Record**	**15**
		Viva Voce	**25**
	Total		**100**

Percentage of marks in the course = (percentage of marks in theory * 3 + percentage of marks in practical) / 4

- **Employability for the Course:**
- Food Technologist
- Nutritional science
- Quality Manager
- Research Scientist

KU 1 DSC BTC 103: MICROBIOLOGY FOR BIOTECHNOLOGY

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
1	DSC	Foundation	KU 1 DSC BTC 103	Total	4	5
				Module 1-3	3	3
				Module 4	1	2

	Learning Approach (Hours/ Week)			Marks Distribution% Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1, 2, 3	3		0	30	70	100	2
4		2		40	60	100	2

Course Description:

This course offers a comprehensive study of the field of microbiology to science majors. The course will give detailed insights into the major themes: Structure and function of microbes (cellular structures, and growth), microbial genetics, and the various tools and techniques for cultivation and growth of microbes. Students are expected to participate in active learning activities and participate in class discussion to deepen their understanding of the microbial world and apply their knowledge to various concepts.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understanding of the structural similarities and differences among microbes and the unique structure/function relationships of prokaryotic cells.	U
2	Understand the fundamentals of microbiology.	U
3	Analyse the diversity of microorganisms and microbial communities	An
4	Apply the knowledge of microbial structure, growth, and metabolism to the identification of an unknown microorganism	A
5	Apply aseptic technique and perform routine culture handling tasks safely and effectively.	A
6	Apply scientific method to collect, interpret, and present scientific data in microbiology and related fields.	A
7	Apply calculations related to the preparation of media, stock/working solutions, and culture dilutions	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**History of Development of Microbiology and Diversity of Microbial World**		
	1	Fundamentals, History and Evolution of Microbiology. Morphology and cell structure of major groups of microorganisms e.g., Bacteria-The ultrastructure of bacterial cell Gram positive and Gram negative, Archaebacteria and Unique features of viruses.	5

	2	Microscopy and Stains: Microscope- Simple and Compound: Principle. Parts, Functions and Applications. Dark Field and Phase Contrast Microscope, Electron Microscope-SEM and TEM.	3
	3	Stains and Staining Solutions Definition of Dye and Chromogen. Structure of Dye and Chromophore. Functions of Mordant and Fixative. Natural and Synthetic Dyes. Simple Staining, Differential Staining and Acid-Fast Staining.	3
	4	Nutrition, Cultivation and Enumeration of Microorganisms: Nutritional Requirements: Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulphur and Growth Factors.	4

2	**Microbial Culture**		
	1	Classification of Different Nutritional Types of Organisms	5
	2	Design and Types of Culture Media. Simple Medium, Differential, Selective and Enrichment Media, Concept of Isolation and Methods of Isolation. Pure Culture Techniques	3
	3	Growth and Enumeration: Growth Phases, Growth Curve. Arithmetic Growth and Growth Yield. Measurement of Growth. Chemostat and Turbidostatic Enumeration of Microorganisms- Direct and Indirect Methods.	4

	4	Preservation of Cultures- Principle and Methods. Cryogenic Preservation Advantages and Limitations	3

3	**Basic Techniques used in Microbiology**		
	1	Gene transfer in microorganisms: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria	3
	2	Control of Microorganisms: By physical, chemical, and chemotherapeutic Agents; Sterilization Techniques Definition: Sterilization and Disinfection. Types and Applications Dry Heat, Steam under pressure, Gases, Radiation and Filtration	5

	3	Chemical Agents and their Mode of Action - Aldehydes, Halogens, Quaternary Ammonium Compounds,	3
	4	Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant	4

4	**Laboratory Experiments**		
	1	Use and care of microscopes	2
	2	Microscopy- Staining -Simple, Negative, Differential staining: Gram staining,	3
	3	Microscopy- Hanging drop motility,	3
	4	Fungal staining-LPCB.	3
	5	Cleaning and sterilization of glassware	2
	6	Use of Hot Air Oven, Autoclave, Incubator, Water bath, Colony counter, Laminar air flow	2
	7	Preparation of culture media - Simple, Selective, Differential	4
	8	Isolation of bacteria by Streak plate method, spread plate and pour plate technique	3
	9	Isolation of microorganisms from soil samples. (Serial dilution and pour plating) and Quantitative estimation of viable microorganisms.	2
	10	Metabolic characterization of bacteria (IMViC test)	3
	11	Antibiotic sensitivity test-use of antibiotic disc diffusion method (Kirby Bauer Technique)	3
	12	Introduction to screening of microbes for metabolites using some easy to detect plate screening methods (E.g. iodine staining for amylase)	3

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Microbiology: Concepts and applications –Michel J Pelczar, E.C.S Chan, Noel R Kreig- 5 edn- AEW Press (2023)
2. Prescott, Harley, and Klein's Microbiology-Prescott-10th edn- McGraw Hill (2017)
3. Microbial Genetics David Frefeilder, Narosa-(2008)

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	2
	3	3
	4	3
2	1	2
	2	1

	3	1
	4	3
3	1	2
	2	3
	3	2
	4	3

Suggested Readings:

5. Textbook of Microbiology- J Black-8th edn-Wiley (2012)
6. Fundamentals of Microbiology- Jeffery Pommerville-2nd edn-Jones and Bartlett (2013)
7. Brock biology of Microorganisms-Michael T Madigan-14th edn-Pearson (2017)
8. Microbiology an introduction-Gerald J Torto-13th edn-Pearson (2020)
9.

Assessment Rubrics:

	Evaluation Type		Marks
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		Marks (%)
Practical	**Continuous Evaluation**	**Lab performance**	**6**

Part		**Record**	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability for the Course:**
- Microbiologist
- Food industry
- Medical field

COURSES OFFERED IN THE SECOND SEMESTER 4YR UGP BSC BIOTECHNOLOGY PROGRAM

KU 2 DSC BTC104: BASIC CELL BIOLOGY

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours/Week
2	DSC	Foundation level	KU 2 DSC BTC104	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
	Lecture	Practical	Tutorial	CE	ESE	Total	
Modules 1, 2, and 3	3			30	70	100	2
Module 4		2		40	60	100	2

Course Description:

The Basic Cell biology course introduces the fundamentals of a cell. Students will be able to understand the origin of a cell, different types of cells, its structure and function, cell division and cell death.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the organization of cell, various level of cellular organization	U
2	Illustrate the structure of cell	U
3	Gain insights on genome organization	U
4	Understand cell cycle and cell division, consequences of uncontrolled cell division	U

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO6	PSO7
CO 1	√						
CO 2	√						
CO 3	√						
CO 4				√			
CO 5							

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS

1	**Module 1 Introduction to cell and cell theory**		
	1	Cell as a basic unit of life- brief introduction on theory of biogenesis and abiogenesis, early conditions on earth- Haldane and Oparin theory of the origin of life, Urey-Miller experiment, Fox's experiments. Robert Hooke –Discovery of cells and cell theory.	6
	2	General organization of cells, broad classification of cell types-PPLO, bacteria, eukaryotic microbes, plant cell and animal cell.	4
	3	Different levels of organization-cell, tissue, organ, and organism as different level of organization	3
	4	Brief account on the structure of cell membrane and cytoplasmic matrix	2

2	**Module 2 Cellular organization**		
	1	Structure and functions of cell organelles-Structure and functions of cell organelles – Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, Nucleolus, Nucleoplasm and Chromatin). Vacuole, brief account on cytoskeleton structures (Microtubules, Microfilaments, and Intermediate filaments)	7
	2	Chromosome structure-General introduction, discovery, morphology, and structural organization-centromere, secondary constriction, telomere, chromonema, Organization of chromatin-Euchromatin and Heterochromatin, karyotype	4
	3	Nucleosome model, Single-stranded and multistranded hypothesis, folded- fiber, Nucleoproteins -histone and non-histone proteins	2
	4	Special type of chromosomes: Salivary gland and Lamp brush chromosomes	2

3	**Module 3 Cell cycle and cell division**	

	1	Mitosis and meiosis – Phases and significance of cell cycle.	4
	2	Control of cell cycle- regulation of cell cycles (brief description on G1, S and G2 checkpoints, cyclins and Cdks),	5
	3	Cancer-brief account on the fate of cells undergoing uncontrolled division	3
	4	Apoptosis (brief account) - intrinsic & extrinsic pathways of programmed cell death	3

4	**Module 4 Practical**		
	1	Study of mitosis using onion root tip	5
	2	Barr body staining	5
	3	Observing meiotic stages under microscope (permanent slides)	10
	4	Measurement of cell size using micrometry	10

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

1. Cytology, Verma P S and Agarwal V.K, 9 March 2021 S. Chand Publications, New Delhi, 978-8121908146
2. Cell Biology and molecular biology, N Arumugam, 1 January 2019 Saras publications

Reference Distribution:

Module	**Unit**	**Reference No.**

1	1	1
	2	2
	3	2
	4	1
2	1	1
	2	1
	3	1
	4	1
3	1	1
	2	1
	3	1
	4	1
4	1	
	2	
	3	
	4	

Suggested Readings:

1. Karp’s Cell and Molecular Biology (9th edition) Gerald Karp, Janet Iwasa, Wallace Marshall (2020) Wiley.

2. Molecular Cell Biology (9th edition) Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Kelsey C. Martin, Michael Yaffe, Angelika Amon (2021) W. H. Freeman.
3. Essential Cell Biology (7th Edition). Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Roff, Keeth Roberts, Peter Walter (2022) W. W. Norton & Company
4. The world of the cell (7th edition). Becker, Wayne M.; Kleinsmith, Lewis J.; Hardin, Jeff; Bertoni, Gregory Paul (2008) Benjamin Cummings.
5. The Cell: A Molecular Approach (9th Edition) Geoffrey M. Cooper and Kenneth W. Adams (2022) Oxford University Press.
6. Cell and molecular biology (8th edition) Eduardo D.P. DeRobertis and E.M.P. DeRobertis (2017) Lea & Febiger, U.S.
7. Cell Biology (4th edition) Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott- Schwartz, Graham Johnson (2023) f Elsevier.

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		Marks (%)
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

Percentage of marks in the course = (percentage of marks in theory * 3 + percentage of marks in practical) / 4

Employability for the Course / Programme

- Clinical diagnostics: Clinical research associate, laboratory technologist, medical researcher.
- Biotechnology Research Institutions: Research assistant, research associate, laboratory technician.
- Academia: Lecturer, academic researcher.

KU 2 DSC BTC 104: BIOCHEMISTRY FOR BIOTECHNOLOGY

	Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
	2	DSC	Foundation	KU 3 DSC BTC 104	Total	4	4
					Module 1-3	3	
					Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1, 2, 3	3		0	30	70	100	2
4		1		40	60	100	2

Course Description:

• This course is designed to serve as a bridge-course between the basics of chemistry and biology learnt in school, and those which will be taught in this degree program.

• It emphasizes on the basic chemical foundations of life: water, carbohydrates, lipids, amino acids, proteins, and nucleic acids, and their unique structural, and physico-chemical properties.

• It also aims to provide hands-on practical training for the qualitative aand quantitative analysis of different biomolecules.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the chemical and molecular foundations of life and their roles	U

	in biological systems.	
2	Comprehend the classification, structure, chemical properties and biological functions of carbohydrates & lipids, amino acids, proteins, and nucleic acids.	U
3	Comprehend the classification, structure, chemical properties and biological functions of amino acids, proteins, and nucleic acids.	U
4	Prepare biochemical solutions and analyse various biomolecules qualitatively and quantitatively in the laboratory.	U
5	Analyze Enzyme Kinetics and Enzyme Mechanisms	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

CO 4	√						
CO 5	√						

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**INTRODUCTION TO BIOCHEMISTRY**	
	1	Foundation of Life. Introduction to cellular, physical and chemical foundations of life.	3
	2	Water: Properties of water, Water a biological solvent, Proton mobility, fitness of the aqueous environment for living organisms, self-ionisation of water: Kw and pKw. Acid base reactions, pH, pOH, pKa, weak and strong acids, physiological importance of pH;	3
	3	Buffers: Buffers, buffer action, buffer capacity, Henderson – Hasselbalch equation, its limitations and uses, laboratory use of buffers, physiological importance of buffers in body fluids and tissues.	3
	4	Measurement of pH: indicators, pH meter, different types of electrodes, advantages and disadvantages of different electrodes, principle, working, application, factors affecting pH determination.	4
	5	Chemical bonding (covalent, ionic, Hydrogen, Van der Waal’s, hydrophobic).	2

		CARBOHYDRATES AND LIPIDS	
2	1	CARBOHYDRATES Classification, chemical and physical properties. Monosaccharide: stereoisomers, enantiomers, epimers, mutarotation. Disaccharides: sucrose, lactose, and maltose. Polysaccharides: homo and hetero polysaccharides.	7
	2	LIPIDS Classification, chemical and physical properties. Fatty acids: saturated, unsaturated, and essential fatty acids; rancidity, saponification number, iodine number, acid number and Reichert– Meissl number. Structure and biological functions of triacylglycerol, phospholipids, sphingolipids, cerebrosides, steroids and other lipids.	8
		PROTEINS AND NUCLEIC ACID	
3	1	PROTEINS Classification, chemical and physical properties of amino acids. Peptide bond. Structural hierarchy of proteins: primary, secondary, tertiary and quaternary structures	7
	2	NUCLEIC ACIDS Chemistry of purine and pyrimidine, nucleosides, and nucleotides. Types of DNA: structure and properties of A-, B- and Z-DNA. Denaturation, renaturation, Tm and hyperchromicity. Types and functions of RNA: rRNA, mRNA, tRNA. Primary, secondary, and tertiary structures of tRNA.	8
	3	ENZYMOLOGY Enzymology: Basic definition, classification and nomenclature- classical & EC recommendation.	15

		Coenzymes, Active site. Enzyme kinetics- single substrate, M.M equation, determination of Vmax & Km, LB plot. Sequential and ping pong mechanism. Activation energy in enzyme reactions, Equilibrium and steady state kinetics, Turn over number, Kcat, Catalytic efficiency, Enzyme Units and specific activity. Research and Industrial uses of enzymes	
	LAB (PRACTICAL)		
4	1	Introduction to Biochemistry Lab: Understanding of Lab Protocols. Safety aspects in Biochemical Laboratory.	1
	2	Biochemical reagent preparations for various solutions with respect to different Normality, Molarity, % Solutions (W/V), (V/V)	2
	3	Determination of pH measurements using pH paper & pH meter.	3
	4	Preparation of buffer and its pH determination.	3
	5	Qualitative tests for Carbohydrate.	3
	6	Qualitative tests for Amino acids.	3
	7	Separation of amino acids by Thin Layer Chromatography.	3
	8	Estimation of glucose by O-Toluidine method.	3
	9	Estimation of protein by Biuret method.	3

	10	Estimation of RNA by Orcinol method.	3
	11	Analyze the effect of pH/temperature/time/substrate concentration on enzyme activity	2
	12	Calculate Michaelis-Menten constant on enzyme activity using LDH as an example	2

Essential Readings:

1. Leininger's Principles of Biochemistry, Nelson and Cox (2012) : Principles of
2. Biochemistry (Worth Publ. Inc. USA)
3. Biochemistry, 5th Edition. Garrett and Grisham
4. Biochemistry, 3rd Edition. Matthews, van Holde, and Ahern
5. Biochemistry. 7th edition. Berg JM, Tymoczko JL, Stryer L. New York: W H Freeman;2014
6. Textbook of Biochemistry with Clinical Correlations, 7th Edition by T. Devlin
7. 6. Voet, D. and Voet, J.G. (2012): Biochemistry 4th ed., (John Wiley & Sons Inc/, New York)
8. Harper's Review of Biochemistry, 25th Edition. Murray RK, Rodwell VW.
9. 8.Introductory Practical Biochemistry by S. K. Sawhney and Randhir Singh. Narosa Publishing House.

Reference Distribution:

Module	Unit	Reference No.
1	1	3
	2	2
	3	1
	4	6

	5	7
2	1	4
	2	5
3	1	1
	2	5
4	1	8
	2	8
	3	8
	4	8
	5	8
	6	8
	7	8
	8	8
	9	8
	10	8
5	1	
	2	
	3	

	4	

Suggested Readings:

10. Concepts in Biochemistry, 3rd Edition. Rodney Boyer
11. 2. http://en.wikibooks.org/wiki/Biochemistry
12. 3.. Introduction to Practical Biochemistry. T. Plummer.
13. 4.. Biochemistry, 4th Edition. U. Satyanarayana and U. Chakrapani. Elsevier; 2013.
14. Lodish et al. Molecular Cell Biology. 8th Edition. W. H. Freeman and Company.

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		**Marks (%)**
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

Employability for the course/programme:

1. Academic Researcher.
2. Scientific Laboratory Technician.
3. Medical Biochemist.
4. Pharmacologist.
5. Analytical Chemist.
6. Quality Control Analyst

KU 2 DSC BTC 106: BIOPHYSICS

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours/Week
	2	DSC	Foundation	KU 2 DSC BTC 106	4	4

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
Module	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description:

The course delves into the intricate physical phenomena governing biological systems. It mainly aims to study life at molecular and cellular level, focusing on structure, function, and interactions of biological molecules. It delves into areas such as structure and dynamics of macromolecules, cells and tissues, energy transformation, biological motility, and biomechanics. By the end of the course, students can familiarize themselves with concepts of macromolecules at structural and molecular level.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the laws of thermodynamics, importance and applications of surface tension, colloids, adsorption, and dialysis	U
2	Analyse the structure and conformation of nucleic acids, proteins, and their interactions	An
3	Understand membrane dynamics and transport system	U
4	Evaluate working and application of radioisotopes, and their biological significance	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

CO 1	√						
CO 2	√						
CO 3	√						
CO 4			√				

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Module 1**		
	1	Bioenergetics: Systems and surroundings (open, closed, and isolated). Laws of thermodynamics (Zeroth, first, second and third law)	3
	2	Concepts of enthalpy, entropy and free energy, thermodynamic equilibrium	3
	3	Biological importance of colloids and surface tension	4
	4	Adsorption and dialysis and their biological importance	5

2	**Module 2**		

	1	Watson Crick model of DNA, Watson – Crick and unusual base pairing (Reverse Watson Crick, Hoogsteen and reverse Hoogsteen, Wobble base pairing and anti-syn)	3
	2	Unusual structures of DNA (palindromes, G quartet, Triple helix)	5
	3	Secondary structure of proteins: alpha helix, beta sheets, triple helix collagens, dihedral angles, Ramachandran plot.	4
	4	Motifs and domains, super secondary structures, DNA-protein interactions	3

3	**Module 3**		
	1	Transport across plasma membrane: passive transport- diffusion, osmosis, facilitated diffusion	4
	2	Active transport- primary and secondary transport, types of ATPases (P type, F type, V type and ABC transporters)	1
	3	Transport across neurons- membrane potential, polarization, repolarization and hyperpolarization)	5
	4	Ligand gated and mechano gated channels	5

4	**Module 4**		
	1		4

		Radiation Biophysics- Ionizing radiations (α, β and gamma rays), rate of radioactive decay, radioactive isotopes	
	2	Interaction of radioactivity with matter- photoelectric effect, Compton Effect, electron-positron pair production, ionization, excitation	5
	3	Biological effects of radiation- dose response relationship, radiolysis of water, effects of radiation on living systems	2
	4	Applications of radioactive tracers in biological systems	2

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

1. Essentials of Biophysics; P. Narayanan; New Age International (P) ltd. publishers; 2007; ISBN: 81-224-2080-X

2. Principles of Biochemistry; Lehninger; David L Nelson, Michael M Cox; W H Freeman and company, New York; 4th ed.; 2005; ISBN: 1-4039-4876-3

3. Biophysics; G R Chatwal; Himalaya Publishing House, Bombay; 1st ed; f(1 January 2011)

4. Biological thermodynamics (2nd Ed) - Donald T. Haynie, 2013, Cambridge University Press, Cambridge.

5. A Textbook of Biophysics: For Medical Science and Biological Science Students, R. N. Roy fNew Central Book Agency (NCBA); 2nd Revised edition (26 January 2001)

Reference Distribution:

Module	Unit	Reference No.
1	1	5
	2	5
	3	6
	4	6
2	1	2
	2	2
	3	2
	4	2
3	1	2

	2	2
	3	2
	4	2
	1	3
4	2	3
	3	3
	4	3

Suggested Readings:

6. Biophysics (2nd Ed) – Vasantha Pattabhi and N. Gautham, 2009, Alpha Science International Ltd.
7. Introduction to Protein Structure - C. Branden and I. Tooz., 2012, Garland Science
8. Biophysics and bioinstrumentation; N Arumugam, V Kumaresan; Saras publication; 1st ed. 2013; ISBN 978-81-89941-63-5.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10

b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
d)	Viva	5
Total		**100**

- **Employability for the Course:**
- Biotechnology companies
- Research and Development
- Teaching
- Biophysicist
- Biological technicians

KU 2 DSC BTC 105: ANIMAL CELL BIOTECHNOLOGY

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
2	DSC	Foundation	KU 2 DSC BTC 105	Total	4	4
				Module 1-4		

Learning Approach (Hours/ Week)	Marks Distribution (%) Ratio	Duration of

						ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

Course Description:

The course offers a thorough understanding on cultivating animal cells in culture and use of biotechnological concepts to manipulate and transform animal cells for human welfare. The course includes topics ranging from basics of animal cell and tissue culture to genetically engineering animals to improve their suitability for industrial, or pharmaceutical applications.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the basics of animal cell culture	U
2	Analyse establishment of primary culture	An
3	Understand the protocol for cell culture-based production of valuable products	U
4	Evaluate the process of Monoclonal antibody and vaccine production	E
5	Analyse transgenic technology and animal cloning	An

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**Basics of Animal Cell Culture**		
	1	History and development of animal cell culture	2
	2	Equipment and materials for Animal cell culture	3
	3	Culture media for animal cell culture: Physio - chemical properties of culture media	5
	4	Balanced salt solutions – Natural and artificial media	5

2	**Culturing Animal Cells**		
	1	Primary culture: Disaggregation – mechanical and enzymatic	5
	2	Cell lines- definite and continuous/transformed cell lines, their origin and characteristics	4
	3	Growth factors promoting proliferation of animal cells (EGF, FGF, PDGF, NGF and Interleukins)	3
	4	Growth kinetics of cells in culture	3

3	**Cell culture-based production of products of biological importance**		
	1	Cell synchronization	2
	2	Bioreactors for large scale culture of cells	3
	3	Expression of cloned proteins in animal cells (erythropoietin, factor VIII, and t-plasminogen activator)	5
	4	Cell culture-based production of vaccines and monoclonal antibodies	5

4	**Transgenic Technology and Animal Cloning**		
	1	Transgenic animals- Gene transfer methods- Transgenic animal models	6
	2	Production of useful products from transgenic animals	3
	3	Animal cloning- somatic cell nuclear transfer	2
	4	Xenotransplantation; Ethics of animal cloning	2

5	**Teacher Specific Module**	**5**

	Directions	
		5

Essential Readings:

1. Animal Biotechnology-Recent Concepts to Development; P Ramadas, 2019 MJP Publishers
2. Biotechnology D Singh, 2012, Kalyani Publishers, Ludhiana
3. Biotechnology, U Satyanarayana, 2010, Books and Allied (P) Ltd
4. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	3
	3	3
	4	3
2	1	3
	2	3
	3	2
	4	3

3	1	3
	2	3
	3	7
	4	7
4	1	3,7
	2	7
	3	3
	4	2

Suggested Readings:

5. Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press.2000
6. R Ian Freshney, Culture of Animal Cells, John Wiley & Sons, 2021

7. Glick and J.J Pasternack, Molecular Biotechnology,2010. 4TH Edition, ASM Press

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
d)	Viva	5
Total		**100**

- **Employability for the Course:**
- Scientific Research
- Biotech industries
- Teaching faculty
- Entrepreneurship

COURSES OFFERED IN THE THIRD SEMESTER 4YR UGP BSC BIOTECHNOLOGY PROGRAM

KU 3 DSC BTC 201: EMBRYOLOGY AND DEVELOPMENTAL BIOLOGY

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	III	DSC	Intermediate	KU 3 DSC BTC 201	4	4

	Learning Approach (Hours/ Week)			Marks Distribution%: Ratio			Duration of ESE (Hours)
Module	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4		0	30	70	100	2

Course Description:

Help to understand production of gametes, fertilization, development of the embryo, emergence of the adult organism, senescence, and death. Developmental biology aims to understand how an organism develops—how a single cell becomes an organized grouping of cells that is then programmed at specific times to become specialized for certain tasks. Developmental biology is the science that investigates how a variety of interacting processes generate an organism's heterogeneous shapes, size, and structural features that arise on the trajectory from embryo to adult, or more generally throughout a life cycle.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the reproduction and reproductive parts of plants.	U
2	Understand the sexual reproduction in animals.	U
3	Analyse the mechanism of transcription and post transcriptional modification	An
4	Understand the cellular changes in the zygote and early, late and post fertilization events.	U
5	Understand applications of developmental biology.	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

CO 2		√					
CO 3		√					
CO 4		√					
CO 5				√			

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**PLANT DEVELOPMENT**		
	1	Microsporangium – Microsporogenesis and male gametophyte, pollen structure.	3
	2	Megasporangium - Megasporogenesis and female gametophyte, structure of female embryo sac.	3
	3	Pollination. Fertilization – Pollen - Pistil interaction, double fertilization, triple fusion, Pollen structure.	4
	4	Polyembryony, Apomixis, Parthenocarpy, Parthenogenesis.	5

2	**EMBRYONIC DEVELOPMENT**		
	1	Gametogenesis - Oogenesis and Spermatogenesis. Structure of Ovum and Sperm.	3
	2	Fertilization (mechanism of fertilization; recognition of egg and sperm, acrosome reaction, cortical reaction, changes in gametes, blocks to polyspermy).	5

	3	Types of fertilization (Internal and External).	4
	4	Implantation of embryo in humans, Placenta (Structure, and functions of placenta).	3

3	**EARLY EMBRYONIC DEVELOPMENT**		
	1	Different types of eggs and patterns of cleavage – types of cleavage based on planes (meridional, vertical, Equatorial and Latitudinal), based on amount of yolk (Holoblastic & Meroblastic), based on development. (Determinate & Indeterminate) and based on Pattern (Radial & Spiral).	5
	2	Blastulation – types and mechanism	2
	3	Gastrulation – morphogenetic movements	4
	4	Organogenesis: How do different cells of tissues combine and remodel to make organs (example: the brain and limbs).	3

4	**LATE EMBRYONIC DEVELOPMENT**		
	1	Cell-cell communication in development (induction, competence, instructive and permissive interactions, epithelial mesenchymal interactions, paracrine factors).	4
	2	Germ layers and fate maps in early embryos	4
	3	In vitro fertilization.	4
	4	Teratogenesis: Teratogenic agents and their effects on embryonic development (Brief explanation).	4

5	**Teacher Specific Module**	**5**

	Directions	
		5

Essential Readings:

1. Michael J.F Baressi and Scott F. Gilbert (2020)-Developmental Biology-12th Ed-Oxford University Press
2. Barry Mitchell and Ram Sharma (2012). Embryology-2nd Ed-Elsevier
3. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thomson Computer Press
4. Carlson, R. F. (2019). Patten's Foundations of Embryology-6th Ed-Elsevier
5. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.

Reference Distribution:

Module	Unit	Reference No.
1	1	4
	2	1
	3	2
	4	2
2	1	3
	2	1
	3	1

	4	2
3	1	2
	2	2
	3	2
	4	2
4	1	1
	2	1

Suggested Readings:

1. P.S.Verma and V.K.Agarwal (2010). Chordate Embryology – Developmental Biology- 2014 S.Chand Publishers

2. S.S.Bhojwani and S.P.Bhatnagar (2018). The Embryology of Angiosperms-Vikas publishers

3. Maheswari, P (2020). Introduction to Embryology of Angiosperms-Alpha

4. Lewis Wolpert (2002). Principles of Development. -II Edition, Oxford University Press

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
d)	Viva	5
Total		**100**

- **Employability for the Course:**
- Developmental biologist
- Research and Development
- Teaching

KU 3 DSC BTC 202: GENETICS

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
3	DSC	Intermediate	KU 3 DSC BTC 202	Total	4	5
				Module 1-3	3	3
				Module 4	1	2

	Learning Approach (Hours/ Week)			Marks Distribution% Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1, 2, 3	3		0	30	70	100	2
4		2		40	60	100	2

Course Description:

Genetics is the study of genes, heredity, and variation in organisms. This course gives an overview on the basic principles of heredity and covers topics ranging from Mendelian and non-Mendelian pattern of inheritance, gene interactions, chromosomal aberrations and population genetics.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Remember basic genetic terms and use these terms to explain genetic concepts	R
2	Analyse the concept of linkage and crossing over	A
3	Understand the influence of sex on heredity and about chromosomal aberrations	U
4	Evaluate the principles of population genetics	E
5	Create crosses and work out monohybrid and dihybrid ratios	C

***_Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)_**

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**Basic Principles of Heredity**		
	1	Genetic terminology-Basic principles of Genetics	2
	2	Mendel's works-selection of experimental plant, experimental procedures, observations, and results-back cross and test cross	3
	3	Monohybrid and dihybrid crosses, law of segregation and law of independent assortment	4

	4	Modifications of basic genetic principles-incomplete and codominance, lethality, penetrance and expressivity, pleiotropy and polygenic inheritance, multiple alleles	6

2	**Gene interactions, Linkage and Mapping**		
	1	Epistasis and its types	2
	2	Complementary genes, duplicate genes with cumulative effect	4
	3	Linkage and crossing over-complete and incomplete linkage, mechanism of crossing over, significance of linkage and crossing over	6
	4	Linkage map- two point and three-point cross	3

3	**Chromosome Variation and Population genetics**		
	1	Sex linked genes and its inheritance, X-linked, Y-linked and XY linked genes, sex limited and sex influenced genes	4
	2	Extra chromosomal inheritance-mitochondria and chloroplast genes	3
	3	Chromosomal aberrations-structural and numerical, chromosomal disorders in humans	4
	4	Population genetics- genotypic and allelic frequency, Hardy Weinberg equilibrium	4

4	**Laboratory experiments**		
	1	Karyotyping with the help of photographs	2
	2	Study of polyploidy in onion root tip by colchicine treatment	3

	3	Working out monohybrid crosses	5
	4	Working out dihybrid crosses	5
	5	Solving genetic problems- concept of dominance	5
	6	Solving genetic problems- concept of multiple alleles	5
	7	Solving genetic problems- concept of linkage and crossing over	5

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

1. P. S Verma and VK. Agarwal, (2009) Genetics, 9th Edition. S. Chand publishers.
2. K. Vijayakumaran Nair, M. Jayaprakash, (2007), Cell biology Genetics and Molecular biology Fourth edition. Academica.
3. Benjamin A. Pierce (2020). Genetics: A Conceptual Approach; VII Edition Macmillan Learning

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	1,3
	3	1
	4	2
2	1	2
	2	2
	3	1
	4	1
3	1	2
	2	1
	3	2,8
	4	1,3
4	1	3
	2	2
	3	1
	4	1

Suggested Readings:

4. Leland H. Hartwell et al., (2021) Genetics from genes to genomes. VII Edition. McGraw Hill.
5. Monroe W Strickberger (2018) Genetics. III Edition. Prentice Hall of India.
6. Principles of Genetics, Sinnot, E.W., Dunn, LC and Dobzhansky.
7. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons
8. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
9. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings

Assessment Rubrics:

<table>
<tr><th></th><th colspan="2">Evaluation Type</th><th>Marks</th></tr>
<tr><td rowspan="5">Theory part</td><td rowspan="3">Continuous Evaluation</td><td>Test Paper</td><td>10</td></tr>
<tr><td>Quiz/Debate/Seminar</td><td>10</td></tr>
<tr><td>Assignment</td><td>5</td></tr>
<tr><td colspan="2">End Semester Evaluation</td><td>50</td></tr>
<tr><td colspan="2">Total</td><td>75</td></tr>
</table>

<table>
<tr><th></th><th colspan="2">Evaluation Type</th><th>Marks (%)</th></tr>
<tr><td rowspan="5">Practical Part</td><td rowspan="2">Continuous Evaluation</td><td>Lab performance</td><td>6</td></tr>
<tr><td>Record</td><td>4</td></tr>
<tr><td rowspan="2">End Semester Evaluation</td><td>Experiment</td><td>10</td></tr>
<tr><td>Viva Voce</td><td>5</td></tr>
<tr><td colspan="2">Total</td><td>25</td></tr>
</table>

Employability for the Course:

- Scientific Researcher
- Genetic Counsellor
- Geneticist
- Teaching faculty

KU 3 DSC BTC 208: PLANT TISSUE CULTURE AND CROP IMPROVEMENT

	Semester	Course Type	Course Level	Course Code	**Credits**		Credits	Total Hours
	3	DSC	Intermediate	KU 3 DSC BTC 208	Total	4	4	4
					Module 1-3	3		
					Module 4	1		

	Learning Approach (Hours/ Week)			Marks Distribution% Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1, 2, 3	3		0	30	70	100	2
4		2		40	60	100	2

Course Description:

The course provides basic principles of plant tissue culture and regeneration pathways of callus to produce plantlets. The students gain knowledge about organ culture, different types of cultures and the procedure of each type of culture. The course also covers how the variant plants with useful characteristics are produced from plant tissue culture. The course includes the production of hybrid plants with improved characteristics through protoplast fusion. The course describes the methodology of production of transgenic plants to improve the crops with the desired traits

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the basic principles of plant tissue culture	U
2	Understand the types and significance of callus culture	U
3	Outline the principles and applications of organogenesis and somatic embryogenesis	A

4	Understand the types of organ culture	U
5	Outline the production and applications of haploid and triploid plants	A
6	Understand protoplast culture and somatic hybridization	A
7	Explain plant genetic transformation and terminator gene technology	A

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**MODULE I**		
	1	Introduction to plant biotechnology- history and development, totipotency, nutritional medium and its components	4
	2	Callus culture, types of calluses, significance, Organogenesis, factors influencing organogenesis	5
	3	Somatic embryogenesis and artificial seed	3
	4	Somaclonal variations and its applications	3

2	**MODULE II**		
	1	Organ culture- types of organ culture- root culture, shoot tip culture, ovary, and ovule culture	4
	2	Embryo culture and embryo rescue, cell suspension culture	3
	3	Production of haploid plants- anther and pollen culture, applications of haploid plants, Production of triploid plants and significance	4
	4	Germplasm storage and conservation- cryopreservation, Invitro pollination and its application	4

3	**MODULE III**		
	1	Protoplast isolation, culture, and fusion. Somatic hybridisation and its applications, hybrid and cybrid	4
	2	Plant genetic manipulation-gene transfer methods in plants, direct gene transfer methods, Agrobacterium mediated genetic transformation, Ti plasmid derived vector system	5
	3	Transgenic plants-golden rice, Bt cotton, Bt brinjal, GM Mustard, Flavr Savr tomato	4
	4	Terminator gene technology	2

4	**MODULE IV**		
	1	Plant tissue culture media preparation – MS media	5
	2	Explant selection, sterilization, and inoculation	3
	3	Callus induction from leaf, node, shoot tip	10
	4	Direct organogenesis	2
	5	Seed culture	2
	6	Cell suspension culture	3
	7	Artificial seed	2
	8	Hardening of regenerated plant	3

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Plant cell and tissue culture, Kalyan Kumar De
2. Biotechnology, Sathyanarayana
3. Biotechnology B D Singh,kalyani Publishers
4. Plant Biotechnology A Laboratory Manual- H. S. Chawla

Reference Distribution:

Module	Unit	Reference No.
1	1	1, 2
	2	1, 2
	3	1, 2
	4	1, 2
2	1	1
	2	1
	3	1
	4	1
3	1	2,3
	2	2, 3
	3	2, 3

	4	5
4	1	4
	2	4
	3	4
	4	4
	5	4
	6	4
	7	4
	8	4

Suggested Readings:

5. Introduction to Plant Biotechnology,H S Chawla,Science Publishers
6. Introduction to plant tissue culture, M.K Razdan.

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		Marks (%)
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability for the Course:**
- Agricultural sector
- Chemical industries
- Pharmaceutical and manufacturing
- Ornamental horticulture
  - Plant tissue culture lab

COURSES OFFERED IN THE FOURTH SEMESTER 4YR UGP BSC BIOTECHNOLOGY PROGRAM

KU 4 DSC BTC 204: MARINE BIOTECHNOLOGY

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours/week
4	DSC	Intermediate	KU 4 DSC BTC 204	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1, 2, 3	3			30	70	100	2
4		2		40	60	100	2

Course Description:

The field of Marine Biotechnology, often called Blue Biotechnology, delves into the rich realm of marine ecosystems, and uses biotechnological techniques to create innovative medications, enzymes, and other items. Among other benefits, it addresses the improvement of aquaculture, seafood safety, the restoration of the marine ecosystem, and production of biofuels. The purpose of this course is to familiarize students with the latest advancements in the field of marine biotechnology and to inspire their creativity to take on new challenges in this area.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Identify the uses of marine bioprospecting.	U
2	Apply biotechnology techniques to enhance aquaculture	A
3	Recognize the role of biotechnological techniques in the marine ecosystem's sustainable growth.	An
4	Gain practical experience assessing marine organisms.	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**UNIT I- Marine Bioprospecting**		
	1	Marine natural products**:** Isolation and separation of marine natural products (MNP) from marine flora and fauna	5
	2	Pharmaceuticals from marine organisms-anti cancer, diagnostic and therapeutic, bio adhesives and thermostable enzymes	4
	3	Marine Toxins as Research tool-EG-Conotoxin, Sea Anemone toxin	3
	4	Marine algae in human nutrition- functional food and antioxidants. Micro algae in biotechnology.	3

2	**UNIT II-Aquatic biotechnology**		
	1	Introduction to aquaculture. Methods-Extensive, semi-intensive and intensive aquaculture practices; Running water aquaculture; Recirculating system; Cage culture and pen culture.	4
	2	Aquaculture food production coupled with carbon sequestration and nutrient management, Carbon capture and nutrient management in coastal ecosystems	5
	3	Genetic engineering and ploidy manipulation to enhance growth	3
	4	Reproduction and development of disease resistance in commercially cultured aquatic organisms	3

3	**UNIT III-Marine biotechnology & Sustainable Development**		
	1	Biofuels from marine microalgae- Biodiesel	2
	2	Biofouling and control technology**:** Biofouling organisms-problems due to Biofouling. Antifouling paints and its environmental pollution. Biotechnological approach to Biofouling control	4
	3	Marine pollution-waste disposal, oil spills, microplastics, algal bloom –impact on marine ecosystem. Coral bleaching & its environmental impact	5
	4	Biotechnological Approaches for restoring marine ecosystem- Coral reef restoration, Genetic engineering for restoration of ocean health and conservation of biodiversity	4

4	**MODULE IV: EXPERIMENTS**		
	1	Identification of commercially Important Fishes, Shell Fishes, Molluscs, Lobsters and Seaweed.	2
	2	Extraction of DNA from aquatic organism	3
	3	SDS PAGE analysis of fish proteins	3
	4	Analysis of microflora & heavy metal presence in shellfish	2
	5	Isolation of microflora from marine sample & other aquatic bodies	2
	6	Study of bio filtering capacity of mangrove plants	2
	7	Estimation of Protein, Lipid, Carbohydrate and Salt Content in Fish.	3
	8	Physical, Biochemical and Microbiological Methods to Examine Freshness of Fish	3
	9	Exploring websites & database in Marine biology-	4

		• WORMS (World Register of Marine Species) • Allen Coral Atlas • IndOBIS (Indian Ocean Biodiversity Information System), • Marine Mammal Research & Conservation –Network of India • CoMBINe (Coastal and Marine Biodiversity Integration Network), • MarinLit database	
	10	Field visit to aquaculture area & prepare a report.	6

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

1. William J. Thieman, Michael A. Palladino, *Introduction to Biotechnology*, Third ed, Pearson, 2014
2. Se-Kwon Kim, *Handbook of Marine Microalgae: Biotechnology Advances, Elsevier Science & Technology*, First ed., 2015
3. Se-Kwon Kim, *Marine Microbiology: Bioactive Compounds and Biotechnological Applications*, John Wiley & Sons, Incorporated,First ed, 2013
4. Nobuhiro Fusetani (Faculty of Fisheries Sciences), William Kem, *Marine Toxins as Research Tools*, Berlin, Heidelberg : Springer Berlin Heidelberg : Imprint: Springer, 1st ed. 2009.
5. J. Icarus Allen, Jill R. Stewart, J. Readman, Keith Davidson, Michael Moore, R. E. Hester, and R. M. Harrison, Marine *Pollution and Human Health*, Royal Society of Chemistry, The,First ed, 2011

Reference Distribution:

Module	**Unit**	**Reference No.**

1	1	3
	2	3
	3	4
	4	2
2	1	1
	2	5
	3	1
	4	1
3	1	2
	2	1
	3	5
	4	5
4	1	
	2	
	3	
	4	

Suggested Readings:

1. Ernesto Fattorusso, William H. Gerwick, Orazio Taglialatela-Scafati, *Handbook of Marine Natural Products* , Dordrecht : Springer Netherlands : Imprint: Springer, 1st ed. 2012.
2. Hans-Curt Flemming, P. Sriyutha Murthy, R. Venkatesan, Keith Cooksey, *Marine and Industrial Biofouling*, Berlin, Heidelberg : Springer Berlin Heidelberg : Imprint: Springer,First ed, 2009
3. Roland Ulber, Yves Gal , *Marine Biotechnology* I, Berlin, Heidelberg : Springer Berlin Heidelberg : Imprint: Springer, 2005

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		**Marks (%)**
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability for the Course:**
- Marine Scientist
- Horticulturist
- Natural resource technician
- Marine research technician
- Consultant
- Teaching

KU 4 DSC BTC 205: MOLECULAR BIOLOGY

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
4	DSC	Intermediate	KU 4 DSC BTC 205	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)	Marks Distribution	Duration of ESE (Hours)

Module	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1, 2, 3	3		0	30	70	100	2
4		2		40	60	100	2

Course Description:

Molecular Biology course focus on the structure and functions of biologically important macromolecules giving you a range of theoretical knowledge and practical lab skills. You will learn about DNA, RNA and Proteins and the molecular events that govern cell function while exploring the relevant aspects of biochemistry, genetics, and cell biology. Advances in Molecular Biology have led to the completion of several large genome projects that are changing the face of modern biology especially in areas of medicine, agriculture, and biotechnology.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the structure of nucleic acid	U
2	Create the knowledge of DNA replication and repair	A
3	Analyse the mechanism of transcription and post transcriptional	An

	modification	
4	Understand the mechanism of translation	U
5	To apply the different techniques of Molecular Biology for Research and Development	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Genes, genome organization and replication**		
	1	Historical development of Molecular Biology	3

	2	Nucleic acid as genetic material-nucleosides and nucleotides. Watson-Crick double helical structure of DNA	3
	3	Genome organization in prokaryotes and eukaryotes-chromatin structure and function	4
	4	DNA replication- mode of action of DNA polymerase, topoisomerase, and ligase. DNA replication in prokaryotes and eukaryotes	5

2	**DNA repair and transcription**		
	1	Molecular basis of mutations-DNA repair mechanisms (Mismatch repair-repair of thymine dimers-light induced repair-excision repair-recombination repair-SOS repair)	3
	2	Transcription in prokaryotes: Initiation, elongation and termination-Prokaryotic promoter structure and RNA polymerase	5
	3	Transcription in eukaryotes: Eukaryotic promoter structure and polymerases. 5' capping, splicing and polyadenylation	4
	4	Synthesis of ribosomal RNA and tRNA	3
3	**Translation and gene regulation**		
	1	Translation in prokaryotes and eukaryotes: Aminoacylation of tRNA, formation of initiation complex, different types of elongation factors, translocation, and termination	4
	2	Post translational modifications	1
	3	Regulation of gene expression in prokaryotes: Positive and negative operons, lac operon and trp operon. Regulation of gene expression through attenuation	5
	4	Mechanism of gene regulation in eukaryotes	5

4	**Laboratory experiments**		

	1	DNA isolation from Bacteria	4
	2	DNA isolation from plant	5
	3	DNA quantitation using spectrophotometer	2
	4	Agarose gel electrophoresis of DNA	2
	5	RNA isolation from liver	3
	6	RNA isolation from plant	3
	7	Protein isolation from bacteria	2
	8	Protein isolation from serum	2
	9	Sodium dodecyl sulphate-Polyacrylamide gel electrophoresis of proteins	3
	10	Protein fingerprinting	4

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

1. Benjamin A Pierce (2012) *Genetics: A conceptual approach* (4th edition). W.H Freeman and Company.
2. Peter.J. Russel (2014) *Genetics: A molecular approach* (3rd edition) Pearson education.

3. James D Watson, Tania A Baker, Stephen P Bell, Alexander Gann, Michael Levine, Richard Losick- (2004) *Molecular Biology of the Gene* (5th edition) Pearson Education.
4. Veer-Bala Rastogi (2016) *Principles of Molecular Biology* (2nd edition) Medtech Publisher.

Reference Distribution:

Module	Unit	Reference No.
1	1	4
	2	8
	3	2
	4	2
2	1	3
	2	6
	3	5
	4	2
3	1	2
	2	2
	3	2
	4	2

4	1	9
	2	9
	3	9
	4	9
	5	9
	6	9
	7	9
	8	9
	9	9
	10	9

Suggested Readings:

5. Benjamin Lewin (2008) *Gene IX* (9th edition) Jone and Bartlett Publishers.
6. De Robertis, EDP and E.M.F Robertis Lippincott Williams and Wilkins (2017) *Cell and Molecular Biology* (8th edition). Lippincott Williams and Wilkins.
7. Karp G-John (2019) *Cell and Molecular Biology* (9th edition) Wiley and Sons.
8. Walker J.M and Ging Old, E.B (2000) *Molecular Biology and Biotechnology* (4th edition) Royal Society of Chemistry U.K.
9. Sambrook and Russel (2000). *Molecular Cloning Vol 1-3* (3rd edition)- CSHL press.

Assessment Rubrics:

	Evaluation Type		Marks
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		Marks (%)
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability for the Course:**
- Biotechnology companies
- Research and Development
- Teaching
- Molecular diagnostics
- Entrepreneurship
- Biological technicians

KU 4 DSC BTC 206: BIOSTATISTICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
4	DSC	Intermediate	KU 4 DSC BTC 206	4	4

Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	0	30	70	100	2

Course Description:

Biostatistics basically involves the application of statistical techniques to scientific research. Therefore, it involves the study of data analysis and statistical reasoning methods which can be applied in different aspects of science and research. This is meant to analyse large quantities of data sets to better understand the field of research and science.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the classification of statistical data, concepts of population and sample and various approaches used in sampling	U
2	Understand the classification, tabulation, and presentation of data	U
3	Understand different measures of central tendency	U

4	Understand different measures of dispersion	U
5	Understand different types of correlation and methods to calculate them.	U
6	Understand tests of significance and probability	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**MODULE**		
	1	Types of data-primary and secondary data, qualitative and quantitative data, grouped and u grouped data, discrete and continuous data.	5
	2	Sources of data, collection of data, population, and sample. Sampling - random and non-random sampling	3
	3	Presentation of data: Classification and tabulation of data, tables- different types	3
	4	Graphical and diagrammatic representation of data- bar diagram, pie diagram, pictogram, histogram, frequency polygon, frequency curve, line chart, stem, and leaf diagram	4
2	**MODULE II**		
	1	Frequency distribution- frequency table, relative and cumulative frequency distribution, cumulative frequency table-less than and more than cumulative series.	5
	2	Measures of central tendency: Mean- arithmetic mean, geometric mean, harmonic mean, median, mode-method of calculation for grouped and ungrouped data.	5
	3	Normal distribution curve-symmetric and asymmetric, kurtosis and skewness.	2
	4	Measures of dispersion: Absolute and relative measures- range, quartile deviation, standard deviation.	3
3	**MODULE III**		
	1	Variance, coefficient of variation. Standard error (with examples from grouped and ungrouped data).	4
	2	Bivariate data. Correlation: types of correlation between variables	4

	3	Methods for studying correlation- Scatter diagram, correlation graph, coefficient of correlation	3
	4	Coefficient of correlation- Karl Pearson's coefficient of correlation, Spearman's method.	4
4	**MODULE IV**		
	1	Test of significance- t test, Z test	3
	2	Test for goodness of fit -chi square test	3
	3	Probability- random experiment, sample space, events - elementary event, compound event, equally likely events, exhaustive events, dependent and independent events.	5
	4	Addition and multiplication laws of probability	4
	5	Use of Python software for statistical analysis	
5	**Teacher Specific Module**		**5**
	Directions		

Essential Readings:

1. Principles of Biostatistics. Pagano M. & Kimberlee G. Duxbury Press. 3rd edition. 2022.
2. Biostatistical analysis. Zar, JH. Pearson Education. 5th edition. 2010
3. Fundamentals of Biostatistics. Khan and Khanum; Ukaas publications. 6th edition 2020
4. Biostatistics-How it works. Steve Selvin; Pearson Education. 2003
5. An Introduction to Biostatistics-2nd edn- N. Gurumani (2015)-MJP

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	2
	3	3
	4	3
2	1	4
	2	5
	3	4
	4	3
3	1	3
	2	5
	3	3
	4	4
4	1	6
	2	7
	3	8
	4	6

Suggested Readings:

6. Probability and Statistical Inference-9th edn- Hogg R. V. Tanis E. A. (2019)-Prentice Hall, New Jersey.
7. Experimental Design Data Analysis for Biologists. Quinn G. P. & Keogh M. J. (2002)-Cambridge University Press.
8. Statistical Methods in Biology-3rd edn- Bailey NTJ (1995)-Cambridge University Press.
9. Biostatistics for the Biological and Health Sciences-2nd edn- Marc Triola, Mario Triola (2017)- Pearson

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
d)	Viva	5
Total		**100**

- **Employability for the Course:**
- Data management and analysis
- Pharmaceutical and clinical trials
- Academic and industrial positions

COURSES OFFERED IN THE FIFTH SEMESTER 4YR UGP BSC BIOTECHNOLOGY PROGRAM

KU 5 DSC BTC 301: IMMUNOLOGY

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
5	DSC	Higher	KU 5 DSC BTC 301	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3	3		0	30	70	100	2
4		2		40	60	100	2

Course Description:

The Immunology course provides the components, principles, and mechanisms of a healthy immune system, and how they coordinate to mount safe and appropriate protection against infection. The course will establish how the immune system can distinguish between self and non-self-antigens. In addition to establishing the workings of a healthy immune system, the course will also address what underlies situations of inappropriate or insufficient immunity, such as allergy, autoimmunity etc. The course also provides information on different immunotechniques and types of vaccines. The course covers therapeutic applications of immune molecules.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the cells and organs of immune system	U
2	Outline the types of immunity and the mechanism of humoral and cell mediated immunity	U

3	Describe the structure and classes of immunoglobulins and antigens	An
4	Outline the structure of MHC molecules, mechanism of antigen processing and presentation, transplantation and mechanism of graft rejection	U
5	Explain the complement pathways and types of hypersensitivity reactions and vaccines	U
6	Understand different immunotechniques and immunotherapy	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**MODULE I**		
	1	Historical perspective, cells and organs of immune system and their functions	3
	2	Innate immunity- components of innate immunity, acquired immunity, humoral and cell mediated immunity	3
	3	Structure and classes of immunoglobulin, antigen, epitope, haptens, adjuvants	5
	4	MHC molecule, Antigen processing and presentation	4
2	**MODULE II**		
	1	Complement activation pathways	3
	2	Hypersensitivity reactions – Type I, II, III & IV	5
	3	Tumour antigens, Transplantation, mechanism of graft rejection	4
	4	Autoimmunity - organ specific and systemic autoimmune diseases	3
3	**MODULE III**		
	1	Antigen antibody interactions, forces involved in antigen antibody interactions	4
	2	Precipitation reactions, agglutination	3
	3	Immunotechniques – blood grouping, immunoelectrophoresis, ELISA, RIA	4
	4	Immunotherapy, Introduction to Vaccines	5

4	**MODULE IV Laboratory Experiments**		
	1	Differential leucocytes count	2
	2	Total leucocytes count	2
	3	Total RBC count	2
	4	Haemagglutination assay	2
	5	Haemagglutination inhibition assay	2
	6	Separation of serum from blood	2
	7	Double immunodiffusion test using specific antibody and antigen	2
	8	ELISA.	3

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Immunology, Richard A. et al., Kuby, W.H. Freeman and company-8th edn-W.H Freeman (2018)
2. Veterinary Immunology, Tizard, Thomson publishers-10th edn (2017)

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1
	2	1

	3	1
	4	1
2	1	1, 3
	2	1,2
	3	1, 2
	4	3
3	1	1, 3
	2	1, 3
	3	1, 3
	4	1, 3
4	1	1, 3
	2	1, 3
	3	1, 4
	4	1, 4

Suggested Readings:

3. Immunology, Roitt et al.,-13th edn-Wiley and Blackwell (2017)
4. Medical immunology, Tristram G. Parslow et al., 10th edn- Mc Graw Hill (2001)

Assessment Rubrics:

	Evaluation Type		Marks
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		Marks (%)
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

Employability for the Course:

- Teaching
- Research and Development
- Biotechnology sector
- Medical field

KU 5 DSC BTC 302: GENETIC ENGINEERING

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
5	DSC	Higher Level	KU 5 DSC BTC 302	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution% Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1, 2, 3	3		0	30	70	100	2
4		2		40	60	100	2

Course Description:

The aim of this course is to acquaint the students to versatile tools and techniques employed in Recombinant DNA technology. A sound knowledge on methodological repertoire allows students to innovatively apply these in basic and applied fields of biological research. The course conceptualizes properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant clones. Introduction to various types of vectors viz., cloning, transformation, expression; and vectors for genomic and cDNA library will be provided. This course will serve to illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences and to expose students to use recombinant DNA technology in agriculture, medicine, and industry

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To understand the mode of action of different types of DNA manipulative enzymes and cloning.	U
2	To understand the molecular characterization of genes using gene library construction	U
3	To apply the principle of PCR and DNA sequencing in different field of life science	A
4	Apply genetic engineering on DNA fingerprinting, transgenic plants, and animals	A
5	To apply the different techniques of recombinant DNA technology for Research and Development	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**DNA manipulation**		
	1	DNA manipulation: Mode of action of Nucleases, Ligases and Polymerases	5
	2	Gene cloning vectors: Plasmid vectors, phage Vectors and cosmids	3
	3	Transformation: Identification of transformants and recombinants	3
	4	Gene library: Genomic DNA library and cDNA library- construction and screening- identification of the desired clone. Colony and plaque hybridization probing	4
2	**PCR, DNA sequencing and rDNA in medicine**		
	1	Polymerase Chain Reaction (PCR): Methodology and applications- Different types of PCR- Nested PCR, Multiplex PCR and Real time RT-PCR	5
	2	DNA sequencing: Methodology and applications- Sanger-Coulson method, Automated DNA sequencing, sequencing of PCR product, pyrosequencing and next generation sequencing	3

	3	Applications of recombinant DNA technology in medicine: Production of recombinant insulin, somatostatin, somatotrophin and factor XIII	4
	4	Production of recombinant monoclonal antibodies and vaccines.	3
3	**DNA fingerprinting, molecular markers and transgenesis**		
	1	Applications of recombinant DNA technology in forensics: DNA fingerprinting techniques	3
	2	Genetically modified plants: Ti plasmid and binary vectors. Gene transfer methods in plants. Plants tolerant biotic and abiotic stresses. Antisense RNA technology	5
	3	Plant molecular markers: Random Amplified polymorphic DNA (RAPD) and Amplified Fragment Length Polymorphism (AFLP)- Marker Assisted Selection (MAS)	3
	4	Transgenic Animals: Embryonic stem cells and gene transfer methods in animals- Applications of transgenic animal	4
4	**Genetic engineering experiments**		
	1	Plasmid isolation	3
	2	DNA isolation from blood	5
	3	DNA isolation from fungus	3
	4	DNA isolation from yeast	3
	5	RNA isolation from blood	4
	6	Restriction digestion	2
	7	DNA ligation	2
	8	Polymerase Chain Reaction	3

	9	Gel extraction	2
	10	DNA fingerprinting using RFLP	3
5	**Teacher Specific Module**		**5**
	Directions		

Essential Readings:

1. James D. Watson (1992). *Recombinant DNA*-W.H Freeman.
2. T.A Brown (2020) *Gene Cloning and DNA analysis* (8th edition) Wiley-Balckwell publishing.
3. Bernard R Glick (2017) *Molecular Biotechnology* (5th edition)-ASM press.

Reference Distribution:

Module	Unit	Reference No.
1	1	2
	2	2
	3	2
	4	3
2	1	1
	2	2
	3	2
	4	3

	1	2
3	2	3
	3	2
	4	3
	1	4
4	2	4
	3	4
	4	4
	5	4
	6	4
	7	4
	8	4
	9	4
	10	4

Suggested Readings:

5. Sambrook and Russel (2000). *Molecular Cloning Vol 1-3* (3rd edition)- CSHL press.
6. James D Watson (2007). *Recombinant DNA*: Genes and Genomes- CSHL press.
7. Carl W Dieffenbach (2003). *PCR primer* (2nd edition)- CSHL Press.
8. SB Primrose and RM Twyman (2006). *Principles of gene manipulations and Genomics* (7th edition)- Blackwell publishing.

Assessment Rubrics:

	Evaluation Type		Marks
Theory part	Continuous Evaluation	Test Paper	10
		Quiz/Debate/Seminar	10
		Assignment	5
	End Semester Evaluation		50
	Total		75

	Evaluation Type		Marks (%)
Practical Part	Continuous Evaluation	Lab performance	6
		Record	4
	End Semester Evaluation	Experiment	10
		Viva Voce	5
	Total		25

- **Employability for the Course:**
- Biotechnology companies
- Research and Development
- Teaching
- Molecular diagnostics
- Entrepreneurship
- Lab Technician
- Healthcare
- Agriculture

KU 5 DSC BTC 303: PLANT BIOTECHNOLOGY

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
5	DSC	Higher	KU 5 DSC BTC 303	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution% Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1, 2, 3	3		0	30	70	100	2

4		2		40	60	100	2

Course Description:

The course provides basic principles of plant tissue culture and regeneration pathways of callus to produce plantlets. The students gain knowledge about organ culture, different types of cultures and the procedure of each type of culture. The course also covers how the variant plants with useful characteristics are produced from plant tissue culture. The course includes the production of hybrid plants with improved characteristics through protoplast fusion. The course describes the methodology of production of transgenic plants to improve the crops with the desired traits

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the basic principles of plant tissue culture	U
2	Understand the types and significance of callus culture	U
3	Outline the principles and applications of organogenesis and somatic embryogenesis	A
4	Understand the types of organ culture	U
5	Outline the production and applications of haploid and triploid plants	A

6	Understand protoplast culture and somatic hybridization	An
7	Explain plant genetic transformation and terminator gene technology	A

*****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS

1	**MODULE I**		
	1	Introduction to plant biotechnology- history and development, totipotency, nutritional medium and its components	4
	2	Callus culture, types of calluses, significance, Organogenesis, factors influencing organogenesis	5
	3	Somatic embryogenesis and artificial seed	3
	4	Somaclonal variations and its applications	3

2	**MODULE II**		
	1	Organ culture- types of organ culture- root culture, shoot tip culture, ovary, and ovule culture	4
	2	Embryo culture and embryo rescue, cell suspension culture	3
	3	Production of haploid plants- anther and pollen culture, applications of haploid plants, Production of triploid plants and significance	4
	4	Germplasm storage and conservation- cryopreservation, Invitro pollination and its applications	4
3	**MODULE III**		
	1	Protoplast isolation, culture, and fusion. Somatic hybridisation and its applications, hybrid and cybrid	4
	2	Plant genetic manipulation-gene transfer methods in plants, direct gene transfer methods, Agrobacterium mediated genetic transformation, Ti plasmid derived vector system	5
	3	Transgenic plants-golden rice, Bt cotton, Bt brinjal, GM Mustard, Flavr Savr tomato	4
	4	Terminator gene technology	2
4	**MODULE IV Laboratory Experiments**		

	1	Plant tissue culture media preparation – MS media	5
	2	Explant selection, sterilization, and inoculation	3
	3	Callus induction from leaf, node, shoot tip	10
	4	Direct organogenesis	2
	5	Seed culture	2
	6	Cell suspension culture	3
	7	Artificial seed	2
	8	Hardening of regenerated plant	3

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

7. Plant cell and tissue culture, Kalyan Kumar De (1997)-New Central Book Agency
8. Biotechnology U. Satyanarayana (2005)-Books and Allied (P) Ltd.
9. Biotechnology B D Singh (2015)-Bsc edn- Kalyani Publishers
10. Plant Biotechnology A Laboratory Manual- H. S. Chawla (2008)-Oxford and IBH

Reference Distribution:

Module	Unit	Reference No.
1	1	1, 2

	2	1, 2
	3	1, 2
	4	1, 2
2	1	1
	2	1
	3	1
	4	1
3	1	2,3
	2	2, 3
	3	2, 3
	4	5
4	1	4
	2	4
	3	4
	4	4
	5	4
	6	4
	7	4
	8	4

Suggested Readings:

11. Introduction to Plant Biotechnology- 3rd edn H S Chawla (2020)-Science Publishers
12. Introduction to plant tissue culture-3rd edn- M.K Razdan (2019)-Oxford and IBH

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		**Marks (%)**
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability for the Course:**
- Agricultural sector
- Chemical industries
- Pharmaceutical and manufacturing
- Ornamental horticulture
- Plant tissue culture lab

KU 5 DSC BTC 304: ANIMAL BIOTECHNOLOGY

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	5	DSC	Higher level	KU 5 DSC BTC 304	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description:

The course offers a thorough understanding on cultivating animal cells in culture and use of biotechnological concepts to manipulate and transform animal cells for human welfare. The course includes topics ranging from basics of animal cell and tissue culture to genetically engineering animals to improve their suitability for industrial, or pharmaceutical applications.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the basics of animal cell culture	U
2	Analyse establishment of primary culture	A
3	Understand the protocol for cell culture-based production of valuable products	U
4	Evaluate the process of Monoclonal antibody and vaccine production	E
5	Analyse transgenic technology and animal cloning	A

******Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**Basics of Animal Cell Culture**		
	1	History and development of animal cell culture	2
	2	Equipment and materials for Animal cell culture	3
	3	Culture media for animal cell culture: Physio - chemical properties of culture media	5
	4	Balanced salt solutions – Natural and artificial media	5

2	**Culturing Animal Cells**		
	1	Primary culture: Disaggregation – mechanical and enzymatic	5
	2	Cell lines- definite and continuous/transformed cell lines, their origin and characteristics	4
	3	Growth factors promoting proliferation of animal cells (EGF, FGF, PDGF, NGF and Interleukins)	3
	4	Growth kinetics of cells in culture	3
3	**Cell culture-based production of products of biological importance**		
	1	Cell synchronization	2
	2	Bioreactors for large scale culture of cells	3
	3	Expression of cloned proteins in animal cells (erythropoietin, factor VIII, and t-plasminogen activator)	5
	4	Cell culture-based production of vaccines and monoclonal antibodies	5
4	**Transgenic Technology and Animal Cloning**		
	1	Transgenic animals- Gene transfer methods- Transgenic animal models	6
	2	Production of useful products from transgenic animals	3
	3	Animal cloning- somatic cell nuclear transfer	2
	4	Xenotransplantation; Ethics of animal cloning	2
5	**Teacher Specific Module**		**5**
	Directions		

Essential Readings:

5. Animal Biotechnology-Recent Concepts to Development; P Ramadas, 2019 MJP Publishers
6. Biotechnology D Singh, 2012, Kalyani Publishers, Ludhiyana
7. Biotechnology, U Satyanarayana, 2010, Books and Allied (P) Ltd
8. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	3
	3	3
	4	3
2	1	3
	2	3
	3	2
	4	3
3	1	3
	2	3
	3	7

	4	7
4	1	3,7
	2	7
	3	3
	4	2

Suggested Readings:

8. Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press.2000
9. R Ian Freshney, Culture of Animal Cells, John Wiley & Sons, 2021

10. Glick and J.J Pasternack, Molecular Biotechnology,2010. 4TH Edition, ASM Press

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
d)	Viva	5
Total		**100**

- **Employability for the Course:**

- Scientific Research
- Biotech industries
- Teaching faculty
- Entrepreneurship

KU 5 DSE BTC 301: FORENSIC BIOTECHNOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
5	DSC	Higher	KU 5 DSE BTC 301	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description:

Forensic biology course equips with skills and knowledge required for investigations and law enforcement. This branch of advanced science brings together the disciplines of forensics, biology, chemistry and law, enlightening the students with basic laboratory skills and theoretical background for confronting issues in forensics.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand forensic science in Criminology	U
2	To apply biotechnology in forensic biology.	A
3	Analyse the significance of biological and serological evidence.	An
4	Understanding of basic laws concerned with forensic biology.	U

******Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**INTRODUCTION TO FORENSIC BIOTECHNOLOGY**		
	1	Overview of forensic science principles and applications.	5
	2	Historical development and milestones in forensic science.	3
	3	Introduction to forensic biotechnology	3
	4	Comprehensive understanding of genetic engineering	4
2	**BIOTECHNOLOGICAL TECHNIQUES IN FORENSIC ANALYSIS**		
	1	Methods of DNA profiling – PCR, Gel Electrophoresis and DNA sequencing	5
	2	DNA phenotyping, RNA profiling and their applications	3
	3	Importance of genetic markers in forensic analysis.	4
	4	Application of microscopy and immune techniques in forensic science	3
3	**CRIME SCENE INVESTIGATION**		
	1	Investigation of crime scenes and types of evidence.	3
	2	Collection and preservation of biological evidence.	5
	3	Determination and identification of biological fluids in investigation	3

	4	Importance of serum proteins in forensic science.	4
4	**MEDICAL BIOTECHNOLOGY AND LEGAL PERSPECTIVES IN FORENSIC SCIENCE**		
	1	Advancements in medical biotechnology	3
	2	Quality control management in Forensic laboratories	5
	3	Organization of forensic science laboratories at Centre and State, NCRB and NICFS	3
	4	Legal standards for admissibility of DNA profiling and its ethical concerns	3
5	**Teacher Specific Module**		**5**
	Directions		

Essential Readings:

1. Gunnn. An Essential Forensic Biology, 2nd edition, Wiley-Blackwell (2009).
2. Saferstein Forensic Science Handbook, Vol.111. Prentice Hall, New Jersey (1993).
3. Chowdhuri, Forensic Biology, BPRD, New Delhi (1971).
4. T. Duncan and M.I. Tracey, Serology and DNA typing in introduction to Forensic Sciences, 2nd Edition, CRC Press, Boca Raton (1997).

Reference Distribution:

Module	Unit	Reference No.
1	1	1

	2	1
	3	4
	4	6
2	1	4
	2	4
	3	4
	4	4
3	1	1
	2	2
	3	3
	4	4
4	1	7
	2	1
	3	2
	4	3

Suggested Readings:

5. Lincoln P.J and Thomson. J; Forensic DNA profiling protocols, 1st edition, Humana Press. (1998).
6. T.A Brown (2020) *Gene Cloning and DNA analysis* (8th edition) Wiley-Balckwell publishing.
7. Prathibha Nallari and V.V Venugopal (2010). *Medical Biotechnology*-Rao-Oxford Press.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

- **Employability for the Course:**
- Central and state forensic labs.
- Private forensic labs
- Medical examiner's offices
- Medical research
- Biotechnology companies

KU 5 DSE BTC 302: INTERMEDIARY METABOLISM

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	5	DSC	Higher	KU 5 DSC BTC 302	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description:

The focus of this course is the study of the intermediary metabolic pathways involved in the synthesis and degradation of carbohydrates, lipids, and nitrogenous compounds within cells. Specifically, the course will analyse the chemical reactions that make up these pathways and explore the process of deriving energy from nutrient breakdown. Additionally, the course will examine the regulation of metabolic pathways by effector molecules and hormones in biological systems and address the origins of various human diseases associated with altered metabolism.

Course Prerequisite: Biochemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains

1	Assess and relate the information to the context of metabolism.	U
2	Explain how reduced electron carriers are used to generate ATP via ETC	U
3	Articulate the various modes of regulation of metabolic pathways.	U
4	Understanding the pathophysiology of metabolic diseases that occur due to alterations in metabolism	U

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**

1		**MODULE I: Carbohydrate Metabolism**	
	1	Glucose metabolism: General overview of metabolism. Glycolysis and Gluconeogenesis pathway - Major enzymes, reaction steps, energetics, regulation, and significance	4
	2	Glycogen metabolism: Glycogenesis and Glycogenolysis - Reaction steps, major enzymes, regulation, and significance.	4
	3	TCA cycle: Reaction process of TCA Cycle, major enzymes involved, ATP yield, antipleuritic reactions of TCA cycle, regulation, and significance.	4
	4	Respiratory chain: Oxidative phosphorylation, the process of ETC. Role of uncouplers.	3
2		**MODULE II: Amino Acid Metabolism**	
	1	General reactions of amino acids metabolism: Essential, non-essential, glucogenic and ketogenic amino acids. General reactions of amino acids - Transamination, Decarboxylation and Deamination.	3
	2	Urea cycle: Reaction process of Urea cycle, enzymes involved, regulation and biological significance	3
	3	Metabolism of non-essential amino acids: Biosynthesis and breakdown of Tyrosine, alanine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, and serine. (Without structure)	4
	4	Inborn errors of amino acid metabolism: General overview on inborn errors of non-essential amino acid metabolism.	3
3		**MODULE III: Lipid Metabolism**	
	1	Lipolysis: breakdown of fatty acids, Different ways of oxidation (β oxidation, ω and α oxidation), energy yield, role of carnitine.	4

	2	Lipogenesis: De Novo synthesis of Fatty acid - reaction process involved. Fatty Acid Synthase complex, regulation. Synthesis of odd and even chain fatty acids.	4
	3	Biosynthesis of lipid derivatives: Brief overview of biosynthesis of Phospholipids, TAG and cholesterol. Clinical importance.	4
	4	Ketone bodies: Ketogenesis, reaction process, regulation, and clinical significance. Ketoacidosis	3
4		**MODULE IV: Nucleic Acid Metabolism**	
	1	Biosynthesis of Purines and Pyrimidines: De novo and Salvage pathways of Purines and Pyrimidines. Reaction steps involved, major enzymes. (Without structure)	4
	2	Catabolism of Purines and Pyrimidines: Degradation of purines and pyrimidines. Reaction steps involved, major enzymes. (Without structure)	4
	3	Biosynthesis of ribonucleotides and deoxyribonucleotides: Reaction process, major enzymes involved in the biosynthesis of ribonucleotides and deoxyribonucleotides. (Without structure)	4
	4	Disorders of nucleic acid metabolism: Major disorders of nucleic acid metabolism - (Gout, Hypouricemia, Lesch Nyhan syndrome etc). Clinical significance	3
5	**Teacher Specific Module**		**5**
	Directions		

Essential Readings:

1. Nelson.D.L, Cox. M. M. Lehninger. (2008) Principle of Biochemistry. 5th ed. Freeman

2. Victor Rodwell, David Bender, et al. (2018). Harper's Illustrated Biochemistry (31st Edn). McGraw-Hill Education, Ahmedabad

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	2
	3	2
	4	1
2	1	1
	2	1
	3	1
	4	2
3	1	5
	2	5
	3	5
	4	2
4	1	2
	2	2
	3	2

	4	2

Suggested Readings:

3. Berg J M, Stryer L, Tymoczko J and Gatto G, Biochemistry (9th ed.), New York: WH Freeman, 2019.
4. Devlin TM, Textbook of biochemistry with clinical correlations, New York: John Wiley & Sons, 2010.
5. Dr. J. L. Jain, Dr. Sunjay Jain and Nitin Jain. Fundamentals of Biochemistry, 7th ed. S. Chand publication.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5

d)	Viva	5
Total		**100**

- **Employability for the Course:**
- Clinical Biochemist

COURSES OFFERED IN THE SIXTH SEMESTER 4YR UGP BSC BIOTECHNOLOGY PROGRAM

KU6 DSC BTC 305 ECOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours/week
6	DSC	Higher level	KU6 DSC BTC 305	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
	Lecture	Practical	Tutorial	CE	ESE	Total	
Module 1,2,3	3			30	70	100	2
Module 4		2		40	60	100	2

Course Description:

Ecology is the study of how organisms interact at the population, community, and ecosystem levels with one another and their surroundings. The course's objective is to acquaint students with the fundamentals of ecological theory, while Environmental Biotechnology seeks to examine how biotechnology contributes to the preservation of ecological equilibrium.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Recognize how biotechnology can be used to address environmental problems on a global scale.	U
2	Understand the significance of various ecological elements influencing living forms.	U
3	Assess the many conservation strategies used to protect biodiversity.	E
4	Acquire hands-on experience evaluating different environmental parameters.	E

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7

CO 1			√				
CO 2	√						
CO 3			√				
CO 4							√
CO 5			√				

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Environmental issues & bio control measures**		
	1	Air pollution & water pollution- cause, consequence, and remedial measures. Global warming- methods of carbon sequestration. Acid rain & it's effect. Marine pollution- Ocean acidification. Remedial measures.	4
	2	Light pollution-impact on wildlife-effect on animal communication, animal migration, ways to reduce light pollution.	3
	3	Waste management techniques- Waste water treatment-preliminary, primary, secondary & tertiary treatment. Solid waste treatment- incineration, composting, recycling, landfill	3
	4	Biopesticide-Bacillus thuringiensis, Biochemical pesticide-use of pheromones in pest management. Plant incorporated protectants and use of GM crops.	5

2	**Concepts of ecology**		
	1	Ecology introduction- Habitat & Niche. Ecotone and edge effect Ecological succession- type and process of succession, concept of climax.	3
	2	Biotic factors-Interspecies interactions- predation, parasitism, mutualism, competition, facilitation & herbivory. Intraspecies interaction- altruism, reciprocal altruism, kin selection, sexual selection, mating system, group living.	5
	3	Population ecology- characteristics, population dynamics, dispersion and population regulation, life history strategies (r and K selection),	4
	4	Concept of metapopulation. Food chain, food web & trophic level. Ecological pyramids.	3
3	**Applications of Biotechnology in Environmental safety**		
	1	Bioremediation: in-situ and ex situ techniques, bioremediation approaches for the removal of oil spills, radioactive elements & heavy metal pollution. Phytoremediation. Application of metagenomics in environmental monitoring.	4
	2	Disaster management-disaster types & cause (tsunami, typhoon, earthquake, landslide & flood). Remedial measures.	2
	3	Biodiversity-types of biodiversity-genetic, species & ecosystem diversity. Reasons for the loss of biodiversity.	5
	4	Conservation biology: Ex situ &in situ mode of conservation. Biotechnological role in conservation of biodiversity. Social approaches- Project Tiger.	4
4	**Laboratory experiments**		
	1	Estimation of DO, BOD in water sample.	2
	2	Microbial analysis of water.	2
	3	Isolation of rhizobium from root nodules.	2

	4	Antibacterial action of plant extract.	2
	5	Study of microbial flora from air, soil and water and compare it with polluted sites	2
	6	Testing antagonistic activity of soil microbes	2
	7	Isolation and Characterization of microbes from Crude Petroleum Oil Contaminated Soil	2
	8	Studying microbial degradation capacity on hydrocarbons/other pollutants	2
	9	Designing composting methods for the utilization of organic waste.	3
	10	Determination of acidity and alkalinity of given water sample	2
	11	Field visit to any wetland/ forest patch-data collection & prepare a report	5
	12	Study any of the interspecies interactions in the nearby area and prepare a report.	4

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Stiling,Ecology-Global insights & investigation, Mc Grawhill companies,Second ed., 2014
2. K.V.Krishnamurthy, Textbook of biodiversity, by CRC Press,First ed.,2003
3. Miller & Spoolman, Living in the Environment Concepts, Connections, and Solutions Brooks/Cole; 19th edition (1 January 2017)

4. Bernard R. Glick (Author), Cheryl L. Patten (Author) Molecular Biotechnology: Principles and Applications of Recombinant DNA (ASM Books) 6th edition (3 March 2022)
5. S.C. Sharma Disaster Management Khanna Publishing House First ed.,2019

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	3
	2	3
	3	3
	4	4
2	1	1
	2	1
	3	1
	4	1
3	1	4
	2	5
	3	2
	4	2
4	1	
	2	

	3	
	4	

Suggested Readings:

1. Odum& Barrett, Fundamentals of ecology, Cengage India Private Limited; 5th edition (15 November 2017)
2. Wright & Boorse, Environmental science-towards a sustainable future, Benjamin-Cummings Pub Co; 13th edition (25 January 2016)

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		**Marks (%)**
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability Of the Course:**
- Scientific officer

- Research assistant
- Environmental health and safety officer
- Wide options in Government sector
- Entrepreneurship
- Environmental consultant

KU 6 DSC BTC 306: BASIC BIOINFORMATICS

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
6	DSC	Higher	KU 6 DSC BTC 306	Total	4	5
				Module 1-3	3	3
				Module 4	1	2

	Learning Approach (Hours/ Week)			Marks Distribution% Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1, 2, 3	3		0	30	70	100	2

4		2		40	60	100	2

Course Description:

The introductory course in bioinformatics is aimed at introducing the students to the rapidly evolving field of bioinformatics. The program will introduce the basic tools, techniques, software and biological databases. The course will familiarise the students about the relationship between the sequences, structure and the function of genes and protein and different methods of Insilco analysis.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand different biological databases and retrieve biological	U

	data from database	
2	Understand sequence alignment methods	U
3	Analyse evolutionary relationship between organism by sequence comparison	An
4	Analyse sequencing techniques	An
5	Perform basic bioinformatics practical like sequence retrieval, BLAST, Clustal etc	A

******Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Bioinformatics**		
	1	Bioinformatics- application, advantages and historical perspective	3
	2	Databases- primary secondary and composite	3
	3	Protein databases- PIR, Swissport, PDB	4
	4	Nucleic acid databases- GenBank, DDBJ, EMBL	4
2	**Sequence comparison tools**		
	1	Sequence alignment- global and local alignment	3
	2	Pairwise alignment tools- BLAST and Multiple sequence alignment tool- Clustal	4
	3	Sequence to structure relationship	4
	4	Phylogenetic tree construction	3
3	**Sequencing methods**		
	1	DNA sequencing methods	5
	2	RNA sequencing methods	2
	3	Protein Sequencing methods	3
	4	Human Genome Project	3
4	**Practical in Bioinformatics**		

	1	Retrieval of DNA sequence from database using given Accession number	2
	2	Retrieval of mRNA sequence from database using the given Accession number	2
	3	Retrieval of protein sequence from database using given Accession number	2
	4	Retrieval and analysis of a gene sequence and protein sequence in FASTA format	2
	5	Identification of protein sequence from nucleotide sequence using translate tool	2
	6	Primary structure analysis of a protein	2
	7	Secondary structure analysis of a protein	2
	8	Tertiary protein structure analysis using RASMOL	2
	9	Pair-wise and multiple sequence alignment using ClustalW	2
	10	Sequence alignment using BLAST	2
5	**Teacher Specific Module**		**5**
	Directions		

Essential Readings:

1. Claverie, J.M. and Notre Dame, C., 2003. Bioinformatics: A Beginner's Guide. Wiley
2. Dandekar, Thomas and Meik Kunz., 2023. Bioinformatics an introductory textbook. Springer Nature
3. Xiong J., 2006 Essential Bioinformatics. Cambridge University Press

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	2

	2	2
	3	3
	4	3
2	1	3
	2	3
	3	2
	4	3
3	1	1
	2	3
	3	3
	4	3
4	1	
	2	
	3	
	4	

Suggested Readings:

1. Melanie Kappelman and Fenzl Next Generation sequencing and data analysis., 2021. Springer

Assessment Rubrics:

	Evaluation Type		Marks
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		Marks (%)
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

Percentage of marks in the course = (percentage of marks in theory * 3 + percentage of marks in practical) / 4

- **Employability for the Course:**
- Bioinformatics and Computational Biology: Computational biologist, bioinformatician.
- Research fellow, research associate or data analyst
- Teaching faculty
- Researcher

KU 6 DSC BTC 307: BIOPROCESS AND INDUSTRIAL BIOTECHNOLOGY

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
6	DSC	Higher	KU 6 DSC BTC 307	Total	4	4
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1, 2, 3, 4	3			70	30	100	2
4		2		40	60	100	2

Course Description:

Industrial biotechnology can produce a wide range of products (chemicals, materials, food and beverages, biofuels, and bio drugs) from bio-based raw materials. It can reduce environmental impact by using biomass as an alternative to fossil resources for manufacturing bioproducts, biofuels and biopolymers. Bioprocess and industrial biotechnology is used in the production of pharmaceuticals, foods, flavours, fuels, and chemicals with the aid of a biocatalyst such as an enzyme, microorganisms, plant cell, or animal cell in a bioreactor. The three key steps of bioprocess are upstream processing, fermentation, and downstream processing.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the basic principle of fermentation	U
2	Analyse the different types of bioreactors.	An
3	Apply Biotechnology for large scale production of acids, vitamins, antibiotics and SCP.	A
4	Understand upstream and downstream processing.	U
5	Apply the principle of fermentation at the laboratory scale	a

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**CONCEPT OF FERMENTATION AND BIOPROCESS TECHNOLOGY**		
	1	The fundamental concept of Fermentation and bioprocess technology.	3
	2	Types of bioprocesses - batch, fed batch and continuous fermentations.	3
	3	Media for industrial fermentation.	2
	4	Design, Formulation and Sterilization of Media for industrial bioprocess.	2

2	**BIOREACTORS-DESIGN, TYPES AND OPERATION**		
	1	Bioreactors - Design and types of bioreactors.	2
	2	Agitation and aeration in the bioreactor, impeller, and sparger design.	3
	3	Concept of scale up and its challenges in bioprocess.	3
	4	Measurement and control of various bioprocess parameters (Aeration, pH, temperature, medium components on product synthesis).	2

3	**UPSTREAM AND DOWNSTREAM PROCESSING**		
	1	Isolation, preservation, and maintenance of industrial microorganisms.	2
	2	Strain improvement of industrially important microorganisms.	3
	3	Downstream processing – definition and cost involved.	2
	4	Typical unit operation for downstream processing – cell harvesting, cell disruption, product recovery.	3

4	**BIOPROCESS BASED PRODUCTS AND APPLICATION**		
	1	Enzyme and whole cell immobilization and their industrial applications.	2
	2	Commercial production of various bioprocess-based products - Enzymes (bacterial and fungal amylase).	5
	3	Industrial production of acids (citric and acetic acid), antibiotics (Penicillin G), vitamins (B12) and SCP. Probiotics and Prebiotics.	5
	4	Biosensors – types (glucose biosensors, immune sensors, DNA biosensors, biosensors for detection of pollutants: water quality and air quality monitoring).	3
	Laboratory experiments		
	Bacterial growth curve analysis		3
	Calculation of thermal death point (TPD) of a microbial sample		4
	Production and analysis of ethanol		4
	Production and analysis of amylase		4
	Production and analysis of lactic acid		4

	Isolation of industrially important microorganisms from natural resources	4
	Production and characterization of different fermented food products	4
	Production and characterization of wine	3

Essential Readings:

1. Industrial microbiology. A H Patel (2008)- MacMillian.
2. Industrial microbiology. Prescott and Dunn. A V I Publishing Co USA.
3. Industrial Microbiology. L E Casida. AGE International Publications.
4. Industrial Biotechnology-Problems and Remedies. Indu Shekhar Thakur

Reference Distribution:

Module	Unit	Reference No.
1	1	6
	2	6
	3	6
	4	6
2	1	6
	2	6
	3	6
	4	6

3	1	1
	2	2
	3	3
	4	4
4	1	1
	2	3
	3	4
	4	2

Suggested Readings:

5. Microbial Biotechnology. Fundamentals of applied microbiology. Alexander N Glazer, Hiroshi Nikalido. Cambridge Univ. Press.
6. Principles of fermentation technology. Stanbury PF, A Whitaker and S J Hall. Pergmon Press

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		Marks (%)
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability for the Course:**
- Agriculture
- Animal Husbandry
- Educational Institutes
- Environmental Conservation
- Pharmaceutical Industries
- Bio Processing Industries

- Chemical Industries

KU 6 DSC BTC 308: MEDICAL BIOTECHNOLOGY

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	6	DSC	Higher level	KU 6 DSC BTC 308	4	4

MODULES	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description:

The course aims to foster the understanding of applications of biotechnological principles in the field of medicine. The curriculum includes topics that offer a thorough understanding of the significant advancements in disease diagnosis and treatment.

Course Prerequisite: Course in Genetics, Molecular Biology

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Remember genetic diseases	R
2	Understand molecular basis of human diseases	U
3	Evaluate molecular diagnostic methods	E
4	Analayse gene therapy procedure	A
5	Understand personalized medicine	U

******Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Classification of Genetic Diseases**		
	1	Unifactorial, chromosomal and multifactorial disorders	3
	2	Structural disorders-deletions, duplications, inversions, and translocations (one example each)	4
	3	Numerical disorders- trisomies and monosomies	4
	4	Gene controlled diseases- autosomal, X linked and mitochondrial disorders	4

2	**Molecular Basis of Human Diseases**		
	1	Pathogenic mutations	3
	2	Gain of function mutations- Oncogenes, Huntington's disease, Pittsburgh variant of α1 antitrypsin	4
	3	Loss of function mutations- Tumour suppressor genes, cystic fibrosis	4
	4	Dynamic mutations- Fragile X syndrome, Myotonic dystrophy	4

3	**An Introduction to Molecular diagnostics**		
	1	Nucleic acid amplification methods-PCR and its variants	5
	2	Diagnostic sequencing and mutation detection	3
	3	Application of microarrays to diseases	3
	4	Prenatal diagnosis- Invasive and non-invasive techniques	4

4	**Gene Therapy and Personalized Medicine**		
	1	Ex-vivo, In-vivo, and In-situ gene therapy, vectors used for gene transfer	5
	2	Strategies of gene therapy	3
	3	Gene therapy trials-Cancer, AIDS, and neurological diseases	3
	4	An overview on personalised medicine	4

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

1. Genetics for clinicians-Shubha R Phadke; PRISM BOOKS
2. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K
3. An introduction to recombinant DNA in medicine- Alan E H Emery; John Wiley and sons
4. Benjamin A. Pierce (2020). Genetics: A Conceptual Approach; VII Edition Macmillan Learning

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	4
	3	4
	4	4
2	1	5
	2	5
	3	5
	4	5
3	1	2
	2	2
	3	2
	4	2
4	1	1
	2	1
	3	6

	4	5

Suggested Readings:

5. T Strachan and Andrew Read (2011) Human Molecular Genetics; Garland Science
6. Gavin Brooks (2005) Gene Therapy; Viva Bools Pvt Lt

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
d)	Viva	5
Total		**100**

Employability for the Course:

Diagnostic Labs

Biotechnologist faculty

○

KU 6 DSE BTC 303: VACCINE BIOTECHNOLOGY

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours

	6	DSE	Higher	KU 6 DSE BTC 303	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description: The Vaccine Biotechnology course explores the scientific principles and cutting-edge technologies behind vaccine development. Topics include immunology, molecular biology, and genetic engineering techniques used to create vaccines. Students will study the history and evolution of vaccines, current methods of production, and regulatory considerations. The course also covers emerging trends in vaccine research, such as mRNA vaccines, and the challenges of developing vaccines for global health threats. Through lectures, and case studies, students gain a comprehensive understanding of the biotechnological innovations driving modern vaccine science and their impact on public health.

Course Prerequisite: Immunology, Microbiology

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Differentiate immune responses in relation to infection	An

2	Understand immune response in relation to vaccination	U
3	Explain the requirement and designing of different types of Vaccines	U
4	Comprehend importance of conventional and new emerging Vaccine technologies	U

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**IMMUNE RESPONSE TO INFECTION:**	
	1	Protective immune response in bacterial, fungal, viral and parasitic infections	5
	2	Primary and secondary immune responses during infection	1
	3	Antigen presentation and role of antigen presenting cell: Dendritic cells in immune response; Innate immune response.	4
	4	Humoral (antibody mediated) response; Cell mediated response: role of CD4+ and CD8+ T cells; Memory responses: Memory and effector T and B cells, Generation, maintenance of T and B Cells	5
2		**IMMUNE RESPONSE TO VACCINATION:**	
	1	Vaccination and immune response: role and properties of adjuvants in vaccination	3
	2	Modulation of immune responses: Induction of Th1and Th2 responses by using appropriate adjuvants and antigen delivery systems-Microbial adjuvants, Liposomal and Microparticles as delivery systems	8
	3	Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and Mucosal Immunity.	4
3		**VACCINE TYPES**	
	1	History of development of vaccines, Overview of Conventional vaccines; Bacterial vaccines, Viral	5

		Vaccines.	
	2	Vaccines based on routes of administration: parenteral, oral, mucosal	2
	3	Live attenuated and inactivated vaccines; Subunit vaccines and Toxoids; Peptide vaccine, Recombinant vaccine, Edible vaccines	5

4	**EMERGING VACCINE TECHNOLOGIES**		
	1	New vaccine Technologies; Rationally designed vaccines; DNA Vaccination; Mucosal vaccination**;** Live-Attenuated Viruses (LAVs) Nucleic acid-based vaccines, mRNA vaccines, nanoparticle (NP) vaccines, viral-like particle (VLP) vaccines, and universal vaccines.	6
	2	New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccine for targeted delivery (Vaccine Delivery systems);	4
	3	Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS Vaccine;	3
	4	New emerging diseases and Vaccine needs (Ebola/Zika/Corona).	2

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Janeway, C.A., Travers, p., Walport, M., and Shlomchik, M.J. (2005). Immuno Biology: the Immune System in Health and Disease. USA: Garland Science Pub.

2. Abul K. Abbas, Andrew H. Lichtman. (2011). Basic Immunology Functions and Disorders of the Immune System. Saunders Elsevier Inc pub.
3. David Male, Jonathan Brostoff, David B Roth, Ivan M Roitt, (2013).Eighth Edition Immunology, Elsevier Ltd.
4. Kindt, T.J., Osborne, B.A., Goldsby, R.A., Kuby, J. (2013). Kuby Immunology. Newyork: W.H. Freeman
5. Kaufmann S.H. (2004). Novel Vaccination Strategies. Weinheim: Wiley-VCH
6. Levine,M.M.(2004).New Generation Vaccines. NewYork: M.Dekker.
7. https://www.nature.com/articles/s41577-020-00479-7
8. Journal articles (relevant issues) from:
   Annual review of Immunology,
   Annual review of Microbiology,
   Current opinion in Immunology,
   Nature Immunology,
   Expert review of Vaccines

Reference Distribution:

Module	Unit	Reference No.
1	1	3,4
	2	3,4
	3	3,4
	4	3,4
2	1	2,3
	2	2,3
	3	2,3
3	1	1,4

	2	1,4
	3	1,4
4	1	5,6,7
	2	5,6,7
	3	5,6,7
	4	5,6,7

Suggested Readings:

1. W. John W. Morrow, Nadeem A. Sheikh, Clint S. Schmidt (2012). Vaccinology: Principles and Practice. Wiley Blackwell pub.
2. Tizard, Ian R. Immunology an introduction, Fourth Ed, Saunders college publishing, New Delhi, 2010

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5

d)	Viva	5
Total		**100**

- **Employability for the Course:**
- Vaccinologist
- Research and Development
- Biotechnology companies

KU 6 DSE BTC 304: PHARMACEUTICAL BIOTECHNOLOGY

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	6	DSC	Higher level	KU 6 DSE BTC 304	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description: Pharmaceutical Biotechnology course explores the intricate relationship between pharmaceuticals and biotechnology, delving into the application of biological techniques in drug discovery, development, and manufacturing. This course provides a comprehensive overview of the fundamental principles and advanced concepts in pharmaceutical biotechnology, equipping students with the knowledge and skills essential for careers in the pharmaceutical and biotechnology industries.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the principles and applications of biotechnological techniques in pharmaceutical research and development.	U
2	Identify and describe various biopharmaceutical products, including monoclonal antibodies, therapeutic enzymes, and vaccines.	A
3	Apply knowledge of drug delivery systems and nanotechnology in designing innovative drug delivery approaches.	A

4	Understand the regulatory framework governing the development and approval of biotechnological products in the pharmaceutical industry.	U
5	Understand the principles and applications of biotechnological techniques in pharmaceutical research and development.	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Pharmaceutical Biotechnology**		
	1	Overview of pharmaceutical biotechnology	3
	2	Importance of biotechnology in drug discovery and development	4
	3	Emerging technologies in pharmaceutical biotechnology	3
	4	Personalized medicine and biomarker discovery	5
2	**Biopharmaceuticals**		
	1	Introduction to biologics and biosimilars	3
	2	Monoclonal antibodies and their production	4
	3	Therapeutic enzymes and hormones	4
	4	Vaccines and vaccine development	4
3	**Drug Delivery Systems and Protein Engineering**		
	1	Principles of drug delivery, Nanotechnology in drug delivery	3
	2	Targeted drug delivery systems, Controlled release systems	4
	3	Protein structure and function, Recombinant protein expression systems	4

	4	Protein purification techniques, Site-directed mutagenesis and protein engineering methods	4

4	**Regulatory Affairs in Pharmaceutical Biotechnology**		
	1	Regulatory framework for biopharmaceuticals	3
	2	Good Manufacturing Practices (GMP) for biotech products	3
	3	Approval process for biologics and biosimilars	5
	4	Intellectual property considerations	4

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

1. Crommelin, Daan J.A., Robert D. Sindelar, and Bernd Meibohm (2019). Pharmaceutical Biotechnology: Fundamentals and Applications.
2. Walsh, Gary (2018). Biopharmaceuticals: Biochemistry and Biotechnology.
3. Ho, Rodney J.Y., and Milo Gibaldi (2013). Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs.
4. Walsh, Gary (2013). Pharmaceutical Biotechnology: Concepts and Applications.

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	1
	3	2
	4	1
2	1	1
	2	3
	3	1
	4	2
3	1	3
	2	3
	3	2
	4	4
4	1	1
	2	2
	3	1
	4	1

Suggested Readings:

BOOKS:

1. "Biotechnology and Biopharmaceuticals: Making the Transition from Laboratory to Manufacturing" by Rodney J.Y. Ho and Milo Gibaldi.
2. "Introduction to Biopharmaceuticals" by Ashim K. Mitra.
3. "Biopharmaceuticals: An Industrial Perspective" by Daan J.A. Crommelin, Robert D. Sindelar, and Bernd Meibohm

JOURNALS:

4. Biopharmaceutics & Drug Disposition
5. Pharmaceutical Research

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	5
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	10
Total		**100**

Employability for the Course:

- Graduates with a background in pharmaceutical biotechnology can pursue various career paths in pharmaceutical companies, biotechnology firms, research institutions, government agencies, regulatory bodies, and academic institutions.
- The pharmaceutical biotechnology field is dynamic, with rapid advancements in technology and research.
- The pharmaceutical biotechnology industry offers opportunities for employment on a global scale.

COURSES OFFERED IN THE SEVENTH SEMESTER 4YR UGP BSC BIOTECHNOLOGY PROGRAM

KU 7 DSC BTC 401: Molecular Immunology

Semester	Course Type	Course Level	Course code	Credits		Credits	Total hours
VII	DSC	Capstone	KU 7 DSC BTC 401	Total	4	4	5
				Module 1-3	3		
				Module 4	1		

Course

	Learning Approach (Hours/Week)			Marks Distribution			Duration of ESE (Hours)
Module	**Lecture**	**Practical**	**Tutorial**	**CE**	**ESE**	**Total**	
1,2,3	3		0	30	70	**100**	**2**
4		2		40	60	**100**	**2**

Description:

The course provides in depth examination of principles of molecular immunology, including B receptors, T cell receptors, and generation of Antibody diversity. The effector functions of the immune system, its role in health and disease and the biomedical and analytical applications.

Course Prerequisite

Should have completed the following courses

1. Intermediate level Immunology
2. Fundamentals of Microbiology
3. Intermediate level Molecular Biology

Course Outcomes:

Upon successfully completing this course, the student will be able to

CO No	Expected Outcome	Learning Domains
1	Comprehend the fundamentals of immunology, and characterize the structural and functional attributes of the immune responses.	U
2	Compare and contrast the tools used to characterise the immune system and immunodeficiency using in-vitro and in-vivo models.	U
3	Analyse the molecular mechanism of antibody generation and molecular basis of class switching.	An
4	Illustrate the various aspects of humoral and cell mediated immune and cytokine response.	U
5	Critically analyse the immunological basis of tolerance and transplantation.	An
6	Evaluate antigen immunodetection and categorize various immunodiagnostic techniques	E

*Remember (R),Understand(U),Apply(A),Analyse (An),Evaluate(E), Create (C)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1			✓				
CO2			✓				

CO3			✓				
CO4			✓				
CO5			✓				
CO6				✓			

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	Overview of the immune system		
	1	Antigens: Antigenicity, immunogenicity, Antigenic determinants/epitopes. Mitogens and superantigens	3
	2	Antibodies: Structure and functions -molecular structure of antibodies; Immuno-globulin domains, Immunoglobulin fold; variable region domains; complementarity determining regions (CDRS), CDRS and antigen binding, hinge region.	4
	3	Tools to study the immune system: Inbred strains, adoptive transfer systems, SCID Mice, SCID-Human Mice, primary lymphoid cultures, cloned lymphoid cell lines, hybrid lymphoid cell lines.	5
	4	Production of humanized monoclonal antibodies using PCR technology (Single chain fragment variable). Immunotherapy with genetically engineered antibodies. Vaccines.	3
MODULE	UNIT	DESCRIPTION	HOURS
	Antibody Diversity		
	1	Models of antibody diversity- multigene organization of Ig genes: λ- chain multigene family. K-chain multigene family. Heavy chain multigene family. V-J rearrangements in light chain DNA. V-D-J rearrangement in heavy chain DNA.	4

2	2	Recombination signal sequences. Enzymatic joining of gene segments and role of RAG-1 and rag -2 genes.	
		Molecular Mechanism of class switching.	4
	3	Molecular Organization of MHC molecules: MHC class-I, class-II and class-III genes in mouse and man, concept of MHC haplotypes. HLA .Antigen processing and presentation by MHC.	4
	4	MHC class III molecules including heat shock proteins. MHC and infectious diseases.Role of MHC in transplantation.	3
MODULE	UNIT	DESCRIPTION	HOURS
3	**B and T-cell receptor**		
	1	T-Cell Receptor: TCR for MHC-associated peptide antigen, CD3-TCR. Accessory molecules of T-cells: CD-28 and CTLA-4 as T-cell receptors for co-stimulators. Integrins, Selectins. Signal Transduction and TCR-Complex-TCR clustering.Molecular mechanism of tolerance.	4
	2	Recruitment and activation of Ras and Rac, calcineurin and protein kinase C signalling pathways in T-cell. Transcription factors regulating gene expression, Co-stimulators and transduction pathways. T cell regulation: Treg-FOXP3	4
	3	B-cell Receptor Complex: Structure of B-cell receptor complex. Recognition of antigen by B-cell receptor and signal transduction. Lymphocyte maturation.Clonal proliferation and memory.	4
	4	Complement receptors and second signal for B-cell. Antibody response to T-dependent and T-independent antigens. Cytokines in immune activation	3

MODULE	UNIT	DESCRIPTION	HOURS
4	Laboratory Experiments		
	1	Immunodetection of antigen in cells and tissues:- Antigen antibody interaction	2
	2	Differential and total Leukocyte Count	3
	3	Single Radial Immunodiffusion	2
	4	Ouchterlony Double Diffusion	2
	5	Counter current Immunoelectrophoresis	4
	6	Immunoblotting (western blot analysis)	5
	7	Immunoprecipitation of antigen complexes Widal Test	2
	8	Rapid Plasma Reagin (RPR) Test	2
	9	Dot ELISA	4
	10	Plate ELISA	4

5	Teacher specific module	5
	Directions	
		5

Essential Readings:

1. Owen JA, Punt J and Stranford SA (2018) Kuby Immunology, 8th Edition,
2. WH Freeman and Company, NY.
3. Abbas AK, Lichtman AH, Pillai S (2020) Cellular and Molecular Immunology. 10th Edition WB Saunders Co. USA.
4. Parham P (2021) The Immune System, 5th Edition, Garland Sciences, London and New York
5. Essential Immunology Roitt I. Blackwell Scientific Publications- Oxford 13th Edition 2017
6. Immunology and Immunotechnology. Ashim K Chakravarthy- Oxford University Press, 2006
7. Immunotechnology: Principles, Concepts and Applications. A. Moran and J.P. Gosling- John Wiley and Sons, 2008

Reference Distribution:

Module	Unit	Reference No
1	1	
	2	
	3	1,2,3

	4	
2	1	2,4,5
	2	
	3	
	4	
3	1	2,3,4
	2	
	3	
	4	
4	1	2,5,6
	2	
	3	
	4	

Suggested reading

1. Kuby Immunology 8th ed-Jenni Punt,Sharon Stanford et al, 2018- WH Freeman.
2. Immunology: A short course. Richard Coico , Geoffrey Sunshine Published by Wiley-Blackwell, 7th edition, 2015
3. Understanding Immunology. Peter Wood- Pearson Education 3rd edition,2011

Assessment Rubrics:

	Evaluation Type		Marks
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		Marks (%)
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability for the Course**

- Research And Development
- Biotechnology Industries
- Teaching
- Medical field
- Laboratory Technicians

KU 7 DSC BTC 402: OMICS AND BIOINFORMATICS

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
7	DSC	Advanced	KU 7 DSC BTC 402	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1, 2, 3	3			30	70	100	2
4		2		40	60	100	2

Course Description:

The course, omics and bioinformatics is aimed at providing an in-depth understanding of bioinformatics- tools, techniques, software and biological databases. The students will be familiarized with computational logic, algorithms and software for obtaining biological solutions. The course train the students to use bioinformatics tools and software for sequence comparison, generation of phylogenetic tree, 3D structures prediction, docking and primer designing.

Course Prerequisite: Should have completed the following courses:

1. **Basic Bioinformatics**
2. **Intermediate Molecular Biology**
3. **Higher level Genetic engineering**

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand different biological databases and retrieve biological data from database	U

2	Understand global and local alignment methods	U
3	Analyse evolutionary relationship by sequence comparison	An
4	Understand the impact gene sequencing and human genome project in identifying the genetic make-up and functionality of genes in different organism	U
5	Apply various tools like BLAST, Clustal, MEGA, SwissDock and SWISS-MODEL for insilico analysis	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Biological databases**		
	1	Bioinformatics- application, advantages and historical perspective	3
	2	Databases- primary secondary and composite	3
	3	Protein databases- PIR, SwissProt, Uniprot, Pfam, PDB, SCOP and CATH	4
	4	Nucleic acid databases- GenBank, DDBJ, EMBL	4

2	**Sequence comparison tools**		
	1	Sequence alignment- global and local alignment	4
	2	Pairwise alignment tools- BLAST, FASTA	4
	3	Multiple sequence alignment tool- Clustal, MEGA	4
	4	Phylogenetic studies- tree construction, cladogram and dendrogram, bootstrapping	5

3	**Genomics, transcriptomics, and proteomics**		
	1	Gene and genome sequencing techniques, NGS, Illumina	4
	2	RNA sequencing, RNA seq, microarray and its application in functional studies	4
	3	Protein sequencing techniques, Sequence to structure relationship, Homology modelling and docking	5

	4	Human genome project	4

4	**Laboratory experiments**		
	1	Retrieval of protein and nucleic acid sequences from NCBI	3
	2	Perform Blastn, Blastp, Blastx and Blastn with given query sequence	5
	3	Perform multiple sequence analysis using tools like Clustal, MEGA	2
	4	Construction of phylogenetic tree using given sequences	2
	5	Translation of DNA/RNA sequence to amino acid sequence using ExpasyTranslate tool	2
	6	Identification of primary secondary structure of protein	3
	7	3D modelling of protein sequences using Swiss Model	2
	8	Performing protein-protein docking or protein ligand docking	2
	9	Primer designing using Primer3 or PrimerQuest software	3
	10	Perform conserved domain search with nucleic acid or protein query	4

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

4. Claverie, J.M. and Notre Dame, C., 2003. Bioinformatics: A Beginner's Guide. Wiley

5. Dandekar, Thomas and Meik Kunz., 2023. Bioinformatics an introductory textbook. Springer Nature
6. Xiong J., 2006 Essential Bioinformatics. Cambridge University Press
.

Reference Distribution:

Module	Unit	Reference No.
1	1	3
	2	3
	3	2
	4	3
2	1	1
	2	1
	3	1
	4	3
3	1	5
	2	5
	3	4
	4	6
4	1	NCBI (National Centre for Biotechnology Information)

	2	NCBI
	3	NCBI
	4	NCBI
	5	NCBI
	6	NCBI
	7	NCBI
	8	NCBI
	9	NCBI
	10	NCBI

Suggested Readings:

7. Posada, D., 2009. *Bioinformatics for DNA sequence analysis*. Humana Press.

8. Melanie Kappelman and Fenzl Next Generation sequencing and data analysis., 2021. Springer

9. Gibbs, R.A., 2020. The human genome project changed everything. Nature Reviews Genetics, 21(10), pp.575-576.

Assessment Rubrics:

	Evaluation Type		Marks
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		Marks (%)
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability for the Course:**
- Researcher
- Biological technicians

- Illumina and RNAseq data analyser
- Pharmaceutical company- drug docking studies
- Bioinformatics and Computational Biology: Computational biologist, bioinformatician.
- Research fellow, research associate or data analyst
- Teaching faculty

KU 7 DSC BTC 403: Molecular Cell Biology

Semester	Course Type	Course Level	Course code	Credits		Total hours
VII	DSC	Capstone	KU 7 DSC BTC 403	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/Week)			Marks Distribution			Duration of ESE (Hours)
Modules	**Lecture**	**Practical**	**Tutorial**	**CE**	**ESE**	**Total**	
1,2,3	**3**		**0**	**30**	**70**	**100**	**2**
4		**2**		**40**	**60**	**100**	**2**

Course Description:

The Course on Molecular Cell Biology will discuss the molecular basis of cell structure/ function at a more advanced level than in the introductory courses of Cell Biology, Molecular Biology and Biochemistry.

Course Prerequisite

Should have completed the following courses

Intermediate level Cell biology
Intermediate level Molecular Biology
Introductory Biochemistry

Course Outcomes:

Upon successfully completing this course, the student will be able to

CO No	Expected Outcome	Learning Domains
1	Explain the detailed structure of a cell including its membrane, cytoskeleton, organelles, and genetic material	U
2	Illustrate the structure of Chromosomes and analyse the packaging of genetic material.	U
3	Compare cell signalling pathways in various cell types.	U
4	Interpret cell coordination and regulation of cell division.	U
5	Explain the compartmentalisation in a cell.	U
6	Illustrate cytoskeletal dynamics and their role in cell shape, division, movement, sensing the environment, and cell-cell communication.	U
7	Critically analyse the experimental approaches used to study cellular activities and interpret experimental results.	An

*Remember (R), Understand(U), Apply(A), Analyse (An), Evaluate(E), Create (C)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1			√				
CO2			√				
CO3			√				
CO4			√				
CO5			√				
CO6			√				
CO7				√			

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
	Cell membrane molecular structure and function		

1	1	Lipid bilayer and membrane protein diffusion, transport across membranes	3
	2	Electrical properties of membranes. Nerve Cells and Action Potentials.	3
	3	Cell signalling: Hormones and their receptors signal transduction pathways, cell surface receptor, signalling through G-protein coupled receptors, second messengers.	5
	4	Regulation of signalling pathways, bacterial and plant two-component systems, light signalling in plants, bacterial chemotaxis and quorum sensing.	4
2	Protein folding and sorting,		
	1	Ultrastructure of ribosomes, lysosomes, peroxisomes (glyoxysomes), plastids. Post translational protein transport into Organelles	4
	2	Structure and functions of endoplasmic reticulum, Co-translational Protein Transport into the ER, ER/Golgi, Vesicular transport and Golgi, Posttranslational Modifications and Quality Control of Vesicle formation & Cargo Sorting, Vesicle targeting and fusion	4
	3	Chloroplast and Mitochondrial dynamics, Regulated Protein Degradation	4
	4	Nuclear dynamics and architecture, Transport across the Nuclear Envelope	3
	Nuclear material and Organisation		
	1	Chromatin Organization- Nature of the genetic material, Proteins associated with Nuclei, packaging of genetic material: nucleosome model.	3
	2	Unique and repetitive DNA, heterochromatin and euchromatin, Control of gene expression, Cell cycle, Apoptosis. Overview of Cancer critical genes.	4
	3	Mechanism of cell communication, Extracellular Matrix and Cell Adhesion,Basic elements of the cytoskeleton of a cell -mechanisms of assembly,Myosin, Muscle architecture and function.	4

3	4	Actin dynamics and regulation, Microtubules, and motors in mitosis. Intermediate Filaments.	4
4	Laboratory Experiments		
	1	Isolating Mononuclear Cells from blood and viability testing	4
	2	SDS PAGE for denatured protein isolation	4
	3	Native PAGE for isolation of protein	4
	4	Plasmid isolation	2
	5	Restriction digestion and ligation	2
	6	DNA PCR for housekeeping genes	5
	7	Primary cell culture (chick embryo fibroblast)	4
	8	Secondary cell culture (VERO cell line)	5

5	Teacher specific module	5
	Directions	
		5

Essential Readings:

1. Molecular Biology of The Cell (7th Edition) Albetrs, Heagan, Raff , Roberts, ld, Johnson, Mor Walter and Wilson (2022). Garland Science, Taylor & Francis.
2. Molecular Cell Biology (9th edition) Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger , Anthony Bretscher, Hidde Ploegh, Kelsey C.Martin, Michael Yaffe, Angelika Amon (2021)W. H. Freeman.
3. Karp’s Cell and Molecular Biology (9th edition) Gerald Karp, Janet Iwasa, Wallace Marshall (2020) Wiley.

4. Lehninger's Principles of Biochemistry (7th edition) David L Nelson and Micheal Cox (2017) WH Freeman and Co.
5. Essential Cell Biology (7th Edition). Bruce Alberts, Alexander Johnson,Julian Lewis, Martin Roff, Keeth Roberts, Peter Walter (2022).W. W. Norton & Company

Reference Distribution:

Module	Unit	Reference No
1	1	1,2,3
	2	
	3	
	4	
2	1	1,2,3
	2	
	3	
	4	
3	1	1,2,3,4
	2	
	3	
	4	
4	1	1,2,3,5
	2	

	3	
	4	

Suggested reading

6 The world of the cell (7th edition). Becker, Wayne M.; Kleinsmith, Lewis J.; Hardin, Jeff; Bertoni, Gregory Paul (2008) Benjamin Cummings.

7 The Cell: A Molecular Approach (9th Edition) Geoffrey M. Cooper and Kenneth W. Adams (2022) Oxford University Press.

8 Cell Biology (4th edition) Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz, Graham Johnson (2023) ƒElsevier.

9 Cell and molecular biology (8th edition) Eduardo D.P. De Robertis and E.M.P. De Robertis (2017) Lea and Febiger,U.S.

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type	**Marks (%)**

Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability for the Course**

- Research And Development
- Cancer Biology
- Cell culture specialist
- Teaching
- Laboratory Technicians

KU 7 DSC BTC 404: INTELLECTUAL PROPERTY RIGHTS

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	7	DSC	Capstone	KU 7 DSC BTC 404	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description: An Intellectual Property Rights (IPR) course typically covers a range of topics related to the legal framework and principles governing the protection of intellectual property. It provides students with a comprehensive understanding of the legal framework and principles surrounding the protection of intellectual property. The course typically covers a range of topics, including patents, trademarks, copyrights, trade secrets, and related agreements at both national and international levels.

Course Prerequisite:

Should have completed the following courses World of Biotechnology (Foundation level) Genetic Engineering (Higher level)

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Define and explain the fundamental concepts of intellectual property.	R
2	Understand the requirements for patentability and demonstrate the ability to analyse and evaluate patent applications.	U
3	Understand the principles of trademarks, trade secrets and copyright protection.	U
4	Understand the legal and trade related aspects of IPR.	U
5	Apply the fundamental concepts of intellectual property.	A

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**Introduction to Intellectual Property Rights (IPR)**		
	1	Overview of IPR, Types of intellectual property (patents, copyrights, trademarks, trade secrets), Importance of IPR in biotechnology.	5
	2	Patents in Biotechnology: Basics of patent law, Patentable subject matter in biotechnology.	3
	3	Patent filing and prosecution process.	5
	4	Patent infringement and litigation.	2

2	**IPR and Biotechnology**		
	1	Copyrights and Biotechnology: Basics of copyright law, Protection of biotechnological works under copyright.	3
	2	Trademarks in Biotechnology: Basics of trademark law, Trademarks in the context of biotechnological products.	4
	3	Trade Secrets in Biotechnology: Definition and importance of trade secrets, Protection of trade secrets in the biotechnology industry.	4
	4	Geographical Indications and Traditional Knowledge.	4

3	Bioethics and Plant Genetic Resources		
	1	Ethical issues in research and development.	3
	2	Biopiracy, bioprospecting, and access and benefit-sharing agreements.	3
	3	Introduction to Plant Genetic Resources and IPR, Importance of Plant Genetic Resources, Nagoya Protocol and its principles.	4
	4	Access and Benefit-Sharing (ABS): ABS agreements and their implications for researchers and breeders.	5

4	International Perspectives on IPR in Biotechnology		
	1	International agreements and conventions: GATT, TRIPS, Paris Convention, Budapest treaty, Berne Convention, Patent Cooperation Treaty (PCT), UPOV, Nagoya Protocol.	5
	2	Global strategies for protecting biotechnological inventions.	3
	3	Comparison of IPR regimes across different countries.	4
	4	Harmonization efforts and challenges.	3

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

1. Intellectual Property laws: containing Acts. rules & amp; regulations. Universal Law Publishing Co. 2012
2. Intellectual Property. The law of Trademarks. Copyrights. Patents and Trade Secrets. Third edition. Deborah E. Bouchoux. 20 l2
3. Intellectual Property law. A Chandrashekaran. C Sitaraman and Co Pvt. Ltd. 2009
4. lntellectual Property Protection and Sustainable Development. Philippe Culle
5. Intellectual Property laws: containing Acts, Rules & Regulations 2008; Universal Lari Publishing Co.

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	3
	3	3
	4	1
2	1	2
	2	1
	3	3
	4	2

3	1	4
	2	1
	3	3
	4	5
4	1	5
	2	4
	3	4
	4	5

Suggested Readings:

6. Intellectual Property Quarterly, *Sweet & Maxwell*
7. Journal of the Patent and Trademark Office Society, *Patent and Trademark Office Society*
8. Intellectual Property & Technology Law Journal, *George Washington University Law School*

E-Resources:

1. Google Patents - https://patents.google.com/
2. United States Patent and Trademark Office (USPTO) - https://www.uspto.gov/

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5

c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

- **Employability for the Course:**

  • Employment with patent offices, trademark offices, and other government agencies responsible for intellectual property regulation and administration

  •Positions in organizations focused on research and development, technology transfer, and innovation.

  •Opportunities in the pharmaceutical and biotech industries, particularly for those with a focus on patent law.

  •Opportunities as intellectual property attorneys, patent agents, trademark attorneys, and legal consultants.

  •Consulting roles where individuals provide advice on intellectual property strategy.

  •Opportunities to work with international bodies such as WIPO, WTO, and others.

KU 7 DSE BTC 401: BIOENTREPRENEURSHIP

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	7	DSC	Capstone	KU 7 DSE BTC 401	4	4

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description:

1. To understand the basic requirements of bio entrepreneurship
2. To understand about innovations/novel applications, problem solving options, prototyping to productization, market plan and investment plan
3. To understand business sustainability and exit strategy

Course Prerequisite: Should have completed Biotechnology foundation course

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the requirements of bioentrepreneurship, product design, basic management techniques, entrepreneurial skills, and funding agencies.	U

2	Develop a business plan, thereby demonstrating the knowledge, skills and attitudes required for bio entrepreneurship	C
3	Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.	A
5	Understand the market opportunity, operational and financial feasibility of new bioventure formation.	U
6	Develop skills and business models required for investment opportunities.	C

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**INTRODUCTION TO BIOENTREPRENEURSHIP**		
	1	Meaning and concept of entrepreneurship and bio entrepreneurship	5
	2	The history of bio entrepreneurship, bio entrepreneurship requirements-factors promoting bio entrepreneurship	3
	3	Barriers to bio entrepreneurship culture-stages in bio entrepreneurial process.	3
	4	Women bio-entrepreneurship and economic development.	4
2	**BUSINESS IDEATION**		
	1	Recognizing opportunities; ideation, innovation, problem statement and problem-solving options.	3
	2	Prototyping to productization; Technology Readiness levels (TRLs).	3
	3	Idea protection-patents and IPR.	2
	4	Trademarks and copyrights.	4

3	**IDEA EVALUATION**		
	1	Opportunity identification and product/service selection-generation and screening the project ideas.	4
	2	Market and Technical analysis-cost benefit and network analysis.	4

	3	Project formulation – assessment of project feasibility.	3
	4	Dealing with basic and initial problems of setting up of bio-entrepreneurships.	4

4	**BUSINESS MODELLING AND FUNDING OPPORTUNITIES**		
	1	Meaning of business plan; factors involved in a business model.	3
	2	Advantages of business planning; preparing a model project report for starting a new venture (Team -based project work) and its evaluation; Scaling up and market strategy.	5
	3	Exit strategy. Sources of Finance; venture capital-venture capital process-commercial banks.	3
	4	Government grants and schemes-start-up grants and schemes.	4

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Swati Agarwal, Sonu Kumari, Suphiya Khan (2021). "Bioentrepreneurship and Transferring Technology into Product Development," Business Science Reference
2. D.F Kuratko and T.V Rao (2012). Entrepreneurship: a south asian perspective. - Cengage, New Delhi.
3. Leach and Melicher (2021). Entrepreneurial Finance (7^{th} edition)-Cengage., New Delhi.
4. K. Sundar (2020). Entrepreneurship Development (2^{nd} edition)-Vijay Nicole Imprints private Limited

5. Khanka S.S (2006). Entrepreneurial Development-S. Chand & Co. Ltd., New Delhi, 2001.
6. Sangeeta Sharma (2022). Entrepreneurship Development (2nd edition) PHI Learning Pvt. Ltd., 2016.

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	5
	2	3
	3	3
	4	4
2	1	5
	2	3
	3	4
	4	3
3	1	3
	2	5
	3	3
	4	4
4	1	3
	2	5
	3	3

	4	3

Suggested Readings:

7. Holger Patzelt and Thomas Brenner (2008). "Handbook of Bio entrepreneurship," Springer publications.
8. Jayshree Suresh (2008). "Entrepreneurial Development," 5th Edition, Margham Publications.
9. Robert D. Hisrich (2009)."Entrepreneurship," 6th Edition, Tata McGraw Hill Publications.
10. Barringer, B (2011). "Entrepreneurship: Successfully Launching New Ventures," 3rd Edition, Pearson. 11.Bessant, J., and Tidd, J (2011) "Innovation and Entrepreneurship," 2nd Edition, John Wiley &Sons.
12. Desai, V (2011). "Small Scale Industries and Entrepreneurship" Himalaya Publishing House.
13. Donald, F.K. (2014). "Entrepreneurship- Theory, Process and Practice," 9th Edition, Cengage Learning.
14. Hirsch, R.D., Peters, M. and Shepherd, D. (2006). "Entrepreneurship," 6th Edition, Tata McGraw-Hill Education Pvt. Ltd.

E-RESOURCES:

15. https://www.startupindia.gov.in/
16. https://startupmission.kerala.gov.in/
17. http://inventors.about.com/od/entrepreneur/
18. https://eship.cornell.edu/category/bioentrepreneurship/
19. http://learnthat.com/tag/entrepreneurship/
20. www.entrepreneur.com
21. https://www.nature.com/bioent
22. https://www.birac.nic.in/

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10

b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

Employability for the Course:

- Entrepreneurship
- Biotechnology companies Development
- Development Executive
- Patent Office Jobs
- Manufacturing
- Research and
- Teaching
- Business

KU 7 DSE BTC 402: BIOINSTRUMENTATION

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours/Week
	7	DSC	Advanced level	KU 7 DSE BTC 402	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description:

Bioinstrumentation is the development of technologies for the measurement and manipulation of parameters within biological systems. The course mainly aims to give students an insight of various biological instruments, thus implementing their knowledge to design and manufacture the same. Students will get a better understanding of the working principle of instruments for characterization, fractionation, isolation and separation of biomolecules for various purposes.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Apply the knowledge of microscopy in analyzing biological specimens	A
2	Analyze the concentration, purity and separation of biomolecules	An
3	Analyse and perform fractionation and separation of biomolecules like proteins, lipids and secondary metabolites	An
4	Apply the knowledge of radioisotopes for the construction of probes, imaging techniques and determine the structures of proteins and nucleic acids by X-ray crystallography	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Module 1**		
	1	Microscopy-Basic principle, diffraction, reflection and refraction, refractive index	3
	2	Light microscope- Bright field, dark field microscope	3
	3	Phase contrast microscope, confocal and fluorescence microscope	4
	4	Scanning electron microscope and transmission electron microscope	5

2	**Module II**		
	1	Spectroscopy: Basic principles, nature of electromagnetic radiation, instrument design.	3
	2	UV-Visible, IR, atomic absorption emission spectrophotometer, CD spectroscopy, GS-MS, NMR, ESR, mass spectroscopy	5
	3	Centrifugation: Basic principle, forces involved, RCF	4
	4	Analytical, density gradient, isopycnic, rate zonal, differential centrifugation	3

3		

	Module III		
	1	Physicochemical fractionation and electroanalytical techniques: Chromatography**:** Basic principle, experiment setup	4
	2	Partition, liquid-liquid, solid-liquid, HPLC and gas chromatography	1
	3	Electrophoresis: principle, electrophoretic mobility, factors effecting EPM	5
	4	Agarose gel and polyacrylamide gel electrophoresis, capillary electrophoresis and isoelectric focusing	5

4	**Module IV**		
	1	X-ray crystallography: Basic principle, Bragg's Law, Thomson scattering	4
	2	X-ray absorption, Auger Emission Spectroscopy, X-ray fluorescence and X-ray diffraction	5
	3	Radioisotope based techniques: Detection and measurement of α, β, γ rays using scintillation counters, Geiger-Muller counters	2
	4	Radiotracer technique and autoradiography	2

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Biophysical chemistry, Avinash Upadhyay, Kakkoli Upadhyay, Nirmalendu Nath, Himalaya Publishing House.2016.
2. Biophysics and bioinstrumentation; N Arumugam, V Kumaresan; Saras publication; 1st ed. 2013; ISBN 978-81-89941-63-5.
3. Biophysics; G R Chatwal; Himalaya Publishing House, Bombay; 1st ed; f(1 January 2011)

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	1
	3	1
	4	1
2	1	2
	2	2
	3	2
	4	2
3	1	2
	2	2

	3	2
	4	2
4	1	3
	2	3
	3	3
	4	3

Suggested Readings:

1. Biophysics (2nd Ed) – Vasantha Pattabhi and N. Gautham, 2009, Alpha Science International Ltd.
2. Principles and techniques of Biochemistry and Molecular Biology. Keith Wilson and John Walker; Cambridge University Press. 8th edition. 2018
3. The Physical Basis of Biochemistry. Peter R Bergethon. Springer-Verlag. 2010
4. Bioseparations. Principles and techniques. Sivasankar. Prentice- Hall India. First edition 2005
5. Principle of physical chemistry. Puri, Sharma, Pathania.VPC publication. 2008

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5

Total	**100**

Employability for the course/programme:

- Research
- Industries
- Medical Bioinstrumentation
- Lab technicians

KU7 DSE BTC 403: BIOTECHNOLOGY IN PHARMACOGNOSY & ETHNOMEDICINE

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours/week
7	DSE	Capstone	KU7 DSE BTC 403	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
	Lecture	Practical	Tutorial	CE	ESE	Total	
Module 1,2,3	3			30	70	100	2
Module 4		2		40	60	100	2

Course Description:

Pharmacognosy is the study of crude drug derived from microorganisms, animals, and most plants while Ethnomedicine is the study of "traditional medicine" of ethnic communities, their knowledge and practices that transmitted orally over centuries, and evolved over millennia of human existence. The purpose of this course is to raise students' awareness of pharmacology, ethnomedicine, traditional knowledge, and the role that biotechnology plays in advancing these fields. It also seeks to raise students' awareness of the rich and diverse cultural histories of different communities, fostering an awareness of the world.

Course Prerequisite:

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of Pharmacognosy	U
2	Create the knowledge on secondary metabolites and its uses	U
3	Apply Biotechnology in Pharmacognosy	A
4	Understand the ethical issues on bioprospecting and traditional knowledge system	An
5	Apply biotechnological tools for the conservation of medicinal plants and production of secondary metabolites	E

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create ©*

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**UNIT I**		
	1	Introduction; History, definition and scope of Pharmacognosy.	3
	2	Importance of Natural drug substance	3
	3	Ethnomedicine & Indigenous knowledge-definition. Indian Traditional medical drugs	4
	4	Importance of ethnomedicine & its role in human health care.	5
2	**UNIT II**		
	1	Bioprospecting & Screening methods. Role of Secondary metabolites in health care.	3
	2	Secondary metabolites in plants- Terpenes, Glycosides, Phenylpropanoids & alkaloids-Function & medical role.	5
	3	Isolation, extraction techniques & bioassay of secondary metabolites	4
	4	In Vitro culture for production of secondary metabolites-Hairy root culture & Elicitation	3
3	**UNIT III**		
	1	Commercial importance of Biogenetic resource & Traditional Knowledge	3
	2	Ethical issues associated with bioprospecting & use of Traditional, Traditional Knowledge system	5

	3	Biopiracy, IPR & ownership of Traditional Knowledge system	3
	4	Protection of Traditional Knowledge system & biogenetic resource-TRIPS agreement, benefit sharing	4

4	**Laboratory experiments**		
	1	Identify some of the medicinal plants using Ethnomedicine data & it,s use.	2
	2	Extraction & Analysis of antimicrobial action of plant extracts	4
	3	Micropropagation of Moringa plant (Moringa Olivera)	4
	4	Micropropagation of Neem	4
	5	In vitro conservation of endangered medicinal plant	4
	6	Production of secondary metabolites and analysis (traditional method)	2
	7	Production of secondary metabolites from tissue cultured plants and analysis	4
	8	Field visit in Biodiversity rich areas to examine possible medicinal plants & prepare a report	5

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Ashutosh Kar, Pharmacognosy and Pharmacobiotechnology, New Age International Ltd.2000
2. William G. Hopkins and Norman P. A. H uner, Introduction to Plant Physiology, Wiley India Pvt Ltd Fourth ed.,2013
3. María Alejandra Alvarez Plant Biotechnology for Health From Secondary Metabolites to Molecular Farming,Springer 2014
4. Jonathan Curci, The Protection of Biodiversity and Traditional Knowledge in International Law of Intellectual Property,Cambridge University Press 2010
5. KV Krishnamurthy, An Advanced Textbook on Biodiversity: Principles And Practice fOxford & IBH Publishing Co Pvt.Ltd (30 March 2018)

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1
	2	1
	3	1
	4	1
2	1	3
	2	2
	3	3
	4	3
3	1	4
	2	4

	3	4
	4	4

Suggested Readings:

1. Ara Kirakosyan · Peter B. Kaufman, Recent Advances in Plant Biotechnology, Springer, 2009
2. K.G. Ramawat (Ed.) Herbal Drugs: Ethnomedicine to Modern Medicine. Springer 2009
3. Nirmal Sengupta, Traditional Knowledge in Modern India Preservation, Promotion, Ethical Access and Benefit Sharing Mechanisms, Springer,2019

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		**Marks (%)**
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability for the Course:**
- Biotechnology companies
- Research and Development
- Teaching
- Government sector
- Plant tissue culture specialist
- Ayurveda and traditional medicine

COURSES OFFERED IN THE EIGHTH SEMESTER 4YR UGP BSC BIOTECHNOLOGY PROGRAM

KU 8 DSC BTC 405: RESEARCH METHODOLOGY

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	8	DSC	Advanced	KU 8 DSC BTC 405	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description:

The course creates a framework for enhancing the quality of research. It helps in developing the skills of investigation, evaluation, reasoning, analysing, comprehension, and writing. The course introduces the relevant tools of the research process such as research design, project drafting, planning and scientific writing. It gives an outline on how research is undertaken and how the results are communicated.

1. To enable the students to understand the basic principles and practices of common methods used for research
2. To understand the data collection and analysis techniques
3. To train and make students aware of scientific writing
4. To familiarize the ethics in scientific research

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the concept of research, implement contemporary research methodologies and experimental designs in research activities.	U
2	Effectively collect, generate data and statistically analyse them to show significance of the work carried out	An
3	Encourages to inculcate the attributes to be followed in research	E
4	Students can effectively convey his/her work to both technical and non-technical audience	C

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**CONCEPT, TYPES AND FORMULATION OF RESEARCH**		
	1	Definition, meaning, need of research,	2
	2	Patterns of Research- Inductive & Deductive, Descriptive vs Analytical, Applied vs Fundamental, Quantitative and Qualitative, Conceptual vs Empirical.	3
	3	Defining and formulating the research problem, Importance of literature review- Web as a source, identifying gaps from literature review, developing working hypothesis	5
	4	Research design – basic principles, need, features and important concepts relating to research design	5

2	**DATA COLLECTION AND ANALYSIS**		
	1	Literature search – Use of databases and experimental design databases for literature search.	3
	2	Types of data, methods of data collection, sampling methods	2
	3	Data processing and analysis strategies, techniques and use of statistical packages, hypothesis testing, flow diagram for hypothesis testing, generalization, and interpretation	5
	4	Data analysis software's, use of internet for research purpose, introduction to UGC infonet, INFLIBNET and ERNET etc.	5

3	**CRITERIA OF GOOD RESEARCH**		
	1	Responsibilities of a researcher, Laboratory behaviour, maintenance of laboratory notebooks.	5
	2	Management of personnel, facilities, buildings, and equipment.	5
	3	Handling and storage of biological material, laboratory waste disposal.	5

4	**SCIENTIFIC WRITINGS AND CONDUCT**		
	1	Structure and Components of scientific reports, writing of manuscript, Research Paper, Research Project, Thesis, Book chapter, Reviews	5
	2	Grants/fellowship, Funding agencies, Intellectual honesty, Research integrity	2
	3	Scientific misconducts- Falsification, Fabrication and Plagiarism (FFP), plagiarism software	3
	4	Redundant publication, selective reporting and misrepresentation of data	3
	5	Calculations of impact factor of a journal, citation Index, ISBN & ISSN	2

5	**Teacher Specific Module**	**5**
	Directions	
	Space to fill the selected area/ activity	5

Essential Readings:

1. Kothari, C. R. And G. Garg (2019), Research Methodology: methods and techniques, fourth multicolour edition, New Age International Publishers.
2. Research Methodology: A step by step guide for research, Delhi: Pearson Education, 2009
3. Becker, H.S. Writing for Social Scientists: How to start and finish your thesis, Chicago; University of Chicago Press, 1986
4. Glass,D.J. (2014). Experimental Design for Biologists, Cold Spring Harbor Laboratory
5. Ruton,G.D and Colegrave, N.(2016). Experimental design for the life Sciences 4th Edition Oxford University Press.
6. An author's guide to publication ethics: a review of emerging standards in biomedical journals. Jason Roberts., 2009
7. Katz, M.J. (2009). From research to manuscript: a guide to scientific writing. Springer Science& Business Media.

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1, 2
	2	1, 2
	3	1, 2
	4	1, 2
2	1	4, 5
	2	4, 5
	3	4, 5

	4	15
3	1	13, 14
	2	13, 14
	3	13, 14
4	1	3,7
	2	3,7
	3	3,7
	4	3,7
	5	6

Suggested Readings:

1. Kothari C.R., 1990. Research Methodology: Methods and Techniques, II edition and above, New Age International.
2. Research Methodology: A step by step guide for beginners – Ranjeet Kumar
3. Holmes, D., Moody,P., Dine,D. and Trueman,L.(2016). Research methods for biosciences. Oxford University Press.
4. Publication ethics., Sabyasatchi et al., 2017
5. Day, R.A., 1992. How to write and Publish a Scientific Paper, Cambridge University Press

E- RESOURCES

6. http://www.cbd.int/biosafety/background.shtml
7. https://dbtindia.gov.in/sites/default/files/uploadfiles/Regulations_%26_Guidelines_for_Reocminant_DNA_Research and Bio containment 2017. Pdf

8. https://nlist.inflibnet.ac.in/veresources.ph

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

- **Employability for the Course:** Research

KU 8 DSC BTC 406: NANOBIOTECHNOLOGY

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours/Week
	8	DSC	Advanced level	KU 8 DSC BTC 406	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description:

Nanobiotechnology is the manipulation of matter on a near atomic scale to produce new structures, materials, and devices. It offers an enticing look into a future engrossed in nanobiotechnological applications with the help of overviews on the enabling technologies being used currently in various biotechnology related industries.

Course Prerequisite: Should have completed the following course

1. **World of Biotechnology**
2. **Biophysics**

Course Outcomes:

CO No.	Expected Outcome	Learning Domains

1	Understand the characters of nanoparticles and have insights on different classifications of nanoparticles	U
2	Apply knowledge on the production process of nanoparticles	A
3	Evaluate the uses of nanoparticles in the field of medicine, environmental and food sector	E
4	Analyze the various toxicological effects of nanoparticles	A

******Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Module I**		
	1	Definition, interdisciplinary nature, and history of nanobiotechnology	3
	2	Siegal classification of nanoparticles; zero, 1D, 2 D, 3 D	3
	3	Different architectures of nanoparticles (nano helices, pyramids, pillars, belts, zig-zags and nano cubes)	4
	4	Nano scale effects on properties (optical, catalytic, magnetic, electrical, mechanical, sterical and biological)	5
2	**Module II**		
	1	Classification of nanoparticles: Organic nanoparticles (dendrimers, liposomes, micelles, ferritin)	3
	2	Inorganic nanoparticles (metal based, metal oxides and carbon based), Quantum dots and CNTs.	5
	3	Synthesis of nanoparticles- Top-down (destructive process), milling	4
	4	Bottom-up- Chemo physical (constructive process), sol-gel, precipitation and hydro-thermal process; Aerosol process	3
3	**Module III**		
	1	Nanomedicine**:** molecular imaging, QD localization, drug delivery, nano robotics and surgery	4

	2	Nanodiagnostics, virus detection	1
	3	Nanosensors, Lab-on-a-chip, nanomotors	5
	4	Nanoemulsions, microbial biofilms analysis, food colloids	5

4	**Module IV**		
	1	Nanotoxicology: Physicochemical determinants, route of exposure	4
	2	Biodistribution, molecular determinants (oxidative stress and inflammation)	5
	3	Genotoxicity: mutagenesis and chromosomal aberrations	2
	4	Regulatory issues: Academy, Industry, and Government	2

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

1. Nanotechnology in Biology and Medicine: Methods, Devices and Application by Tuan Vo-Dinh. CRC press, 2007.
2. Nanotechnology: Importance and Application by M.H. Fulekar, IK International, 2010.
3. Comprehensive nanobiotechnology; V Sreekrishna; Ist edition 2011; New Age international (P) Ltd; ISBN 978-81-224-3082-0.

4. Nanobiotechnology: concepts, Applications, and perspectives 2004; Christof M Niemeyer, Chad A Mirkin, Wilet VCH.

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	1
	3	1
	4	1
2	1	1
	2	1
	3	1
	4	3
3	1	2
	2	2
	3	2
	4	2
4	1	4
	2	4

	3	4
	4	4

Suggested Readings:

1. Nanosystem characterization tools in the life sciences by Challa Kumar. WileyVCH, 2006.
2. Enviro Nanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin Wang, Rachid Sliman, Ian Wright. Elsevier, 2010.
3. Introduction to Nanoscience by Gabor L. Hornyak, Joydeep Dutta, Harry F.Tibbals, Anil K. Rao. CRC Press, 2008.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

Employability for the Course:

Biotechnology companies

Development diagnostics

Entrepreneurship

Research

KU 8 DSC BTC407: MOLECULAR DIAGNOSTICS

Semester	Course Type	Course Level	Course Code	**Credits**		Total Hours
8	DSC	Capstone	KU 8 DSC BTC 407	Total	4	5
				Module 1-3	3	
				Module 4	1	

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1, 2, 3	3			30	70	100	2
4		2		40	60	100	2

Course Description:

Molecular diagnostics are the tools based on the principles of Molecular diagnosis. It is the process of identifying a disease by understanding the molecules, such as DNA, RNA and Proteins in a tissue or fluid, which form the markers of the disease directly or indirectly. Molecular diagnostics is a new discipline that captures genomic and proteomic expression patterns and uses the information to distinguish between two or more conditions at the molecular level. The conditions under investigation can be human genetic diseases or infectious diseases. Molecular diagnostics is not confined to human diseases but can be used in animals and plants also. The course will provide the theory and the use of molecular techniques in the diagnostic techniques, with more importance on nucleic acid based techniques.

Course Prerequisite: Should have completed the following courses

1. **Molecular Biology**
2. **Genetics**

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the historical development of Molecular Diagnostics and techniques like restriction digestion and nucleic acid hybridization	U, A
2	Apply the technique polymerase chain reaction and DNA ligation in molecular diagnosis of diseases	A
3	Analyse the molecular diagnostic tools like RFLP and genetic testing for infectious diseases	An
4	Apply the molecular diagnostic tools for the diagnosis of different types infectious and genetic disorders (Laboratory testing)	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**Introduction to Molecular Diagnostics**	
	1	Historical development of Molecular Diagnostics: Molecular Diagnostics in post genomic era-Areas used in Molecular Diagnostics-Future prospects- Commercializing Molecular Diagnostics	5
	2	Characterization and analysis of nucleic acids and proteins: Extraction, isolation and detection of DNA, RNA and Protein	3
	3	Restriction endonucleases and restriction Mapping	3
	4	Hybridization Techniques: Southern, Northern, Western and FISH-Markers, Probes and its clinical applications	4

2		**Nucleic Acid Amplification Methods**	
	1	Polymerase Chain Reaction (PCR): General principle, components of a typical PCR reaction- Experimental Design-Primer Designing-	5
	2	Control of PCR contamination and mispriming-PCR product clean-up and detection	3
	3	Types of PCR: Nested PCR, Multiplex PCR, Hot start PCR and Real time RT-PCR	4
	4	Probe amplification: Ligase chain reaction	3

3	**Molecular Biology Based Diagnostics**		
	1	DNA polymorphism and identification: RFLP and Parentage testing, RFLP and Sickle-Cell Anaemia	3
	2	Molecular Diagnostics for Infectious Diseases: Molecular testing for Neisseria, Molecular diagnosis for HPV-1	5
	3	Genetic testing- Need and uses, genetic counselling. Case studies-Diagnostic testing for Cystic fibrosis-Fragile X diagnostics and carrier testing	3
	4	Ethical, Social and Legal issues to Molecular Genetic testing	4

4	**Molecular Diagnostics Experiments**		
	1	DNA isolation from blood	3
	2	RNA isolation from blood	5
	3	Agarose gel electrophoresis of DNA	3
	4	Molecular diagnosis using restriction digestion	3
	5	Molecular diagnosis using southern blotting and hybridization	4
	6	Molecular diagnosis multiplex PCR	2
	7	Molecular diagnosis using Hot Start PCR	2
	8	Molecular diagnosis using reverse transcriptase PCR	3
	9	Molecular diagnosis of Tuberculosis	2
	10	ELISA testing for HIV	3

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Prathibha Nallari and V.V Venugopal (2010). Medical Biotechnology-Rao-Oxford Press.
2. J.J Pasternack (2005). Introduction to Human Molecular Genetics (2nd edition)-John Wiley Publishers.
3. Tom Strachen and A.P Read (2018). Human Molecular Genetics (5th edition)-Bios Scientific Publishers.
4. A.H Emrey and S Malcolm (1995). Recombinant DNA (2nd edition)- John Wiley & Sons.
5. W.B Coleman (2005). Molecular Diagnostics for the Clinical Laboratorian (2nd edition)-Humana press.

Reference Distribution:

Module	Unit	Reference No.
1	1	8
	2	8
	3	7
	4	7

2	1	8
	2	8
	3	4
	4	4
3	1	3
	2	1
	3	6
	4	9
4	1	7
	2	7
	3	7
	4	7
	5	7
	6	7
	7	7
	8	7
	9	7
	10	7

Suggested Readings:

6. Edwin H. McConkey (1993). Human Genetics: The Molecular Evolution- Jones and Bartlett
7. Emery and Rimoin's (2002). Principles and Practice of Medical Genetics: I, II, III volumes (4^{th} edition)- Churchill Livingstone.
8. Glick and J. J Pasternack (2017). Molecular Biotechnology: Principles and Applications of Recombinant DNA (5^{th} edition)- Tylor and Francis.
9. David E Burns, Edward R. Ashwood, Carl A Burtis (2013). Fundamental of Molecular Diagnostics (5^{th} edition)- Saunders Group.
10. Lele Buckingham (2019). Molecular Diagnostics: Fundamentals, Methods, and Clinical applications (3^{rd} edition)- F.A Davis Company.

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**10**
		Quiz/Debate/Seminar	**10**
		Assignment	**5**
	End Semester Evaluation		**50**
	Total		**75**

	Evaluation Type		**Marks (%)**
Practical Part	**Continuous Evaluation**	**Lab performance**	**6**
		Record	**4**
	End Semester Evaluation	**Experiment**	**10**
		Viva Voce	**5**
	Total		**25**

- **Employability for the Course:**
- Medical Biotechnologist
- Government Hospitals
- Pharma companies
- Medical Technician
- Research and Development
- Teaching
- Manufacturing

KU 7 DSE BTC 404: PRINCIPLES OF DRUG DESIGN AND DEVELOPMENT

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	7	DSC	Capstone	KU 7 DSE BTC 404	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description: This course provides an in-depth exploration of the principles and techniques employed in the design and development of therapeutic drugs. Students will gain a comprehensive understanding of the drug discovery process, from target identification to preclinical and clinical development. Emphasis will be placed on the integration of medicinal chemistry, pharmacology, and modern technologies in the pursuit of effective and safe pharmaceutical compounds.

Course Prerequisite: Course in Biophysics, Course in Bioinformatics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the phases of drug development, from discovery to market approval.	U
2	Explain the challenges and complexities associated with each stage of drug development.	U
3	Understand the principles of medicinal chemistry and structure-activity relationships (SAR).	An
4	Understand the impact of personalized medicine, biotechnology, and other innovations.	A
5	Understand the phases of drug development, from discovery to market approval.	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Drug Design**		
	1	Overview of drug discovery and development process, Historical perspective on drug design,	3
	2	Pharmacokinetics and Pharmacodynamics: Absorption, distribution, metabolism, and excretion (ADME) of drugs	4
	3	Drug-receptor interactions and pharmacological effects	4
	4	Importance of drug design in healthcare	4

2	**Medicinal Chemistry**		
	1	Introduction to medicinal chemistry	3
	2	Structure-activity relationship (SAR) studies and Pharmacophore identification	4
	3	Identification of drug targets, Validation of drug targets using experimental and computational methods	4
	4	Pharmacophore identification and optimization, Drug metabolism	4

3	**Computer-Aided Drug Design (CADD)**		
	1	Molecular modeling techniques	4
	2	Ligand-based drug design	3
	3	Structure-based drug design	4

	4	Quantitative Structure-Activity Relationship (QSAR): Principles of QSAR, Applications in drug design	4

4	**Natural Products in Drug Discovery**		
	1	Overview of natural products as sources of drugs, Isolation and characterization of bioactive compounds, compound selection and lead optimization	4
	2	Preclinical and clinical development phases	4
	3	Regulatory requirements and approval process	4
	4	Ethical considerations in drug development	3

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

6. Patrick, Graham L. (2013). Introduction to Medicinal Chemistry.
7. Kuntz, Irwin D., et al. (2018). Computer-Aided Drug Design: Methods and Applications.
8. Stevens, C. Erland (2015). Medicinal Chemistry: The Modern Drug Discovery Process.
9. Rowland, Malcolm, and Thomas N. Tozer (2018). Pharmacokinetics and Pharmacodynamics: The Dynamics of Drug Absorption, Distribution, Action, and Elimination.

Reference Distribution:

Module	Unit	Reference No.
1	1	1
	2	1
	3	1
	4	1
2	1	2
	2	2
	3	3
	4	1
3	1	1
	2	3
	3	3
	4	1
4	1	4
	2	3
	3	3
	4	3

Suggested Readings:

BOOKS

9. "Principles of Medicinal Chemistry" by William O. Foye, Thomas L. Lemke, and David A. Williams
10. "Medicinal Chemistry: The Modern Drug Discovery Process" by Erland Stevens
11. "Computer-Aided Drug Design and Discovery" by Gerd Folkers and Hugo Kubinyi

JOURNALS

12. Current Topics in Medicinal Chemistry
13. Journal of Chemical Information and Modeling

WEBSITES

14. National Center for Biotechnology Information (NCBI) - https://www.ncbi.nlm.nih.gov/
15. ChemTube3D - http://www.chemtube3d.com/

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

Employability for the Course:

- Pharmaceutical and Biotechnology Industries: Medicinal chemist, drug designer, computational chemist, research scientist.
- Contract Research Organizations: Research scientist, project manager.
- Academic and Research Institutions: Researcher, postdoctoral fellow, faculty member.
- Government Agencies and Regulatory Bodies: Regulatory affairs specialist, pharmacologist.
- Biomedical and Pharmaceutical Consulting: Consultant, advisor.
- Clinical Research Organizations (CROs): Clinical research associate, clinical project manager.
- Bioinformatics and Computational Biology: Computational biologist, bioinformatician.
- Pharmacogenomics and Personalized Medicine: Pharmacogenomics researcher, personalized medicine specialist.
- Chemoinformatics and Informatics Roles: Chemoinformatician, data scientist.
- Pharmaceutical Sales and Marketing: Medical science liaison, product manager.
- Quality Control and Assurance: Quality control analyst, regulatory compliance specialist

KU 8 DSE BTC 405**: ENZYMOLOGY**

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	8	DSC	Capstone	KU 8 DSE BTC 405	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	0	0	30	70	100	2

Course Description:

1. To understand the classification of enzymes and fundamentals of enzyme assay. Understanding of kinetics of enzyme catalyzed reactions and derivation of MM equation.
2. To advance the knowledge on mechanism of enzyme action, enzyme inhibition as well as regulation of enzyme action

with relevant examples.

3. To study about the techniques of immobilization and application of enzymes in various industries.

Course Prerequisite: Should have completed the following courses

1. **Basic Biochemistry**
2. **Basic Biophysics**

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the basic concepts of nomenclature and classification of enzymes.	U
2	Understand the enzyme kinetics.	U
3	Understand the various types of enzyme inhibition with examples.	U
4	Understand the various mechanisms enzyme regulation Apply enzyme technology in various fields	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**ENZYMES**	
	1	Basic definition, classification, and nomenclature- classical and EC recommendation	5
	2	Coenzyme and their function, Active site and factors influencing enzyme activity. Units of enzymatic action.	3
	3	Enzyme structure and function. Isolation and purification of enzymes. Criteria for purity.	3
	4	Measurement of enzyme activity; specific activity and molar activity.	4

2	**ENZYME KINETICS**		
	1	Single Substrate-Single intermediate, Michaelis-Menten and Briggs Haldane kinetics	5
	2	Graphical analysis of kinetic data	3
	3	Determination of Km and Vmax; Experimental aspects	4
	4	Sequential and ping-pong mechanism.	3

3	**ENZYME INHIBITION**		
	1	Mechanism and rate studies. Reversible and irreversible inhibition	3
	2	Reversible enzyme inhibition; competitive, noncompetitive, and uncompetitive inhibition	5
	3	Irreversible inhibition Activation	3
	4	Graphical analysis; primary and secondary kinetic plots.	4

4	**ENZYME REGULATION AND ENZYME ENGINEERING**		
	1	Allosteric regulation example Aspartate transcarbamylase; isozymes- Lactate Dehydrogenase and creatine phosphokinase	3
	2	Zymogen activation; reversible covalent modification. Cooperativity; MWC and sequential model of allosteric enzymes.	5
	3	Active site mapping; immobilized enzymes and its application in food, industry, and medicine	3
	4	Ribozyme; drug design based on active site of an enzyme	3
	5	Demonstration of any single enzyme production assay,	3

		purification, basic characterization and kinetics	

5	**Teacher Specific Module**	**5**
	Directions	

Essential Readings:

1. Nicholas C. Price & Lews Stevens (1999). *Fundamentals of Enzymology*-Ox.Uni. Press.
2. M. Dixon and E.C Webb (1987). *Enzymes* (3rd edition) Academic Pr.
3. T Palmer (2001). *Enzymes: Biochemistry, Biotechnology, Clinical chemistry* (2nd edition). East West Press.
4. Joeffrey Zubay (2020). *Principles of Biochemistry* (5th edition)-Medtech.
5. Introduction to Enzyme and Coenzyme Chemistry by Bugg. T. D. H. (2012), Third Edition. John Wilel' & Sons Ltd. Chichester. UK.
6. Fundamentals of Biochemistry by Donald Voet and Judith Voet,. 4th edition: 2006.
7. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd.

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	3
	2	5
	3	3

	4	7
2	1	3
	2	3
	3	3
	4	6
3	1	3
	2	6
	3	3
	4	6
4	1	6
	2	7
	3	1
	4	4

Suggested Readings:

8. Trevor Palmer (1995). *Understanding Enzymes* (4th edition). Ellia Horwood Scientific Publisher.
9. Hans Neurath (2012). *The Proteins* (2nd edition. 4 volumes.)- Academic Press.
10. KJ Laider & PS. Bunting (1973). *Chemical Kinetics of Enzyme Action*- Oxford Univ. Lond.
11. Fersht, W. H (1984). *Enzyme Structure and Functions* (2nd edition)- Freeman & Co, NY.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

- **Employability for the Course:**
- Enzymologist
- Research and Development
- Teaching
- Pharmaceuticals
- Food processing

KU 8 DSE BTC 406**: STEM CELL AND NEUROBIOLOGY**

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	8	DSC	Advanced	KU 8 DSE BTC 406	4	4

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Module	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	4	-	0	30	70	100	2

Course Description:

This course will introduce students to stem cells and its application. Basic stem cell discoveries and their potential clinical application will be discussed. The course will be relevant to those interested in the exciting new field of brain research

Course Prerequisite: Cell Biology, Embryology and Developmental Biology

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Overview of stem cell biology	U
2	Stem cell disorders and therapeutic application	U
3	Cellular and molecular Organization of the nervous System	U
4	Understand the mechanism of translation	U
5	Introduction to neuroscience	U

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7
CO 1	✓					✓	
CO 2			✓		✓		
CO 3	✓			✓			
CO 4			✓				
CO 5							

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**STEM CELLS**		
	1	Introduction to stem cells- Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells.	3
	2	Overview of stem cell biology, culture, derivation, Types of stem cells - Embryonic stem cells (ESCs), fetal stem cells, adult stem cells. Culture of Embryonic Stem Cells, Differentiation of ES cells, ES cell research	3
	3	Differentiation of embryonic/adult/fetal stem cells, Role of adult stem cells in tissue level regeneration, Stem cell plasticity, Dedifferentiation, pluripotent stem cells (PSCs), adult stem cells (ASCs), and cancer stem cells (CSCs).	4
	4	Neural stem cells: Maintenance of neural stem cell niche, Neural stem cell differentiation	5

2	**STEM CELL DISORDERS AND THERAPEUTIC APPLICATION**		
	1	Different kind of stem cell banking -Cell sources for banking, Banking of stem cells for future therapeutic use	3
	2	Overview of stem cell dysfunctions and disorders -stem cell aplasia (aplastic anemia), monoclonal hematopoietic stem cell proliferative syndrome (leukemia and myelodysplastic syndrome), and polyclonal hematopoietic stem cell proliferative syndrome	5
	3	Clinical and experimental applications of stem cells-Stem cell therapy- Factors for successful cell-based	4

		therapy, Categories of cell-based therapy-hematopoietic Stem Cells (Blood Stem Cells) Mesenchymal Stem Cells. Neural Stem Cells. Epithelial Stem Cells.	
	4	Regulatory and Ethical Considerations of Stem Cell and Gene Therapy, Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies.	3

3	**NEUROANATOMY**		
	1	Introduction to the Nervous System- Cellular and molecular Organization of the Nervous System	4
	2	Introduction to the structure and function of the nervous system - Anatomy of Central nervous system, anatomy of peripheral nervous system Comparative Neuroanatomy	1
	3	Ion Channels and Transporters- Neurotransmitters and Receptors, Cellular and molecular biology of the neuron-structure and types of neurons, synthesis and trafficking of neuronal proteins, membrane potential	5
	4	Brain structure-Ventricular system of human brain, Blood brain barrier, Polarity of cell	5

4	**NEUROSCIENCE**		
	1	Introduction to neuroscience- Neuronal plasticity and learning and memory	4
	2	Mechanisms of neural excitability: models of membrane permeability and membrane conductance. Neurotransmitter release: Molecular mechanisms, Computational models of excitability	5
	3	Neurodegenerative diseases- Alzheimer's disease, Amyotrophic Lateral Sclerosis (ALS), Ataxia, Huntington's disease, Parkinson's disease.	2
	4	Research area in neurobiology-cellular neurobiology, Developmental neurobiology, Behavioral genetics, Computational neuroscience, Cognitive neurobiology and Computational cognitive science.	2

5	**Teacher Specific Module**	**5**
	Directions	
		5

Essential Readings:

1. Robert Lanza and Anthony Atala (2014) Essentials of Stem Cell Biology, Third Edition, Academic Press
2. Nagwa El-Badri (2020) Regenerative Medicine and Stem Cell Biology 1st edition, Springer nature SwitzerlandAG.
3. Stewart Sell (2013) Stem Cells Handbook,2^{nd} edition, Humana Press Inc
4. Alexander Battler, Jonathan Leor (2006) Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Springer.
5. Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, Steven A. Siegelbaum, and A. J. Hudspeth (2012) Principles of Neural Science,5^{th} edition. McGraw-Hill Education
6. Mark F. Bear, Barry W. Connors, and Michael A. Paradiso,Wolters Kluwer (2015) Neuroscience: Exploring the Brain, 4^{th} edition, Lippincott Williams and Wilkins.
7. Michael J. Zigmond, Lewis P. Rowland and Joseph T. Coyle (2022) Neurobiology of Brain Disorders- Biological Basis of Neurological and Psychiatric Disorders.2^{nd} edition, Academic Press.
8. Deepak Sharma, Rameshwar Singh, Sangeeta Singh (2021) Textbook of Neurobiology, IK International Pvt. Ltd.

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1
	2	2

	3	2
	4	1
2	1	3
	2	4
	3	1
	4	1
3	1	6
	2	6
	3	6
	4	6
4	1	5
	2	5
	3	7
	4	8

Suggested Readings:

9. The Science of Stem Cells, Jonathan M. W. Slack, Wiley Blackwell
10. Stem Cell Science, Dr. Pratik RajanMungekar,Adhyyan Books
11. Stem Cell Research, JosephPanno,Facts On File Inc.
12. Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press

13. Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press
14. Neurobiology: A Functional Approach,George J. Augustine, David Fitzpatrick, William C. Hall, Anthony-Samuel LaMantia, and Leonard E. White , Sinauer Associates
15. Neurobiology: A Molecular Approach, Gustavo Deco and Joseph G. Howland, Oxford University Press
16. Neurobiology: Molecules, Cells, and Systems,Gary G. Matthews,Wiley,
17. Neurobiology of Disease, Sid Gilman, Dennis J. Selkoe, and John T. Coyle,Academic Press

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

- **Employability for the Course:**
- Biotechnology companies
- Research and Development
- Teaching
- Molecular diagnostics
- Pharmaceutical industry
- Hospitals or clinical applications

GENERAL FOUNDATION COURSES: BIOTECHNOLOGY

SKILL ENHANCEMENT COURSES (SEC)					
Semester	Course Code	Name of the course	Credits		
			Theory	Practical	Total

4	KU 4 SEC BTC 101	BIOFERTILIZERS, BIOPESTICIDES AND BIOFUELS	1	2	3
5	KU 5 SEC BTC 102	VERMICOMPOSTING AND MUSHROOM CULTIVATION	1	2	3
6	KU 6 SEC BTC 103	SKILL DEVELOPMENT COURSE IN BIOTECHNOLOGY	1	2	3

KU 4 SEC BTC 101: BIOFERTILIZERS, BIOPESTICIDES AND BIOFUELS

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	4	SEC	Foundation	KU 4 SEC BTC 101	3	5

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
Module	Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
1	1			30	70	100	2
2, 3		4		40	60	100	2

Course Description:

The unselective use of synthetic chemical fertilizers and chemical pesticides for increasing agricultural yield has affected soil fertility, the water retention capacity, and micronutrients. content in the soil. Under these circumstances biofertilizers and biopesticides offer great possibilities for efficient use of various resources for increasing agricultural output on a sustainable basis. This course focuses on providing experience for students and empowering them with the right knowledge on biopesticides and biofertilizer technology, also helps students to gain skills and practical knowledge regarding the production, characterization, and application of different types of biofertilizers and biopesticides. Additionally, this course introduces various types of biofuels and its production technology. This course also aims to provide practical experience in the production process of biofuels and helps to attain awareness about its significance and environmental impacts.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Gain an understanding of various types of biofertilizers and their applications in agriculture	U
2	Explore the different types of biopesticides and their mechanism of action	An
3	Familiarize students with the production and properties of different biofuels	A
4	Expedit and amplify the benefits of biofertilizers, biopesticides and biofuels	A

******Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create ©***

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

CO 4			√				

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to Biofertilizers, Biopesticides and Biofuels.**		
	1	**Biofertilizers:** Bacterial, Fungal (Endo, Ecto & VAM mycorrhizae) and Algal (Blue green algae) biofertilizers. Applications and uses. Phosphate solubilizing organisms. Vermi-compost as biofertilizer	5
	2	**Mass production of biofertilizers:** Strain selection, sterilization, growth and fermentation, mass production of biofertilizers involving Rhizobium, azotobacter and azolla – anabaena.	3
	3	**Biopesticides:** Definition, mechanism of action and application of bacterial (Bacillus thuringiensis), viral (baculovirus), Biofungicide – (Trichoderma and Pseudomonas fluorescens) as examples) - mode of action and mechanism.	4
	4	**Biofuels:** Definition, Classification, Types (Biodiesel, Bioethanol, Biomethane, Biohydrogen), Raw materials used in production, process technology, feed stocks. Advantages and limitations. Environmental Impacts of Biofuel	3

2	**Laboratory experiments on biofertilizer production technology**		
	1	Isolation of Rhizobium from root nodules and its mass production.	3

	2	Estimation of efficiency of Rhizobium through pot culture experiments and nodulation test	4
	3	Microscopic examination of blue green algae	2
	4	Microscopic examination of blue green algae	2
	5	Mass multiplication of azolla, and its application in the field.	4
	6	Isolation of azospirillum from paddy root samples	2
	7	Isolation and purification of phosphate solubilizers	4
	8	Demonstration of different methods of biofertilizer application – seed treatment, root dipping, soil inoculation, foliar spraying using suitable crops.	3
	9	Study on VAM growth on Guinea grass roots and observation for root colonization	3
	10	BIS standards for assessing the quality of biofertilizers.	3

3	**Laboratory experiments on Production Process and Characterization of Biopesticides and Biofuels.**		
	1	Isolation and purification of *Bacillus thuringiensis*	3
	2	Isolation and purification of *Trichoderma*	3
	3	Mass production of *Trichoderma viride*	3
	4	Isolation and purification of pseudomonas and it's production	3
	5	Quality control tests for biopesticides	3
	6	Preparation of neem based biopesticide	3
	7	Identification of important botanicals in pest management	3
	8	Production of bioethanol from lignocellulosic biomass	3

	9	Production of biodiesel from vegetable oils	3
	10	Production of methane from kitchen wastes	3

4	**Teacher Specific Module**	
	Directions	

Essential Readings

1. Biotechnology of Biofertilizers Kannaiyan, S., (2003), CHIPS, Texas.
2. Handbook of Biofertilizers and Microbial Pesticides, M. S Vora, Mrs N. H Shalet, 2013. SSPH
3. Biotechnology, D Singh, 2012, Kalyani Publishers, Ludhiyana.
4. Handbook of Microbial biofertilizers,Mahendra K. Rai (2005). The Haworth Press, Inc. New York.
5. A textbook of Biotechnology, Dubey R. C., (2005). S. Chand and Co., New Delhi.
6. Soil microorganisms and plant growth. Subba Rao N.S, 1995. Oxford and IBH Publishing co. Pvt. Ltd. NewDelhi.
7. Handbook of Biofuels Production, Luque, R., Campelo, J.and Clark, J. Woodhead Publishing Limited 2011.

Reference Distribution:

Module	Unit	Reference No.
1	1	1, 4, 5
	2	3, 5
	3	2, 5, 10
	4	5,7,8
2	1	2, 4
	2	2,4
	3	2, 4
	4	2, 4
	5	2, 4
	6	2, 4
	7	2, 4
	8	2, 4
	9	2,4
	10	2 ,4
3	1	7
	2	7

	3	7
	4	7
	5	7
	6	7
	7	7
	8	7
	9	7
	10	7

Suggested Readings:

8. Biotechnology Kumaresan, V. (2005), Saras Publications, New Delhi.
9. Advanced Environmental Biotechnology, Agarwal SK (2005). APH publication.
10. Biotechnology, U. Satyanarayana, 2010, Books and Allied Pvt Ltd
11. Principles of pest control management by Dhaliwal, G. S and Arora. R. 2006. Kalyani Publishers. New Delhi.

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**5**
		Seminar	**5**
	End Semester Evaluation		**15**
	Total		**25**

	Evaluation Type		Marks
Practical Part	**Continuous Evaluation**	**Lab performance**	**12**
		Record	**8**
	End Semester Evaluation	**Experiment**	**20**
		Viva Voce	**10**
	Total		**50**

- **Employability for the Course:**
- Agronomist
- Agri-entrepreneurs
- Agricultural Research Scientist
- Biofuel Engineer/Biofuel Production Manager
- Biofuel Production operator

KU 5 SEC BTC 102: VERMICOMPOSTING AND MUSHROOM CULTIVATION

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	5	SEC	Intermediate	KU 5 SEC BTC 102	3	5

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2	1		0	30	70	100	2
3		4		40	60	100	2

Course Description:

This course aims to cater subject-matter and manual knowledge on mushroom farming and vermicomposting and to popularize its advantageous farm economics. It thoroughly describes and infuses the theory and practical knowledge on the subject. The learner will get enriched with knowledge and experience on mushroom farming and vermicomposting.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Acquire critical knowledge on the role of earthworms in making	U

	compost from organic wastes.	
2	Gain skills on production of vermicompost	A
3	Provide basic knowledge in cultivation of mushroom	A
4	Propose strategies for improving post-harvest storage and transportation of mushrooms	C

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create ©**

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Introduction to vermicomposting and mushroom cultivation**		
	1	Earthworm biology: Morphology and classification of earthworms. Reproduction, and life cycle, species of earthworm used in vermicomposting.	4
	2	Vermicomposting: Definition, meaning, methodology (preparation and maintenance of vermi bed, preparation of feed, harvesting and packing), economic importance, their value in maintenance of soil structure, role of earthworms in bio transformation of the residues of organic wastes and production of organic fertilizers.	4
	3	Mushroom morphology and classification: Mushroom morphology. Key to differentiate edible from poisonous mushrooms. Classification - Based on occurrence, Natural habitats & Color of spores	3
	4	Principle of Mushroom Cultivation: Structure and construction of mushroom house. Sterilization of substrates. Spawn production-culture media preparation, Preparation of mother spawn, production of planting spawn, storage/transportation of spawn, Criteria for selection of good quality spawn. Cultivation of Button mushroom and paddy straw mushroom	4

2	**Practicals on vermicomposting technology**	

	1	Study of habit and habitat of earthworms.	2
	2	Study of reproduction of earthworm	2
	3	Establishment of vermicompost unit pit method	2
	4	Establishment of vermicompost unit pit method	2
	5	Vermicompost production, harvesting and packaging	2

3	**Practicals on mushroom cultivation**		
	1	Orientation to mushroom farm	2
	2	Preparation of pure culture and maintenance cultures	2
	3	Preparation of spawn and its storage	2
	4	Composting methods	2
	5	Pawning, casing, cropping and post-harvest handling	2

4	**Teacher Specific Module**	

	Directions	

Essential Readings:

1. Earthworms for Solid Waste Management; Sathyendra M. Singh.
2. Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Agricultural Pests and their Controls. Pradip Jabde Publisher.
3. Mushroom Cultivation, Tripathi, D.P. (2005) Oxford & IBH Publishing Co. PVT.LTD, New Delhi.
4. Handbook on Mushrooms, Nita Bahl, oxford & Text Book of Vermicompost, Vermiwash & Biopesticides; Dr.Keshav Singh, Astral International Publications
5. Vermitechnology; M. Seethalekshmi & R. Santhi, Saras Publications

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1
	2	2,5
	3	3
	4	4
2	1	4
	2	4
	3	4
	4	6

	5	6
	1	6
	2	7
3	3	6
	4	7
	5	6

Suggested Readings:

6. The Handbook of Biofertilizers & Vermiculture Publisher: Engineers India Research Institute
7. The handbook of edible mushrooms, Skinnerian & K.Ramasamy (1980). Today & Tomorrow's printers & publishers, New Delhi
8. Handbook on Mushrooms, Nita Bahl, oxford & IBH Publishing Co.
9. Handbook of organic farming and organic foods with vermicomposting. Neem publisher: Engineers India research institute

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**5**
		Seminar	**5**
	End Semester Evaluation		**15**
	Total		**25**

	Evaluation Type		**Marks**
Practical Part	**Continuous Evaluation**	**Lab performance**	**12**
		Record	**8**
	End Semester Evaluation	**Experiment**	**20**

		Viva Voce	**10**
	Total		**50**

- **Employability for the Course:**
- Agronomist
- Agri-entrepreneurs

KU 6 SEC BTC 103: SKILL DEVELOPMENT COURSE IN BIOTECHNOLOGY

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	6	SEC	Foundation	KU 6 SEC BTC 103	3	5

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2	1		0	30	70	100	2
3		4		40	60	100	2

Course Description:

The course introduces different techniques and tools in biotechnology. Students will learn about the techniques and different methods for isolation and separation of biomolecules. The skill development course is aimed at providing a practical based study of the techniques of immunology, basic biotechnology, and molecular biology.

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Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the basic concept of biotechnology	U
2	Understand techniques like electrophoresis and chromatography	U
3	Apply DNA and plasmid isolation from different samples	A
4	Apply techniques like chromatography and electrophoresis for separation of biological samples	A

5	Perform different immunological studies	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

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

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**Basic of cell and genetic material**	
	1	Introduction to biological world, basic concept of cell	4
	2	DNA and RNA as genetic material, double helix model of DNA	3
	3	Gene, non-coding sequences, repetitive sequences	3
	4	Central Dogma of molecular biology	2
		General laboratory techniques	
	1	**Chromatography, principle and types**	3
	2	Electrophoresis, principle and different types	5
	3	Antigen Antibody, structure, and function	3
	4	Antigen antibody interaction- precipitation and agglutination-based techniques, ELISA	4
2		**Practical- Chromatography and immunological assays**	
	1	Paper chromatography	3
	2	Thin layer chromatography	3
	3	Column chromatography	4
	4	Preparation of blood smear to identify different types of WBC	3
	5	Hemagglutination reaction	3
	6	Radial Immunodiffusion	2
	7	Ouchterlony double immunodiffusion	3
	8	Rocket immunoelectrophoresis	3
	9	Immunoelectrophoresis	3
	10	ELISA	3
3		Practical Molecular biology techniques	
	1	Phenol Equilibration	4
	2	Preparation of 10X and 1X TBE	2

MODULE	UNIT	DESCRIPTION	HOURS
	3	Preparation of 10X and 1X TAE	2
	4	Preparation of buffers for DNA isolation	2
	5	Isolation of DNA from plant	4
	6	Isolation of DNA from bacteria	4
	7	Isolation of plasmid DNA	3
	8	Quantification of nucleic acid by spectrophotometric technique	3
	9	Agarose gel electrophoresis	3
	10	Isolation of protein from blood sample	3
4		Teacher Specific Module	
		Directions	

Essential Readings:

- Sambrook, J. and Russell, D.W., 2001. Molecular Cloning: Ch. 8. In Vitro amplification of DNA by the polymerase chain reaction (Vol. 2). Cold Spring Harbor Laboratory Press.
- Brown, T.A., 2020. Gene cloning and DNA analysis: an introduction. John Wiley & Sons. “Owen, J.A., Punt, J. and Stranford, S.A., 2013.
- Pattabhi, V. and Gautham, N., 2002. Biophysics. Springer
- Kuby immunology (Vol. 27, p. 109). New York: WH Freeman.

Reference Distribution:

Module	Unit	Reference No.
1	1	6
	2	6
	3	6
	4	6
2	1	3
	2	3
	3	4
3	4	4
	1	3
	2	3
	3	3
4	4	3
	1	1
	2	1
	3	1
	4	1

Suggested Readings:

- Primrose, S.B. and Twyman, R., 2006. *Principles of gene manipulation and genomics*. John Wiley & Sons.
- Karp, G., Iwasa, J. and Marshall, W., 2020. *Karp's Cell and Molecular Biology*. John Wiley & Sons.

Assessment Rubrics:

	Evaluation Type		**Marks**
Theory part	**Continuous Evaluation**	**Test Paper**	**5**
		Seminar	**5**
	End Semester Evaluation		**15**
	Total		**25**

	Evaluation Type		**Marks**
Practical Part	**Continuous Evaluation**	**Lab performance**	**12**
		Record	**8**
	End Semester Evaluation	**Experiment**	**20**
		Viva Voce	**10**
	Total		**50**

Percentage of marks in the course = (percentage of marks in theory + percentage of marks in practical * 2) / 3

- **Employability for the Course:**
- Biotechnology companies
- Research
- Laboratory Technician
- Molecular Biotechnologist
- Medical field

GENERAL FOUNDATION COURSES: BIOTECHNOLOGY

VALUE ADDED COURSES (VAC)					
Semester	Course code	Name of the course	Credits		
			Theory	Practical	Total
3	KU 3 VAC BTC 101	BIOTECHNOLOGY IN SUSTAINABLE DEVELOPMENT	3		3
4	KU 4 VAC BTC 102	HEALTH CARE BIOTECHNOLOGY	3		3
4	KU 4 VAC BTC 103	ETHICS IN BIOTECHNOLOGY	3		3

KU 3 VAC BTC 101**: BIOTECHNOLOGY IN SUSTAINABLE DEVELOPMENT**

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours/week
	3	VAC	Foundation course	KU 3 VAC BTC 101	3	3

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
	Lecture	Practical	Tutorial	CE	ESE	Total	
Module 1,2,3 & 4	3		0	30	70	100	2

Course Description:

Using natural resources to support human progress without compromising the environment is known as sustainable development. Since the introduction of biotechnology, sustainable development has advanced through significant stages while maintaining ecological balance. The goal of this course is to educate students on a variety of biotechnology-related topics that will help to promote sustainable development.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Outline and clarify important ideas in sustainable development	U
2	Explain biotechnological contribution for the conservation of natural resources while meeting human demands.	U
3	Identify biotechnological aspects required to address current energy challenges.	A
4	Utilize modern advancements in biotechnology to fulfill the world's growing food needs.	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Sustainable development-introduction**		
	1	Definition & need for sustainable development	2
	2	Scientific principles of sustainability	3
	3	Importance of living in an environmentally sustainable society	2
	4	Role of Biotechnology in sustainable development	3
2	**Role of Biotechnology in sustaining natural resources**		
	1	Biotechnological innovations enhancing soil fertility-use of Plant Growth Promoting bacterias.	3
	2	Importance of biofertilizers, Merits of biofertilizers over chemical fertilizers. Important organisms as Biofertilizers: Rhizobium, Azotobacter, Mycorhiza	3

	3	Impact of plastic & microplastic in environment-Using biotechnology for plastic degradation & remediation. Developing bioplastic as remedial measure-brief account only.	3
	4	Use of biosensors for environmental monitoring of pollution.	3

3	**Role of Biotechnology in energy management**		
	1	Renewable & Nonrenewable source of energy-pro's & cons.	3
	2	Biofuels-Biodiesel, bio ethanol and biohydrogen-properties & environmental significance	4
	3	Using organic waste as a source of energy-biogas: production of biogas. Recent development of biogas production in India.	4
	4	Oil recovery techniques-Primary, Secondary & Tertiary-Microbial enhanced oil recovery (MEOR) to retrieve the unrecoverable oil from oil reservoirs	4

4	**Role of Biotechnology in Food technology**		
	1	Biotechnological innovations in aquaculture-increasing food supply & nutritional value using genetic engineering	3
	2	Different types of aquaculture farming practices for sustainable development-Aquaponics	3
	3	Use of food waste as manure-composting techniques-microbial vs vermicomposting techniques.	2
	4	Challenges & future aspects of biotechnology in sustainable development	2

5	**Teacher Specific Module**	**5**

	Directions	
		5

Essential Readings:

1. Richard T. Wright | Dorothy F. Boorse, Environmental Science-towards a sustainable future, f Pearson; 13th edition (January 7, 2016)
2. Bernard R. Glick, Cheryl L. Patten, Molecular Biotechnology: Principles and Applications of Recombinant DNA (ASM Books) 6th edition (3 March 2022)
3. T. Satyanarayana • Bhavdish Narain Johri Anil Prakash, Microorganisms in Sustainable Agriculture and Biotechnology, Springer 2012
4. Ara Kirakosyan, Peter B. Kaufman · Recent Advances in Plant Biotechnology, Springer,2009
5. Mohd. Shahnawaz, Manisha K. Sangale, Avinash B. Ade, Bioremediation Technology for Plastic Waste, Springer Nature Singapore 2019
6. William J. Thieman, Michael A. Palladino, Introduction to Biotechnology, Third ed, Pearson, 2014

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	1
	2	1
	3	1
	4	1

2	1	2
	2	2
	3	5
	4	2
3	1	3
	2	3
	3	3
	4	3
4	1	6
	2	6
	3	4
	4	4

Suggested Readings:

1. Thomas Potthast Simon Meisch *Climate change and sustainable development Ethical perspectives on land use and food production*, Wageningen Academic Publishers, The Netherlands, 2012
2. G. Tyler Miller, Jr. and Scott E. Spoolman, *Living in the Environment: Concepts, Connections, and Solutions*, Cengage Learning; 19th edition (January 1, 2017)

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Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

○ **Employability of the Course:**

- Research and Development
- Environmental Scientist
- Urban planner
- In Government sector
- Sustainable engineers
- Energy managers
- Waste management consultant
- QHSE manager (Quality, Health, Safety and Environment)

KU 4 VAC BTC 102: HEALTH CARE BIOTECHNOLOGY

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours/week
	IV	VAC	Foundation level	KU 4 VAC BTC 102	3	3

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
	Lecture	Practical	Tutorial	CE	ESE	Total	
Module 1,2,3 & 4	3		0	30	70	100	2

Course Description:

The field of biotechnology has the potential to improve human health standards in the existing healthcare environment. Improved strategies for treating and preventing diseases result from understanding the molecular underpinnings of health and disease. Biotechnology products bring novel and safer treatment approaches, treatments with fewer side effects, and faster and more accurate diagnostic tests in the field of human health care.The goal of this course is to encourage students to innovate the health industry by bringing fresh therapeutic concepts.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Outline the application of biotechnology in the field of health care.	U
2	Recognize novel biotechnology techniques used in the medical industry.	U
3	Utilize Biotechnological methods in improvising public health	A
4	Evaluate the challenges and potential of biotechnology in the healthcare industry.	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7
CO 1			√				
CO 2			√				
CO 3			√				
CO 4			√				

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Overview of Healthcare Biotechnology**		
	1	Health management & need.	1
	2	Need for Biotechnological contributions in the era of emerging & re-emerging diseases- COVID 19-a case study	2
	3	Biotechnological contributions in development of COVID Vaccines & Cancer vaccines.	3
	4	Use of biosensors for the diagnosis of diseases & various medical conditions- Glucose biosensor, pregnancy kit, COVID detection kit.	3

2	**Innovative Biotechnological approach in medicine.**		
	1	Application of Nutrigenomics in health & diet management.	2
	2	Applications of Monoclonal antibodies in disease treatment & cancer therapy.	2
	3	Exploring human microbiome & role in health-health management using gut microbiome of humans.	2
	4	Bioprinting of tissues & organ fabrication	2

3	**Biotechnological approaches to improve public health**		
	1	Production of nutrient enriched genetically modified food	1

	2	Biofortification & formulation of precision food.	2
	3	Biotechnology in skin care-use of plant-based products, role of micro algae & probiotics in cosmetics.	2
	4	Platelet rich plasma treatment & use of stem cells in skin care.	2

4	**Challenges & opportunities in healthcare biotechnology**		
	1	Status of India in the field of Health care Biotechnology	2
	2	Role of bioinformatics in creating patient-based database for personalized medicines	3
	3	Ethical concerns in medical data safety	2
	4	Challenges & prospects in Healthcare Biotechnology	2

5	**Teacher Specific Module**	
	Directions	

Essential Readings:

1. Debmalya Barh, Biotechnology in Healthcare, Volume 1-Technologies and Innovations · Volume 1. Elsevier Science, 30 March 2022, ISBN: 9780323898782, 0323898785

2. Debmalya Barh, Biotechnology in Healthcare, Volume 2, Applications and Initiatives · Volume 2, Elsevier Science, 14 August 2022, ISBN: 9780323903646, 0323903649
3. M.T.Ravi Subbiah, Nutrigenomics-Application to the development of Nutraceuticals & Cosmaceuticals, Nova Science Publishers, Inc., 2013

Reference Distribution:

Module	Unit	Reference No.
1	1	2
	2	2
	3	1
	4	1
2	1	3
	2	1
	3	1
	4	1
3	1	2
	2	2
	3	2
	4	2
4	1	2
	2	1

	3	2
	4	2

Suggested Readings:

1. Debmalya Barh, Vasco Ariston De Car Azevedo, Omics Technologies and Bio-engineering Volume 2: Towards Improving Quality of Life, Academic Press, 2018
2. Sheikh Umar Ahmad, Modern Biotechnology in Healthcare Advances and Applications, Apple Academic Press, August 18, 2023
3. Lara Marks, Engineering Health How Biotechnology Changed Medicine, Royal Society of Chemistry, 25 October 2017
4. Carsten Carlberg, Stine Marie Ulven, Ferdinand Molnár, Nutragenomics, Springer International Publishing, 11June 2016

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

Employability of the Course:

- Research and Development
- In Health care sectors

- In Government Sector
- In Pharmaceutical sectors
- In Cosmeceutical sectors
- Entrepreneurship & start-up

KU 4 VAC BTC 103: ETHICS IN BIOTECHNOLOGY

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours/week
	IV	VAC	Foundation level course	KU 4 VAC BTC 103	3	3

	Learning Approach (Hours/ Week)			Marks Distribution (%) Ratio			Duration of ESE (Hours)
	Lecture	Practical	Tutorial	CE	ESE	Total	
Module 1,2,3&4	3		0	30	70	100	2

Course Description:

The course is designed to comprehend, deliberate and respond to the moral & ethical concerns from diverse fields of life science, biotechnology, medicine, public health, law and public policy. The course is intended to function at both the individual and societal levels, evaluating the potential of biotechnology to usher positive development in quality life indices while maintaining a pace with the natural world.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand ethical issues faced in Biotechnology	U
2	Assess bioethical aspects of Agricultural & Food Biotechnology	An
3	Critically evaluate the role of Animal & Clinical Biotechnology	E
4	Comprehend key ethical issues in genomics	E

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PSO7
CO 1			√				
CO 2			√				
CO 3			√				
CO 4			√				

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**Bioethics-introduction**		
	1	Define ethics. Origin, scope & approaches to ethics.	1
	2	Principle of bioethics.	1
	3	Benefits & harm of Biotechnology	2
	4	Ethics & role of Biotechnology. Bioethics advisory committee.	2

2	**Bioethics in Agricultural & Food biotechnology**		
	1	Bioethical aspects in creation of GM crops.	3
	2	Ethical concerns with Terminator & Traitor technology in plant breeding.	2
	3	Ethical issues encompassing nutraceuticals & cultured meat	3
	4	Safety assessment of Consuming Genetically Modified Food	2

3	**Bioethics in Animal & Clinical Biotechnology**		
	1	Impact of Genetically Modified Organisms on the Environment. Public concerns & bioethical issues in genomic technologies applied to breeding farm animals	3
	2	Bioethics and in vitro fertilization, embryo research, surrogacy, Eugenesis, concerns with designer babies.	3
	3	Ethical assessment of prenatal screening of genetic diseases. Analyzing issues associated with Stem cell research, organoids & synthetic life	2
	4	Ethical issues in animal cloning, tissue engineering and transplantation	2

4	**Bioethics in Genomics**	

	1	Ethical assessment of gene therapy & gene editing.	3
	2	Ethical, Legal and Social Implications (ELSI) of the Human Genome Project	2
	3	Ethical and Social Issues Raised by the patenting of life forms.	2
	4	Ethical concerns on bio weapons.	1

5	**Teacher Specific Module**	**2**
	Directions	

Essential Readings:

1. Bernard R. Glick (Author), Cheryl L. Patten (Author) *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (ASM Books) 6th edition (3 March 2022)
2. Richard Sherlock (Editor), John D. Morrey (Editor), Nicholas Agar (Contributor), Miguel Altieri (Contributor), *Ethical Issues in Biotechnology*, fRowman & Littlefield Publishers (16 October 2002)
3. H. S. Chawla, *Introduction to Plant Biotechnology*, CBSPD / OXFORD & IBH, 3rd Edition, 2023
4. Padma Nambisan, *An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology*, Elsevier Science, 21 June 2017

Reference Distribution:

Module	**Unit**	**Reference No.**
1	1	2,4

	2	2,4
	3	2,4
	4	4
	1	1
2	2	3
	3	1
	4	1
	1	1,4
3	2	4
	3	4
	4	4
	1	1,4
4	2	1,4
	3	2,4
	4	4

Suggested Readings:

1. Thomas Potthast Simon Meisch Climate change and sustainable development Ethical perspectives on land use and food production, Wageningen Academic Publishers, The Netherlands, 2012
2. William J. Thieman, Michael A. Palladino, Introduction to Biotechnology, Third ed, Pearson, 2014

3. Lynn B. Jorde, PhD, John C. Carey, MD, MPH and Michael J. Bamshad, MD, Medical Genetics, Elsevier, 6th Edition,2019

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

- **Employability of the Course:**
- Research Assistant & Consultants in Biotechnology & Pharmaceutical companies

- Research and Development
- Teaching
- Bioethics Compliance Consultant
- Medical ethicist

GENERAL FOUNDATION COURSES: BIOTECHNOLOGY

MULTIDISCIPLINARY COURSES (MDC)					
			Credits		
Semester	Course code	Name of the course	Theory	Practical	Total
I	KU 1 MDC BTC 101	BIOTECHNOLOGY AND BUSINESS	3		3
II	KU 2 MDC BTC 102	APPLIED BIOTECHNOLOGY	3		3

KU 1 MDC BTC 101: BIOTECHNOLOGY AND BUSINESS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	MDC	General Foundation Course	KU 1 MDC BTC 101	3	3

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3		0	30	70	100	2

COURSE DESCRIPTION

Biotechnology and Business courses provide basic knowledge on biotechnology and categories of biotechnology. The paper introduces various disciplines within biotechnology such as environmental biotechnology, industrial biotechnology, plant tissue culture and genetic engineering. Biotechnology is a revolutionary field with a high degree of innovation, and the course presents cases from different biotechnology areas, as well as an introduction to sustainability. Students will understand the core concepts underlying the manipulation of living organisms for various purposes, including environment, agriculture, and industry.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Define biotechnology and understand its significance.	U
2	Understand the various fields of biotechnology and its applications.	U
3	Explore the use of biotechnology in food, industry, and waste management.	An
4	Explore the role of biotechnology as startups and enterprises.	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1		√		
CO 2		√		
CO 3		√		
CO 4		√		
CO 5				√

COURSE CONTENTS:

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**Food Biotechnology**		
	1	Introduction to biotechnology. Fermentation in food.	2
	2	Food preservation methods: maintenance of anaerobic conditions	3
	3	High temperature and low temperature preservation.	3
	4	Radiation and chemical preservatives, Pascalization, Pasteurization.	3

2	**Industrial Biotechnology**		
	1	Introduction to fermentation technology	2
	2	Fermenter design and Types.	3
	3	Production of Industrial Enzymes, antibiotics, organic acids, insulin, and enzymes.	4
	4	Production of ethanol, wine, beer, and distilled liquors.	3

3	**Waste Treatment and Management**		
	1	Waste management technologies: composting and vermicomposting	4
	2	Technology of wastewater treatment. Primary, secondary and tertiary sewage treatment process.	3
	3	Landfill engineering and the management of landfill leachate.	3
	4	Production of biogas, Bioplastic, and biodiesel.	3

4	**Biotech Enterprises**		
	1	Major start-ups in Biotechnology, Concept, and theories of Entrepreneurship	3

	2	Government schemes for commercialization of technology (e.g. Biotech Consortium India Limited)	3
	3	Bio entrepreneurship efforts in India, Biotech policy initiatives.	3
	4	Small, Medium & Large-scale industry, Quality control in Biotech industries.	2

5	**Teacher Specific Module**	
	Directions	

Essential Readings

BOOKS

1. “Entrepreneurship in Biotechnology: Managing for growth from start-up” By Martin Gross Mann. Physica-Verlag Company,2003.
2. “Biotechnology for Beginners" by Reinhard Renneberg.Elsevier Science, 2023.
3. “Biotechnology” by U Sathyanarayanan. Books And Allied (p) Limited, 2017.
4. “Environmental Biotechnology” by S N Jogdand. Himalaya Publications, 2010.
5. “Food Microbiology”. William C Frazier and Dennis Westhoff. Mc Graw Hills Education, 2017.
6. “Environmental Biotechnology” by Alan Scragg. OUP, 2004.
7. “A Textbook of Biotechnology” by Dubey, R.C. S Chand and Company Limited,2021.
8. “Integrated Solid Waste Management”, George Tchobanoglous et.al. McGraw-Hill Companies, Incorporated, 1993.
9. “Industrial Microbiology,” by Casida, L.E. New Age International (P) Ltd. New Age International (P) Limited Publishers, 2005.
10. “Industrial Microbiology,” by Presscott, S.C. and Cecil G. Dunn. McGraw-Hill, 2009.

Reference Distribution:

Module	Unit	Reference No.
1	1	5
	2	5
	3	5
	4	5
2	1	9,10
	2	9,10
	3	9,10
	4	9,10
3	1	3,7
	2	3,7
	3	3,7
	4	3,7

4	1	1,8,9
	2	1,8,9
	3	1,8,9
	4	1,8,9

Core Suggested Readings

11. “Basic Biotechnology” Ratledge, Colin and Bjorn Kristiansen. Cambridge University Press, 2006.
12. “Recombinant DNA”. James D Watson. W H Freeman. 2007.
13. "Introduction to Biotechnology" by William J. Thieman and Michael A. Palladino.Pearson, 2014.
14. "Innovation and entrepreneurship in biotechnology: Concepts, theories & cases by D. Hyne & John Kapeleris,
15. "Biotechnology for the 21st Century" by Jessica Palmer

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5

e)	Viva	5
Total		**100**

- **Employability for the Course:**
- Biotechnology companies
- Research and Development
- Entrepreneurship
- Quality controller in food industry, waste management, bioenergy production.
- Startups in biotechnology

KU 2 MDC BTC 102: APPLIED BIOTECHNOLOGY

	Semester	Course Type	Course Level	Course Code	Credits	Total Hours
	2	MDC	Foundation	KU 2 MDC BTC 102	3	3

	Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Modules	Lecture	Practical	Tutorial	CE	ESE	Total	
1,2,3,4	3	0	0	30	70	100	2

Course Description:

Applied biotechnology involves the utilization of biological systems or their products to create useful products or processes for specific purposes in fields like agriculture, medicine, food science, environmental science, and industrial manufacturing. This course teaches students about plant tissue culture, fermented foods, environmental management, and genetic engineering. By the end of the course, students should view biotechnology as a versatile tool that can be applied across various sectors to promote sustainability and improve quality of life.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the importance of bioremediation in environmental management.	U

2	Understand the basic processes involved in plant tissue culture.	U
3	Aware of the role of fermentation in the production of alcoholic beverages and dairy products.	U
4	Perceive the principles that form the basis for recombinant DNA technology and use them in genetic engineering	U

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
		Bioremediation techniques	
1	1	Bioremediation – Concept, scope, and importance. Ex situ and In situ bioremediation.	2
	2	In situ bioremediation – Biostimulation, bioaugmentation, bioventing.	2
	3	Ex situ bioremediation – Composting, soil biopiles, landfarming, slurry reactors.	3
	4	Phytoremediation – Phytoextraction, phytotransformation, rhizofiltration, phytovolatilization	3
		Plant tissue culture.	
2	1	Introduction to plant tissue culture: Brief History on development of plant biotechnology. Totipotency.	2
	2	Callus culture-types, cell division, differentiation, morphogenesis, organogenesis, and embryogenesis	2
	3	Basic requirements for plant tissue culture: Explant, nutritional medium-basic media components and growth regulators.	2
	4	Cell suspension culture, organ culture – a brief account of root, shoot tip, embryo, and ovary culture. Applications of plant tissue culture.	3
3		**Food fermentation technology**	
	1	Food fermentation, scope of food fermentation, Primary and secondary fermentation.	4
	2	Fermented beverages- Wine, different types of wine – production process.	1

	3	Beer – brewing - steps involved in beer production.	5
	4	Fermented milk products – Cheese, butter, and yogurt.	5

4		**Recombinant DNA technology – Process and Applications**	
	1	Recombinant DNA technology, definition, steps involved in rDNA technology, applications.	4
	2	Gene manipulation: Introduction of DNA into living cells, physical methods of gene transfer – electroporation, microinjection, gene gun, sonication	5
	3	Chemical methods of gene transfer - lipofection, PEG mediated, DEAE dextran mediated, calcium phosphate co-precipitation.	2
	4	Transgene, transgenesis, transgenic organisms – few examples.	1
5	**Teacher Specific Module**		**5**
	Directions		

Essential Readings:

1. Food microbiology. W.C. Frazier. 5th ed. Tata McGraw-Hill Publishing Company Ltd.
2. Introduction to Plant Biotechnology, H S Chawla. 3rd ed. CBS Publishers.
3. Plant cell and tissue culture, Kalyan Kumar De. New Central Book Agency Publishing.
4. Environmental Biotechnology. Agarwal S.K- S B Nangia for APH Publishing Corporation.
5. Gene cloning and DNA analysis. T.A Brown. 8th ed. Blackwell Publishing
6. A Textbook of Biotechnology. Dubey. R.C. 5th ed. S. Chand & Co Ltd, New Delhi.

Reference Distribution:

Module	Unit	Reference No.
1	1	4
	2	8
	3	2
	4	2
2	1	3
	2	6
	3	5
	4	2
3	1	1
	2	1
	3	1
	4	1
4	1	5
	2	6
	3	6
	4	6

Suggested Readings:

7. Biotechnology, expanding horizons. B.D Singh. 2014 ed. Kalyani Publishers.
8. Biotechnology. Dr. U. Satyanarayana. 4th ed. Books and Allied Pvt Ltd publishing.
9. Food microbiology. Martin R Adams, Maurice O Moss. 4th ed. Royal society of chemistry publishing.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation		**70**
Continuous Evaluation		
a)	Test Paper	10
b)	Assignment	5
c)	Quiz	5
d)	Book review/Debate	5
e)	Viva	5
Total		**100**

- **Employability for the Course:**

- Technical brewers
- Food production manager
- Tissue culture laboratory technician
  Research assistant.