CAUVERY COLLEGE FOR WOMEN

(AUTONOMOUS)

DEPARTMENT OF BIOTECHNOLOGY

UG SYLLABUS

(For the candidates admitted from the academic year 2019 -20 onwards)

B.Sc BIOTECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES

THE PROGRAMME AIMS

1. To make our student competent in various areas of biotechnology.
2. To inculcate the capability to work as entrepreneurs with strong ethics and communication skills.
3. To equip the students to pursue higher education and research in reputed institutes at national and international levels.
4. To develop a working knowledge of biotechnological product and processes.

PROGRAMME OUTCOMES

1. Apply ethical principles and commit to professional ethics and responsibilities in technology usages.
2. Function effectively as an individual and as a member in multidisciplinary settings.
3. Demonstrate knowledge in various environment with respect to sustainable development.
4. Recognize the need for and have the preparation & ability to engage independent and lifelong learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES

1. Acquire knowledge on the fundamentals of biotechnology for sound and solid base which enables them to understand the emerging and advance concepts in life sciences.
2. Acquire knowledge in domain of biotechnology enabling their applications in industry and research.
3. Empower the students to acquire technological knowhow by connecting disciplinary and interdisciplinary aspects of biotechnology.
4. Recognize the importance of biotechnological applications as to usher next generation entrepreneurship.

CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)
DEPARTMENT OF BIOTECHNOLOGY
B.Sc., BIOTECHNOLOGY COURSE STRUCTURE
(For the candidates admitted fromthe academic year 2019 -2020 onwards)

Semester	*Part*	**Course**	**Title**	**Subject Code**	**Inst. Hour / Week**	*Credit*	**Exam Hours**	**Marks**		*Total*
								Int	*Ext*	
I	I	Language Course–I (LC) –Tamil/Other Languages	இக்கால இலக்கியம்	19ULT1	6	3	3	25	75	100
			Story, Novel, Hindi, Literature & Grammar – I	19ULH1						
			History of Popular Tales, Literature and Sanskrit Story	19ULS1						
			Communication in French – I	19ULF1						
	II	English Language Course – I (ELC)	Functional Grammar for Effective Communication – I	19UE1	6	3	3	25	75	100
	III	Core Course–I (CC)	Cell Biology	19UBT1CC1	6	4	3	25	75	100
		Core Practical – I (CP)	Lab in Cell Biology	19UBT1CC1P	3	3	3	40	60	100
		First Allied Course– I (AC)	General Microbiology	19UBT1AC1	4	4	3	25	75	100
		First Allied Course– II (AP)	Lab in Microbiology	19UBT1AC1P	3	-	-	-	-	-
	IV	Value Education	Value Education	19UGVE	2	2	3	25	75	100
	Total				**30**	**19**				**600**
II	I	Language Course– II (LC)–Tamil /Other Languages	இடைக்கால இலக்கியமும்புதினமும்	19ULT2	6	3	3	25	75	100
			Prose, Drama, Hindi Literature – 2 & Grammar – II	19ULH2						
			Poetry, Textual Grammar and Alakara	19ULS2						
			Communication in French – II	19ULF2						
	II	English Language Course–II (ELC)	Functional Grammar for Effective Communication – II	19UE2	6	3	3	25	75	100
	III	Core Course–II (CC)	Molecular Biology	19UBT2CC2	6	4	3	25	75	100
		Core Practical – II (CP)	Lab in Molecular Biology	19UBT2CC2P	3	3	3	40	60	100
		First Allied Course– II (AP)	Lab in Microbiology	19UBT1AC1P	4	2	3	40	60	100
		First Allied Course– III(AC)	Bioinstrumentation	19UBT2AC2	3	3	3	25	75	100
	IV	Part –IV	Environmental Studies	19UGES	2	2	3	25	75	100
	Total				**30**	**20**				**700**

III	I	Language Course – III (LC)–Tamil/Other Languages	காப்பியமும் நாடகமும்	19ULT3	6	3	3	25	75	100
			Medieval, Modern Poetry & History of Hindi Literature – 3	19ULH3						
			Prose, Textual Grammar and Vakyarachana	19ULS3						
			Communication in French – III	19ULF3						
	II	English Language Course-III(ELC)	Reading and Writing for Effective Communication – I	19UE3	6	3	3	25	75	100
	III	Core Course – III (CC)	rDNA Technology	19UBT3CC3	6	4	3	25	75	100
		Core Practical – III (CP)	Lab in rDNA Technology	19UBT3CC3P	3	3	3	40	60	100
		Second Allied Course – I(AC)	Biochemistry	19UBT3AC3	4	4	3	25	75	100
		Second Allied Course-II (AP)	Lab in Biochemistry	19UBT3AC2P	3	-	-	-	-	-
	IV	Non Major Elective I-for those who studied Tamil under Part-I a) Basic Tamil for other language students b) Special Tamil for those who studied Tamil upto +2 but optfor other languages in degree programme	Basics of Biotechnology	19UBT3NME1	2	2	3	25	75	100
			Basic Tamil	19ULC3BT1						
			Special Tamil	19ULC3ST1						
	V	Swayam Online Course	Animal Physiology	-	-	-	As per UGC norms			
			Total		**30**	**19**				**600**
15 Days Internship during Semester Holidays										
IV	I	Language Course –IV (LC) -Tamil/Other Languages	பண்டைய இலக்கியம்	19ULT4	6	3	3	25	75	100
			Letter writing, General essays, Technical Terms, Proverbs, Idioms& Phrases, Hindi Literature – 4	19ULH4						
			Drama, History of Drama Literature	19ULS4						
			Communication in French – IV	19ULF4						
	II	English Language Course – IV(ELC)	Reading and Writing for Effective Communication – II	19UE4	6	3	3	25	75	100
	III	Core Course – IV (CC)	Immunology	19UBT4CC4	5	4	3	25	75	100
		Core Practical – IV (CP)	Lab in Immunology	19UBT4CC4P	3	3	3	40	60	100
		Second Allied Course - II (AP)	Lab in Biochemistry	19UBT3AC2P	3	2	3	40	60	100
		Second Allied Course – III(AC)	Plant Anatomy and Physiology	19UBT4AC4	3	3	3	25	75	100

	IV	Non Major Elective II- for those who studied Tamil under Part-I a) Basic Tamil for other language students b) Special Tamil for those who studied Tamil upto +2 but opt for other languages in degree programme	Applied Biotechnology Basic Tamil Special Tamil	19UBT4NME2 19ULC4BT2 19ULC4ST2	2	2	3	25	75	100
		Skill Based Elective -I	A) Information in Omics and Applications	19UBT4SBE1A	2	2	3	25	75	100
			B) Bioinformatics	19UBT4SBE1B						
	V	Extra Credit Course	Internship	19UBT4INT	-					
			Swayam Online Course	To be fixed later	-	-	As per UGC recommendations			
	Total				**30**	**22**				**800**
V	III	Core Course – V (CC)	Plant Biotechnology	19UBT5CC5	5	5	3	25	75	100
		Core Course – VI (CC)	Animal Biotechnology	19UBT5CC6	5	5	3	25	75	100
		Core Course – VII (CC)	Biostatistics	19UBT5CC7	5	5	3	25	75	100
		Core Practical – V (CP)	Lab in Plant and Animal Biotechnology	19UBT5CC5P	4	4	3	40	60	100
		Major Based Elective – I	A) Pharmacognosy	19UBT5MBE1A	5	5	3	25	75	100
			B) Cancer Biology	19UBT5MBE1B						
	IV	Skill Based Elective – II	A) Molecular Diagnostics and Therapeutics	19UBT5SBE2A	2	2	3	25	75	100
			B) Lab in Bioinformatics	19UBT5SBE2BP				40	60	
		Skill Based Elective – III	A)DNA Fingerprinting	19UBT5SBE3A	2	2	3	25	75	100
			B) Lab in Plant Tissue Culture	19UBT5SBE3BP				40	60	
		UGC Jeevan Kaushal Life Skills	Professional Skills	19UGPS	2	2	3	25	75	100
	V	Extra Credit Course	Swayam OnlineCourse	To be Fixed Later	-	-	As per UGC Recommendation			
	Total				**30**	**30**				**800**
		Core Course – VIII (CC)	Microbial Biotechnology	19UBT6CC8	6	6	3	25	75	100
		Core Course – IX (CC)	IPR, Bioethics and Biosafety	19UBT6CC9	6	6	3	25	75	100
		Core Practical – VI (CP)	Lab in Microbial Biotechnology	19UBT6CC6P	5	4	3	40	60	100

VI	III	Major Based Elective – II	A)Environmental Biotechnology	19UBT6MBE2A	6	6	3	25	75	100
			B) Stem Cell Biology	19UBT6MBE2B						
		Major Based Elective – III	A) Bioentrepreneurship	19UBT6MBE3A	6	6	3	25	75	100
			B) Drug Discovery and Development	19UBT6MBE3B						
	V	Extension Activities	Extension Activities	19UGEA	-	1	-	-	-	-
		Gender Studies	Gender Studies	19UGGS	1	1	3	25	75	100
	Total				**30**	**30**				**600**
Grand Total					**180**	**140**				**4100**

CORE COURSE – I

CELL BIOLOGY

Semester – I	CELL BIOLOGY	Hours/Week - 6	
Core Course – I		Credits - 4	
Course Code - 19UBT1CC1		Internal 25	External 75

Preamble

- To study about cell, its types, cellular organelles and their functions.
- To study about cell cycle and its regulations.
- To study about cell signaling pathways

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Exhibit a knowledge base in classes of cells, types of cell division.	K1
CO 2	Outline a clear and concise idea about cell membrane and cytoskeleton	K2
CO 3	Discuss the properties and functions of the cytoplasmic organelles.	K2
CO 4	Illustrate the reactions that comprise energy metabolism.	K2
CO 5	Explain about cell cycle and its regulations.	K2

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	M	S	S	M
CO2	M	M	S	M
CO3	S	M	M	M
CO4	S	S	S	S
CO5	M	M	S	S

S-Strong, M-Medium, L-Low

CORE COURSE – I

CELL BIOLOGY

Unit I - Fundamentals of cell structure **18 Hours**

Discovery of Cells - Basic properties of cells, cell size and shape, cell theory, cell morphology, Different classes of cells – Prokaryotic and Eukaryotic cells. Cell cycle, cell division – Mitosis and Meiosis.

Unit II - Cellular membranes and matrices **18 Hours**

Cell Membrane – Plasma Membrane - Chemical composition and fluidity of membranes; transport of nutrients, ions and macromolecules across the membranes; structural organization of cell wall ; Extracellular matrices – structure and function; Cytoskeleton and cell motility: Microtubules, Microfilaments and Intermediate filaments.

Unit III - Endomembrane System **18 Hours**

Structure and functions of Nucleus - Endoplasmic Reticulum – Smooth and Rough; Functions of Endoplasmic Reticulum; Golgi Complex – Structure and functions; Ribosomes- Types, structure and functions; Types of Microbodies; Peroxisomes; Glyoxysomes; Lysosomes - Types, structure and functions.

Unit IV- Cellular Organelles in Energy Metabolism **18 Hours**

Mitochondria – Morphology; Chemical Composition; Enzyme System of Mitochondria; functions- Oxidation of Carbohydrates. Chloroplast – Morphology; Chemical Composition; functions- Photosynthesis and Protein Synthesis.

Unit V- Applications of Cell Biology **18 Hours**

Apoptosis analysis, Cytotoxicity, Cell viability, signal transduction – Cell to cell recognition and adhesion, Cell signalling pathways.

Text Books

S. No.	Author name	Title of the book	Publishers name	Year of publication
1	Geoffrey M.Cooper and Robert E.Hausman	The Cell A Molecular Approach (Sixth Edition)	Ingram Publishers	2018 (Reprint)
2	Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter.	Molecular Biology of Cell. 6th Edition.	Garland Science, Taylor & Francis group Publishers	2017
3	Anne Wanjie	The Basics of Cell biology	Rosen Publishers	2013

Reference Books

S. No.	Author name	Title of the book	Publishers name	Year of publication
1	Griffith Reid	Cell biology(Meiosis & Mitosis)	Harsen and keller Education	2017
2	Jeff Hardin, Gregory Bertoni and Lewis J. Klein Smith	Becker's World of the Cell – Technology Update – 8th Edition	Pearson Education Ltd.	2015
3	Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D. Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter.	Essential Cell Biology	Garland Science, Taylor & Francis group Publishers	2013
4	T.A. Brown.	Introduction to genetics: A molecular approach. 1st Edition.	Garland Science.	2011
5	Benjamin Lewin	Genes XI. 9th Edition.	Jones & Bartlett Learning.	2008
6	Lewin B	Genes IX.	Oxford University Press, London.	2007

CORE PRACTICAL – I

LAB IN CELL BIOLOGY

Semester – I	**LAB IN CELL BIOLOGY**	**Hours/Week - 3**	
Core Practical – I		**Credits - 3**	
Course Code - 19UBT1CC1P		**Internal 40**	**External 60**

Preamble

- To study about cells and their enumeration by appropriate techniques
- To study about the cell division and development.
- To study about the embryonic development

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Describe the basic instruments involved in Cell Biology	K1
CO 2	Demonstrate the morphology of various types of cells and their enumeration.	K1
CO 3	Illustrate the different types of cell division.	K2
CO 4	Outline a clear and concise idea about embryogenesis.	K2
CO 5	Identify the Barr body from Buccal Cells.	K2

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	M	L	M	M
CO2	M	M	M	L
CO3	M	L	L	M
CO4	S	M	L	M
CO5	L	L	L	L

S- Strong, M-Medium, L-Low

CORE PRACTICAL – I

LAB IN CELL BIOLOGY

1. Demonstration of Principles and working mechanism of Microscope and Microtome.
2. Morphological Characterization of various types of Plant tissue cells.
3. Structure observation of Prokaryotic cells.
4. Structure observation of Eukaryotic cells.
5. Enumeration of Eukaryotic cells (Yeast).
6. Enumeration of Red Blood Cells.
7. Enumeration of White Blood Cells.
8. Cell organelle separation by centrifugation methods.
9. Cell Division - Mitotic stages
10. Cell Division - Meiotic stages
11. Cell Division – Binary fission of yeast cells
12. Osmosis and Tonicity
13. Grading the stages of chick embryo development (demo only).
14. Barr body Identification in cells of Buccal Smear.

Reference Books

S. No.	Author name	Title of the book	Publishers name	Year of publication
1	Dr. William H. Heidcamp	Cell Biology Laboratory manual	Pearson Education	2017
2	David A. Thompson	Cell and Molecular Biology Lab. Manual.	Create Space Independent Publishing Platform	2011
3	P. Gunasekaran.	Laboratory Mannual in Microbiology.	New Age International.	2007
4	Mary L. Ledbetter.	Cell Biology: Laboratory Manual.	RonJon Publishing. Incorporated.	1993

FIRST ALLIED COURSE – I

GENERAL MICROBIOLOGY

Semester – I	**GENERAL MICROBIOLOGY**	**Hours/Week - 4**	
First Allied Course – I		**Credits - 4**	
Course Code - 19UBT1AC1		**Internal 25**	**External 75**

Preamble

- To study about the classification of microorganisms.
- To study about the media composition and their types
- To study about the structure and characteristics of bacteria, algae, fungi, protozoa and virus.

Course Outcomes

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

CO Number	**CO Statement**	**Knowledge Level**
CO 1	Recall the history of Microbiology and list out the scopes.	K1
CO 2	Outline the methods involved in media preparation and sterilization.	K2
CO 3	Summarize the structural organization of Bacteria.	K2
CO 4	Explain the general characteristic features of Algae and Fungi.	K2
CO 5	Describe the Diversity, Ecology and Characteristics of different Protozoa and Viruses.	K3

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	M	S	S	S
CO2	L	L	L	M
CO3	M	M	M	M
CO4	M	M	S	M
CO5	M	M	S	S

S-Strong, M-Medium, L-Low

FIRST ALLIED COURSE – I

GENERAL MICROBIOLOGY

Unit I - History and Classification **12 Hours**

Historical development of Microbiology - Theories of Spontaneous generation – Biogenesis The scope of Microbiology; General principles and nomenclature – Haeckel's three kingdom concept, Whittaker's five kingdom concept- Carl Woese's three domain classification. Cavalier – Smith's Eight kingdom classification.

Unit II - Media Preparation and Sterilization **10 Hours**

Media Composition and their types based on physical state & ingredients. Microbial Growth- Factors influencing the growth of Microorganisms – Growth Curve. Types of Sterilization and Disinfection.

Unit III – Bacteria **12 Hours**

Structural organization of bacteria – Size, shape and arrangement of bacterial cells – Ultrastructure of a bacterial cell – cell wall, cell membrane, ribosomes, nucleoid, slime, capsule, flagella, fimbriae, spores , cysts, plasmid, mesosomes and cytoplasmic inclusions.

Unit IV – Diversity of Microbial world **13 Hours**

General characteristics of Algae (*Chlamydomonas* sp) including occurrence, thallus organization, Ultra structure, pigments, flagella, eyespot, food reserves. Reproduction – Sexual and Asexual reproduction. Fungi (*Aspergillus* sp) – General characteristics of fungi including habitat, distribution, nutritional requirements, Ultrastructure, thallus organization and aggregation.

Unit V – Protozoa & Viruses **13 Hours**

Protozoa: General characteristics with special reference to *Amoeba, Paramecium* and *Giardia.* Viruses: Viruses, viroids and prions - A general introduction with special reference to the structure of the following: TMV, poliovirus. Lytic and lysogenic cycle.

Text Books

S. No.	Author name	Title of the book	Publishers name	Year of publication
1	Gerarad J.Tortora Berdell R.Funke and Christine L.Case	Microbiology An Introduction (11th Edition)	Pearson Education	2018
2	Dr. C. P. Baveja	Text Book of Microbiology	Anja Publications	2017
3	A.K. Rathoure	Essentials of Microbiology	Brillion Publishing	2017

Reference Books

S. No.	Author name	Title of the book	Publishers name	Year of publication
1	Tortora, Funke and Case	Microbiology: An Introduction – 13th Edition	Pearson	2018
2	Madigam M.T. Bender K.S. Buckley D.H Sattley W.M and Stahl D.A	Brock Biology of Microorganism(15th Edition)	Pearson Education	2017
3	Prescott, Harley and Klein.	Microbiology. 10th Edition.	McGraw Hill	2016
4	Pelczar, Chan and Kreig	Microbiology 9th Edition.	McGraw-Hill.	2016
5	Michael T. Madigan, John M. Martinko and Kelley S Bender	Brock Biology of microorganisms	Pearson	2014

FIRST ALLIED COURSE- II

LAB IN MICROBIOLOGY

Semester – I	**LAB IN MICROBIOLOGY**	**Hours/Week – 4**	
First Allied Course – II		**Credits - 2**	
Course Code - 19UBT1AC1P		**Internal 40**	**External 60**

Preamble

- To acquire knowledge about aseptic techniques.
- To comprehend the various methods for identification of unknown microorganisms.
- To study about the Biochemical Characterization

Course Outcomes

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

CO Number	**CO Statement**	**Knowledge Level**
CO 1	Illustrate the techniques involved in sterilization of media and glasswares.	K1
CO 2	Outline the methods for isolation and enumeration of microorganisms from different samples.	K2
CO 3	Demonstrate the various pure culture techniques and to measure the bacterial growth.	K2
CO 4	Identify the organisms by various staining techniques.	K3
CO 5	Apply various biochemical tests to characterize microorganisms.	K3

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	M	S	L	M
CO2	M	S	S	S
CO3	S	S	M	M
CO4	L	L	M	M
CO5	M	S	M	M

S- Strong, M-Medium, L-Low

FIRST ALLIED COURSE- II

LAB IN MICROBIOLOGY

1. Laboratory Rules and Regulations.
2. Sterilization Techniques – Media and Glasswares.
3. Media Preparation.
4. Isolation and Enumeration of Microorganisms from Water and Soil.
5. Pure Culture Techniques – Spread plate, Streak plate, Pour plate, Stab and Slant preparation.
6. Measurement of Bacterial Growth – Turbidometric method
7. Staining Techniques –Simple staining, Gram's staining, Capsule Staining,
8. Lactophenol Cotton Blue Staining.
9. Cell Motility – Hanging drop technique.
10. Biochemical Characterization of microorganisms – IMViC tests.
11. Counting of Microbial colonies using colony counter.
12. Micrometry (Ocular and Stage).

Reference Books

S. No	Author name	Title of the book	Publishers name	Year of Publication
1	Joanne Willey, Linda Sherwood and Christpher J. Woolverton	Prescott's Microbiology	Mc Graw Hill Education	2017
2	James G. Cappuccino	Microbiology - Laboratory Manual	Pearson	2017
3	Michael J. Leboffe & Burton E. Pierce	Microbiology: Laboratory Theory and Application, Brief.	Morton	2016
4	Mark Gladwin, William Trattler and C. Scott Mahan	Clinical Microbiology made Ridiculously simple – 6th Edition	Medmaster	2016
5	Brown A and Smith	Benson's Microbiological Application; Laboratory Manual in General Microbiology (13th Edition)	Mc Graw Hill Companies	2015

CORE COURSE – II

MOLECULAR BIOLOGY

Semester – II	MOLECULAR BIOLOGY	Hours/Week – 6	
Core Course – II		Credits - 4	
Course Code - 19UBT2CC2		Internal 25	External 75

Preamble

- To study about the chromosomes, genes and their functions
- To study about the DNA damage and repair mechanism
- To study about the central dogma of molecular biology

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Describe the organisation and development of the genetic makeup on cellular, chromosomal and gene level.	K1
CO 2	Recall basic concepts of hereditary and population genetics.	K1
CO 3	Explain DNA replication and repair mechanism.	K2
CO 4	Summarise the mechanisms of transcription and translation	K2
CO 5	Outline the gene regulatory mechanisms.	K2

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	M	M	M	M
CO2	S	S	S	M
CO3	S	M	M	M
CO4	L	L	L	L
CO5	S	M	M	M

S-Strong, M-Medium, L-Low

CORE COURSE – II

MOLECULAR BIOLOGY

Unit I – Genetic Material 18 Hours

Structural organization of Chromatin and chromosome .Basic structure of Chromosomes; Chromosomal Proteins – Histones and Protamines. Special types of Chromosomes: Polytene and Lampbrush chromosomes. Experiments to prove DNA and RNA as the Genetic Material; Components, types & Structure of nucleic acids

Unit II – Classical Genetics 18 Hours

Mendelein Inheritance, Laws of inheritance – single and dihybrid ratio. Linkage analysis – Fruit fly. Population Genetics – Hardy Weinberg Law, Developmental Genetics using *Drosophila melanogaster* as model system.

Unit III – DNA Replication and Repair 18 Hours

DNA Replication- Prokaryotic and Eukaryotic DNA replication, enzymes and proteins involved in DNA replication. Models of replication – Semi-conservative, unidirectional, bidirectional, rolling circle mechanism. Inhibitors of DNA replication. DNA Damage and repair.

Unit IV – Transcription and Translation 18 Hours

Transcription – Prokaryotic and Eukaryotic transcription, Enzymes involved in transcription. Post transcriptional modifications – 5' – CAP formation, 3' processing and polyadenylation, splicing. Translation – Prokaryotic and Eukaryotic translation, the translational machinery, mechanisms of initiation, elongation and termination, regulation of translation, Co-translational and post-translational modifications - Importance of Glycosylation and Phosphorylation.

Unit V – Gene Regulation 18 Hours

Prokaryotes: *lac* operon, *gal* operon and *trp* operon. Eukaryotes: Gene loss, gene amplification, gene rearrangement.

Text Books

S.No.	Author name	Title of the book	Publishers name	Year of publication
1	David Clark, Nanette Pazdernik, Michaelle and Mc. Gehee	Molecular Biology – 3rd Edition	Elsevier	2018
2	William S. Klug, Michael R. Cummings, Charlotte A. Spencer and Michael A. Palladino	Concepts of Genetics	Pearson Education India	2016
3	George M. Malacinski	Freifelder's Essentials of Molecular Biology	Viva	2015

Reference Books

S.No.	Author name	Title of the book	Publishers name	Year of publication
1	James D. Watson	Molecular Biology of the gene – 7th Edition	Pearson	2017
2	Michael M. Cox, Jennifer Doudna and Michael O' Donnell	Molecular Biology – Principles and Practice	W.H. Freeman	2015
3	Bruce Alberts, Alexander Johnson. Julian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter.	Molecular Biology of Cell.	Garland Science publication	2014
4	Stanely R. Maloy, Jhon E Cornan Jr and David Freifelder.	Freifeder's Essentials of Molecular Biology.	Norosa Publishing House.	2013
5	George M. Malacinski and Burton E. Tropp.	Molecular Biology – Genes to Proteins.	Jones and Bartlett Publishers.	2012

CORE PRACTICAL – II

LAB IN MOLECULAR BIOLOGY

Semester – II	LAB IN MOLECULAR BIOLOGY	Hours/Week – 3	
Core Practical – II		Credits - 3	
Course Code - 19UBT2CC2P		Internal 40	External 60

Preamble

- To develop skills pertaining to Molecular Biology
- To study about the Quantification of Nucleic acids
- To study about Bacterial mutagenesis

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Demonstrate the methods for the isolation and purification of genomic DNA and plasmid DNA.	K1
CO 2	Outline the process of separation of DNA and protein by electrophoresis.	K2
CO 3	Apply the various methods for the quantification of nucleic acids.	K3
CO 4	Experiment with various gene transfer methods.	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	S	S	S
CO2	M	M	M	M
CO3	L	L	M	M
CO4	S	S	S	S

S- Strong, M-Medium, L-Low

CORE PRACTICAL – II

LAB IN MOLECULAR BIOLOGY

1. Isolation and purification of Genomic DNA from Prokaryotes
2. Isolation and purification of Genomic DNA from Eukaryotes
3. Isolation and purification of Plasmid DNA
4. Separation of DNA by using AGE
5. Separation of Protein by using SDS- PAGE
6. Quantification of Nucleic Acids – DNA by chemical method
7. Quantification of Nucleic Acids – RNA by chemical method
8. Bacterial mutagenesis using Physical Method
9. Transformation
10. Conjugation
11. Transduction

Reference Books

S.No.	Author name	Title of the book	Publishers name	Year of publication
1	Andreas Hofmann and Samuel Clokie	Willson and Walker's Principles and Techniques of Biochemistry and Molecular Biology	Cambridge University Press	2017
2	George M. Malacinski	Freifeder's Essentials of Molecular Biology	Norosa Publishing House	2013
3	Dr. David Thompson	Cell and Molecular Biology Lab Manual	Norosa Publishing House	2011
4	J Sambrook and D. W. Russell	Molecular cloning: a laboratory manual Vol 1, 2 & 3	CSHL Press	2001

FIRST ALLIED COURSE- III

BIOINSTRUMENTATION

Semester – II	**BIOINSTRUMENTATION**	**Hours/Week - 3**	
First Allied Course – III		**Credits - 3**	
Course Code - 19UBT2AC2		**Internal 25**	**External 75**

Preamble

- To understand the working principles of different bioinstruments.
- To provide a better understanding of various analytical techniques
- To apply the principle of instruments in different fields.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Define the principle of microscope and its various types	K1
CO 2	Demonstrate the various Electrophoretic techniques and its applications	K2
CO 3	Explain the principle, types and applications of Chromatographic techniques.	K2
CO 4	Outline the principle, types and applications of Colorimetry.	K2
CO 5	Summarize the principle, types and applications of Centrifugation.	K2

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	M	S	M	S
CO2	S	M	M	S
CO3	S	M	M	S
CO4	S	S	M	S
CO5	M	S	S	M

S-Strong, M-Medium, L-Low

FIRST ALLIED COURSE- III

BIOINSTRUMENTATION

Unit I – Microscopy **10 Hours**

Introduction to Instrumentation, Microscope – Light Microscopy, Bright and Dark field Microscopy, Fluorescence Microscopy, Phase Contrast Microscopy, TEM, SEM.

Unit II – Electrophoresis **10 Hours**

Principle and Applications of Electrophoresis –Types of electrophoresis- AGE, SDS-PAGE and 2 D gel; Blotting Techniques; Gel documentation.

Unit III – Chromatography **7 Hours**

Fundamentals of Chromatography. Principle and its applications, Types – Paper, TLC, Column, Affinity, Ion –exchange, HPLC, GC-MS Chromatography.

Unit IV- Colorimeter **7 Hours**

Colorimeter – Principle and its applications, Beer Lambert's Law, Spectrophotometer-Principle and its applications, Types of Spectrophotometer-UV – Visible & IR.

UNIT V – Centrifugation and Tracer Techniques **11 Hours**

Centrifugation – Principle, Types – Zonal, Differential and Density gradient centrifugation and its applications, Imaging Techniques- X-ray and NMR.

Tracer Techniques - Radioactive isotope – Half life, GM Counter, Liquid Scintillation Counter, Autoradiography.

Text Books

S.No.	Author name	Title of the book	Publishersname	Year of Publication
1	M. J. Reilly	Bioinstrumentation	CDS Publishers	2016
2	L. Veerakumari	Bioinstrumentation	MJP Publishers	2015
3	R. S. Khandpur	Handbook of Bio-Medical Instrumentation	Tata McGraw Hill.	2014
4	Carr and Brown	Introduction to Biomedical Equipment Technology	Pearson Education,	2001
5	J. Webster	Bioinstrumentation	Wiley and Sons	2000

Reference Books

S.No.	Author name	Title of the book	Publishers name	Year of Publication
1	Avinash Upadhyay, Niramalendu Nath and Kakoli Upadhyay	Biochemical Chemistry Principles and Techniques	Himalaya Publication	2009
2	P. Narayanan	Essentials of Biophysics	New Age International	2007
3	Vasantha Pattabhi and N. Gautham	Biophysics	Narosa	2004
4	Wilson and Walkar	A Biologist guide to principles and techniques of practical biochemistry	Cambrige University press	2000

PART– IV

ENVIRONMENTAL STUDIES

Semester – II	ENVIRONMENTAL STUDIES	Hours/Week - 2	
Part– IV		Credits - 2	
Course Code - 19UGES		Internal 25	External 75

PREAMBLE

To train the students to get awareness about total environment and its related problems and to make them to participate in the improvement and protection of the environment.

Course Outcome

1. Outline the nature and scope of environmental studies
2. Illustrate the various types of natural resources and its importance.
3. Classification of various types of ecosystem with its structure and function.
4. Develop an understanding of various types of pollution and biodiversity.
5. List out the various types of social issues related with environment.

CO	CO Statement	Knowledge Level
CO1	Outline the nature and scope of environmental studies	K2
CO2	Illustrate the various types of natural resources and its importance.	K2
CO3	Classification of various types of ecosystem with its structure and function.	K2
CO4	Develop an understanding of various types of pollution and biodiversity.	K3
CO5	List out the various types of social issues related with environment.	K4

PART– IV

ENVIRONMENTAL STUDIES

Unit: 1 Introduction to environmental studies
Definition, scope and importance. Need for public awareness

Unit: 2 **Natural Resources:**
Renewable and non-renewable resources:

a) Forest resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.
b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems.
c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.
d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.
e) Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources.
f) Land resources: Land as a resources, land degradation, man induced Landslides, soil erosion and desertification. Role of an individual in conservation of natural resources.

Unit: 3 **Ecosystems**

- Concept, Structure and function of an ecosystem.
- Producers, consumers and decomposers
- Energy flow in the ecosystem and Ecological succession.
- Food chains, food webs and ecological pyramids
- Introduction, types, characteristic features, structure and function of the following ecosystem:-
  a. Forest ecosystem
  b. Grassland ecosystem
  c. Desert ecosystem
  d. Aquatic ecosystems, (ponds, streams, lakes, rivers, oceans, estuaries)

Unit: 4 **Biodiversity and Environmental Pollution**

- Introduction, types and value of biodiversity
- India as a mega diversity nation
- Hot-spots of biodiversity
- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.
- Endangered and endemic species of India
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
- Definition, Causes, effects and control measures of :
  a. Air Pollution
  b. Water Pollution
  c. Soil Pollution

d. Noise pollution
e. Nuclear hazards

- Solid waste Management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Disaster management: floods, earthquake, cyclone and landslides.

Unit: 5 Social Issues and the Environment

- Water conservation, rain water harvesting, watershed management.
- Climate change, global warming, acid rain, ozone layer depletion,
- Wasteland reclamation.
- Environment Protection Act
- Wildlife Protection Act.
- Forest Conservation Act.
- Population explosion – Family Welfare Programmes
- Human Rights - Value Education
- HIV/ AIDS - Women and Child Welfare
- Role of Information Technology in Environment and human health

References:

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Public Ltd Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt ltd, Ahamedabad – 380013, India, E-mail: mapin@icenet.net(R)
3. Brunner R.C. 1989, Hazardous Waste Incineration, McGraw Hill Inc 480 p
4. Clark R.S. Marine Pollution, Clanderson Press Oxford (TB)
5. Cunningham, W.P.Cooper, T.H.Gorhani E & Hepworth, M.T. 2001.
6. De A.K. Environmental Chemistry, Wiley Eastern Ltd
7. Down to Earth, Centre for Science and Environment (R)
8. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford University, Press 473p.
9. Hawkins, R.E. Encyclopedia of India Natural History, Bombay Natural History Society, Bombay (R)
10. Heywood, V.H & Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge University Press 1140 p.
11. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws Himalaya Pub. House, Delhi 284 p.
12. Mckinney, M.L. & Schoch R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition 639 p.
13. Mhaskar A.K. Matter Hazardous, Techno-Science Publications (TB)
14. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
15. Odum, E.P. 1971 Fundamentals of Ecology. W.B. Saunders Co. USA. 574 p
16. Rao MN & Datta, A.K. 1987 Waste Water treatment, Oxford & IBH Publication Co. Pvt Ltd 345 p.
17. Sharma B.K. 2001 Environmental chemistry Goel Publ House, Meerut.
18. Survey of the Environment, The Hindu (M).
19. Townsend C. Harper, J and Michael Begon, Essentials of Ecology, Blackwell science (TB)

20. Trivedi R.K. Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media (R).
21. Trivedi R.K. and P.K. Goel, Introduction to air pollution, Techno-Science Publications (TB).
22. Wagner K.D. 1998 Environmental Management. W.B. Saunders Co. Philadelphia USA 499 p
23. Magazine (R) Reference (TB) Textbook http://nbaindia.org/uploaded/Biodiversityindia/Legal/33%20Biological%20Diversity%20 Rules,%202004.pdf.

CORE COURSE – III

rDNA TECHNOLOGY

Semester – III	rDNA TECHNOLOGY	Hours/Week - 6	
Core Course – III		Credits - 4	
Course Code - 19UBT3CC3		Internal 25	External 75

Objectives

- To illustrate the use of modern tools and techniques for manipulation and analysis of genomic sequences.
- To train students in strategizing research methodologies employing genetic engineering techniques.
- To expose students to the applications of recombinant DNA technology in biotechnological research.

Course Outcomes

On the Successful completion of the course the students would be able to

CO No.	CO Statement	Knowledge Level
CO1	Utilize Knowledge on various tools & principles in Genetic Engineering	K1
CO2	Recall the knowledge on creation of genomic libraries & explain the strategies in generating transgenics.	K2
CO3	Contrast the methods of gene cloning using different vectors & assessing a recombinant plasmid	K2
CO4	Technical knowhow on versatile techniques in Recombinant DNA Technology and to employ them in isolation procedures.	K3
CO5	Outline the applications of Genetic engineering in basic and applied biology, proficiency in designing and conducting experiments involving genetic manipulation for societal applications.	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	S	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	L	**S**	S

S-Strong, M-Medium, L-Low

CORE COURSE – III

rDNA TECHNOLOGY

Unit I **18 Hours**

Introduction to recombinant DNA (rDNA) technology. Steps involved in rDNA technology. Enzymes in rDNA technology. Restriction Enzymes -Types of Endonuclease and Exonuclease. DNA modifying enzymes - Polymerase, Transferase, Kinase, Ligase

Unit II **16 Hours**

Vectors; Cloning vectors - Plasmids, Cosmids, Phagemids. Viral vectors- Animal viral vectors - SV40 and Retrovirus. Plant viral vectors - CaMV vector and TMV vector. Shuttle vectors and Expression vectors - YAC, BAC - *S.cerevisiae* system as model.

Unit III **20 Hours**

Gene transfer techniques - Physical methods – Microinjection, Electroporation and gene gun. Chemical methods- CaCl2 mediated and Polyethylene Glycol Mediated. Construction of Genomic libraries and cDNA libraries. Probe construction. DNA amplification using PCR - Concepts, Analysis of amplified products and Applications of PCR. Principles and applications of RFLP and RAPD.

Unit IV **18 Hours**

Recombinant selection and Screening. Selection methods - Antibiotics, Expression basis, GUS expression, Blue White Selection. DNA Sequencing - Chemical degradation, Chain termination, Automated sequence and Next Generation Sequencing - New sequencing methods. Site Directed Mutagenesis.

Unit V **18 Hours**

Applications of Genetic Engineering- Transgenic products - Bt Cotton, Golden rice, Flavr savr tomato, Humulin, Factor VIII, Trangenic mouse, Transgenic Fish. Xenotransplantation. Gene therapy - Types - Applications - SCID and Sickle cell anemia. Metagenomics.

Text Books

S.No	Author	Title	Publisher	Year of Publication
1	David Irvine	An Introduction to Genetic Engineering	Syrawood Publishing House	2018
2	Bernard R. Glick and Cheryl L. Patten	Molecular Biotechnology: Principles and Applications of Recombinant DNA. 5th Edition	ASM Press, Washington DC	2017
3	Nessa carey	Junk DNA: A Journey through the Dark Matter of the Genome	Columbia University Press	2017
4	T. A. Brown	Gene Cloning and DNA Analysis: An Introduction.7th Edition	Wiley Blackwell	2016
5	Dr. Arun Dev Sharma	rDNA Technology.2nd Edition	Himalaya Publishing House	2014

Reference Books

S.No	Author	Title	Publisher	Year of Publication
1	Munis Dundar	Current Applications of Biotechnology	European Biotechnology Thematic Network Association	2015
2	Keya Chaudhuri	Recombinant DNA Technology	The Energy Resources Institute, TERI	2013
3	K. Rajagopal	Recombinant DNA Technology and Genetic Engineering	Tata Mc Graw Hill education Private Ltd.	2012
4	Jane K. Setlow	Genetic Engineering : Principles and Methods	Springer	2012
5	M.Wink	An Introduction to Molecular Biotechnology : Molecular Fundamentals Methods and Applications in Modern Biotechnology	Wiley Blackwell	2011

Pedagogy

Power point presentation, Group Discussion, Seminar, Assignment, Animations.

Web Links

1. https://youtube.be/Yh9w_fyvpUk
2. www.bx.psu.edu/~ross/workmg/Isolat_analyz_genes_Chpt3.htm
3. www.biologydiscussion.com/essay/tools-of-recombinant-dna-technology-essay-tools- biotechnology/75954
4. https://youtube.be/D3If9ycpyXM

CORE PRACTICAL - III

LAB IN rDNA TECHNOLOGY

Semester – III	LAB IN rDNA TECHNOLOGY	Hours/Week - 3	
Core practical – III		Credits - 3	
Course Code - 19UBT3CC3P		Internal 40	External 60

Objectives

- ❖ To acquire a skills about the various techniques in recombinant DNA technology.
- ❖ To understand the types of enzymes used to produce recombinants.
- ❖ To study about the experiments involving genetic manipulation.

Course Outcomes

On the Successful completion of the course the student would be able to

CO No.	CO Statement	Knowledge Level
CO1	Demonstrate the genomic DNA isolation method from different sources.	K1
CO2	Describe the method of Agarose Gel Electrophoresis.	K2
CO3	Illustrate about the restriction digestion and ligation of DNA.	K2
CO4	Outline a clear and concise idea about transformation.	K3
CO5	Identify the recombinant DNA products.	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	S	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	L	**S**	S

S-Strong, M-Medium, L-Low

CORE PRACTICAL - III

LAB IN rDNA TECHNOLOGY

1. Isolation of genomic DNA from plant tissue.
2. Isolation of genomic DNA from Animal cells.
3. Isolation of genomic DNA from Bacteria.
4. Isolation of Plasmid DNA.
5. Size analysis of DNA by Agarose Gel Electrophoresis.
6. Restriction digestion of DNA.
7. Ligation.
8. PCR amplification*.
9. Preparation of competent cells *E.coli* cells*.
10. Transformation of *E.coli* with Plasmid DNA using $CaCl_2$ *.
11. Southern blotting*.

* Practical by demonstration only

Reference Books

S. No	Author	Title	Publisher	Year of Publication
1	Siddra I, Imran ULH	Recombinant DNA Technology. 1st Edition	Cambridge Scholar	2019
2	Tiwari S, Sharma M.	Recombinat DNA Technology in the synthesis of Human Insulin	LAP LAMBERT Academic Publishing	2018
3	Rajalakshmi AG	Manual on Plant Biotechnology and Recombinanat DNA Technology	LAP LAMBERT Academic Publishing	2017
4	Sambrook, J and Russel DW	Molecular Cloning : A laboratory Manual – 4th Edition	Cold Spring Harbor, N.Y. : Cold Spring Harbor Laboratory Press.	2012
5	Ashok Kumar	Molecular Biology and Recombinant DNA Technology : Practical Manual Series (Volume II)	Narendra Publishing House	2011

Pedagogy

Power point presentation, Group Discussion, Seminar, Assignment.

Web Links

1. http://www.biology.arizona.edu/molecular_bio/problem_sets/Recombinant_DNA_Technology/recombinant_dna.html.
2. http://www.genome.ou.edu/protocol_book/protocol_index.html.
3. http://www.biology.arizona.edu/molecular_bio/problem_sets/Recombinant_DNA_Technology/recombinant_dna.html

SECOND ALLIED COURSE – I

BIOCHEMISTRY

Semester – III	BIOCHEMISTRY	Hours/Week – 4	
Second Allied Course – I		Credits – 4	
Course Code – 19UBT3AC3		Internal 25	External 75

Objectives

- To make the students understand the basics of biomolecules.
- To study structural and functional properties of carbohydrates, proteins, lipids and nucleic acids.
- To make the students learn the disorders of metabolic pathways

Course Outcome

On the Successful completion of the course the student would be able to

CO No.	CO Statement	Knowledge Level
CO1	Study the structures and functions of biomolecules	K1
CO2	Outline the metabolism of macromolecules- proteins and nucleic acids	K1
CO3	Understand the regulations and disorders of metabolic pathways	K2
CO4	Impart knowledge in principles and applications of Biochemistry	K3
CO5	Obtain knowledge in Pharmaceutical, Microbial and Industrial Biochemistry.	K3

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4
CO1	M	M	M	M
CO2	M	S	L	M
CO3	S	S	S	S
CO4	S	S	S	S
CO5	S	S	S	S

S-Strong, M-Medium, L-Low

SECOND ALLIED COURSE – I

BIOCHEMISTRY

Unit I - Carbohydrates **12 Hours**

Definition, Classification and properties of carbohydrates - Monosaccharides, Disaccharides, Oligosaccharides and polysaccharides – Structure and function. Glycolysis or Embden–Meyerhof–Parnas or Entner–Doudoroff pathway and TCA cycle.

Unit II - Lipids **12 Hours**

Definition, Properties and Classification of lipids - Simple lipids, Compound lipids and Derived lipids. Structure and function of phospholipids, glycolipids and lipoproteins. Biosynthesis of fatty acids.

Unit III- Proteins **12 Hours**

Introduction, Structure, Properties and classification of Amino acids (Essential and non-essential amino acids) and Proteins – Peptides, Polypeptides: Primary, secondary and tertiary structure and functions.

Unit IV- Vitamins and Minerals **12 Hours**

Vitamins: Definition, Classification. Fat soluble vitamins- sources, structure and physiological functions; Water soluble vitamins-sources, structure and physiological functions. Vitamin deficiency diseases. Minerals: Macro minerals and micro minerals - sources and functions.

Unit V- Enzymes **12 Hours**

Definition, Properties, Nomenclature, Classification of enzymes, Enzyme Kinetics – Michaelis & Menton Equation. Factors influencing enzyme activity. Enzyme Inhibition – Competitive, Non- Competitive, Uncompetitive, Feedback and Allosteric Inhibition.

Text Books

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	Robert K. Murray, David Bender, Kathleen M. Botham and Peter J. Kennelly, Harpers	Illustrated Biochemistry-29th Edition	Mc Graw Hill	2012

2	Lehninger, Nelson and Cox	Principles of Biochemistry-6th edition	W.H. Freeman and Company	2013
3	U. Sathyanarayana and U Chakrapani	Biochemistry-5th edition	Generic	2019
4	Dr. J. L Jain, Dr Sunjay Jain and Nitin Jain	Fundamentals of Biochemistry	Chand Publication	2016
5	Dr. Mrs Padmaja H. Agarkar, Dr Yogesh kulkarni and Dr Rammohan Rao	Biochemistry	Nirali Prakashan	2019

Reference Books

S.No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	Voet & Voet	Fundamentals of Biochemistry	John Willey & Sons	2010
2	R. Appling Dean, J. Anthony-Cahill Spencer, K. Mathews Christopher	Biochemistry: Concepts and Connections	Pearson Education	2017
3	Dean R Appling, Spencer J Anthony-Cohill and Christopher K Mathews	Biochemistry Concepts and Connections	Pearson Education	2017
4	Jeremy M. Berg, Lubert Stryer, John Tymoczko , Gregory Gatto	Biochemistry	Freeman and Company	2019
5	Naik Pankaja	Essentials Of Biochemistry	Jaypee Brothers Medical Publishers(P) Ltd	2017

Pedagogy

Power point presentation, Group Discussion, Seminar, Assignment.

Web links

1. https://nptel.ac.in/courses/102105034/
2. https://youtu.be/DhwAp6yQHQI
3. https://youtu.be/YWEiQlEUFak
4. https://youtu.be/f7jRpniCsaw
5. https://youtu.be/ZqoX2W1N6l0

SECOND ALLIED COURSE –II

LAB IN BIOCHEMISTRY

Semester – III	**LAB IN BIOCHEMISTRY**	**Hours/Week – 3**	
Second Allied Course – II		**Credits – 2**	
Course Code – 19UBT3AC2P		**Internal 40**	**External 60**

Objectives

- To impart the students with hands on skills related to biochemical techniques.
- To enable the students to perform qualitative and quantitative analysis of biomolecules.
- To make the students analyse the enzyme kinetics

Course Outcome

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

CO Number	**CO Statement**	**Knowledge Level**
CO 1	Outline the process of separation of plant pigments by chromatographic techniques	K1
CO 2	Apply the various methods for the estimation of proteins, lipids and carbohydrates	K3
CO 3	Analysis of Blood glucose level	K3
CO 4	Analysis of Enzyme Kinetics for various enzymes	K3

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	S	S	S	S
CO2	S	S	S	S
CO3	S	S	S	S
CO4	M	M	M	M

S- Strong, M-Medium, L-Low

SECOND ALLIED COURSE –II

LAB IN BIOCHEMISTRY

1. Units and Measurements.
2. Estimation of Monosaccharides – Glucose
3. Estimation of Disaccharides – Sucrose
4. Estimation of Polysaccharides – Starch.
5. Analysis of Blood glucose level.
6. Estimation of Proteins - Bradford and Lowry method.
7. Estimation of lipids.
8. Analysis of amino acids.
9. Separation of plant pigments using Chromatography techniques - TLC, Paper Chromatography.
10. Separation of Blood, Plasma and Serum.
11. Measurement of Enzyme activity- Catalase**.**
12. Enzyme Kinetics of Amylase.

Reference books

S. No.	Author's Name	Title of the Book	Publishers Name	Year of Publication
1.	ArunRastogi, Mathur, N.B.L.	An Introduction to Practical Biochemistry	Anmol publications, India	2010
2.	Rajan,S.Anjanaa	Experimental Procedures in Life Sciences	Book House	2010
3.	Jayaraman	Laboratory manual in Biochemistry	New Age International private limited.	2011
4.	Sadasivam.S. and Manickam A.	Introduction to Practical Biochemistry. 2nd Edition	New Age International Private Ltd Publishers.	2009
5.	Plummer, D.T.	An Introduction to Practical Biochemistry – 3rd Edition.	Tata McGraw Hill Co., New Delhi	2006
6.	Joshi, R.A. and Saraswat, M.	A textbook of Practical Biochemistry	Jain Publishers private limited, India.	2002

NON MAJOR ELECTIVE – I

BASICS OF BIOTECHNOLOGY

Semester – III	BASICS OF BIOTECHNOLOGY	Hours/Week – 2	
Non Major Elective – I		Credits – 2	
Course Code – 19UBT3NME1		Internal 25	External 75

Objectives

- To understand the basic concepts of Biotechnology
- To familiarize with the basic tools and techniques employed in Biotechnology
- To understand the applications of biotechnological aspects in various fields

Course Outcomes

Upon successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge level
CO1	Understand the basic concepts and significant findings in the field of biotechnology.	K1
CO2	Understand the structure and function of cells and organelles	K2
CO3	Learn the basic structure of DNA, RNA and understand the flow of genetic information	K2
CO4	Apply the existing techniques in waste management	K3
CO5	Explore more advanced application based aspects in biotechnology	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	M	M	S	M
CO2	L	M	M	M
CO3	S	M	S	M
CO4	S	S	S	M
CO5	S	S	M	M

S – Strong, M – Medium, L - Low

NON MAJOR ELECTIVE – I

BASICS OF BIOTECHNOLOGY

Unit I **4 Hours**

Biotechnology: Definition, Brief history of biotechnology, Scope and branches of biotechnology.

Unit II **7 Hours**

Introduction to cells - Discovery of cells and cell theory- Types of cells -Structure of prokaryotic (Bacteria) and eukaryotic cells (Plant and Animal).

Unit III **6 Hours**

Structure and components of nucleic acids, Forms of DNA and types of RNA, DNA as genetic material – Hershey and Chase and Griffith's experiment. RNA as genetic material- TMV.

Unit IV **6 Hours**

Biotechnology for solid and liquid waste management - Bioremediation, Biodegradation, Bioleaching and waste water treatment. Degradation of xenobiotics, Oil spills – Superbugs.

Unit V **7 Hours**

Applications of biotechnology in various fields — Food – Algae (SCP) and Fungi (Mushroom), Pharmaceutical– probiotics *(Lactobacillus).* Biofertilizers – Rhizobium, Biofuel - Ethanol.

Text books

S. No	Name of the Author(s)	Title of the book	Publishers name	Year of publication
1	William J Thieman and Micheal A. Palladino	Introduction to Biotechnology	Pearson	2014
2	R. C. Dubey	A text book of Biotechnology	S Chand	2014
3	U. Satyanarayana	Biotechnology	Books and Allied (P) Ltd.	2008
4	Gerald Karp, Janet Iwasa, Wallace Marshall	Karp's Cell Biology, 8th Edition	Willey – Blackwell	2018
5	Michael Pelczar, E.C.S. Chan, Noel R. Krieg	Microbiology	Tata McGraw – Hill	2001

Reference books

S. No	Name of the Author(s)	Title of the book	Publishers name	Year of publication
1	David L. Nelson and Michael M. Cox	Lehninger Principles of Biochemistry	W. H. Freeman	2017
2	Jeremy W Dale and Malcolm Von Schantz	From genes to genome	Willey - Blackwell	2011
3	Alberts, Johnson, Lewis, Morgan, Raff, Roberts and Walter	Molecular biology of the cell	W.W. Norton & Co	2014
4	Peter Stanbury, Allan Whitaker and Steve Hall	Principles of fermentation technology	Butterworth - Heinemann	2016
5.	Keith Wilson and John Walker	Principles and techniques of biochemistry and Molecular Biology	Cambridge University Press	2010

Pedagogy

Powerpoint presentation, Simulation, Animated videos, Lab and industrial visits, Group Discussion, Seminar and Assignment.

Web links

1. www.sciencedirect.com
2. https://www.ncbi.nlm.nih.gov/pubmed/
3. https://nptel.ac.in/courses/102103045/
4. http://www.nih.gov
5. http://www.nas.edu

CORE COURSE – IV

IMMUNOLOGY

Semester – IV	**IMMUNOLOGY**	**Hours/Week – 5**	
Core Course – IV		**Credits – 4**	
Course Code – 19UBT4CC4		**Internal 25**	**External 75**

Objectives

- To know about the immune system and their functions.
- To acquire knowledge about the vaccines and its types.
- To study about the cellular responses in immune system.
- To know the significance of various immunological disorders and their remedies

Course Outcomes

CO Number	CO Statement	Knowledge Level
CO 1	Demonstrate the types of cells involved in immune system.	K1
CO 2	Describe the agents of nonspecific immunity.	K2
CO 3	Illustrate about the structure and functions of immunoglobulins and monoclonal antibodies.	K2
CO 4	Outline the clear and concise idea about Vaccines	K3
CO 5	Obtain Knowledge in transplantation and tumor immunology.	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	S	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	L	S	S

S- Strong, M- Medium, L-Low

CORE COURSE – IV

IMMUNOLOGY

Unit I - Fundamental Concepts and Anatomy of the Immune system **12 Hours**

Basics of Immunology - Terminology - antigen, immunogen, hapten, super antigen, allergen, antigenecity, immunogenicity, immunoglobulin, antibody, epitope, paratope, tolerogen. Organs of immune system, tissues of immune system, cells of immune system and mediators of immune system. Lymphoid organs: Primary lymphoid organs (Thymus, Bone marrow), Secondary lymphoid organs (Spleen, Lymph node, MALT). Haematopoiesis and differentiation; Haematopoietic stem cells, T-cells, B-cells, Macrophages, Monocytes, Polymorphs, Platelets and Null cells. Immunity: Innate and acquired immunity. Theory of clonal selection.

Unit II - Cellular Responses **12 Hours**

T- Cells and B- Cells: Development, maturation, activation and differentiation. Antigen: Properties and Biology. Factors affecting antigenicity – Super antigens, epitopes, haptens, adjuvants and vaccines; Antigen –antibody binding; Immunoglobulin: Structure, functions and Classifications. Monoclonal antibodies - Principles and applications; APC's, MHC, antigen processing and presentation, regulation of T and B cell responses.

Unit III - Non specific Immunity **12 Hours**

Natural built in barriers – skin, semen, saliva, tears, enzymes. Mediators of immune system - lymphokines, cytokines, interferon, tumor necrosis factor. Complement components, natural killer cells, macrophages, phagocytosis, pinocytosis. Inflammatory response. Mucosal and Gut associated lymphoid tissue (MALT and GALT) and mucosal immunity.

Unit IV - Vaccinology **12 Hours**

Active, passive and combined immunization. Live, killed, attenuated, plasma derived, sub unit, recombinant DNA, protein based, plant-based, peptide, anti-idiotypic and conjugate vaccines – production and applications. Role and properties of adjuvants and ISCOMS.

Unit V - Transplantation and Tumor Immunology **12 Hours**

Transplantation: Mechanism, Types of Grafts[#], Graft rejection, General and specific immunosuppressive therapy; Clinical transplantation; - Hypersensitivity - Type I-IV; Tumor immunology; Autoimmunity: Autoimmune diseases, diagnosis and treatment.

 # Self Study Topics

Text Books

S.No	Author	Title	Publisher	Year of Publication
1	Lauren M.Sompayrac	How the Immune system works. 6th Edition	Wiley Blackwell	2019
2	Dr.P.Madhavee Latha	A Textbook of Immunology	S.Chand Publishing	2018
3	Abul K.Abbas, Andrew H.Lichtman Shiv Pillai	Cellular and Molecular Immunology. 9th Edition	Elsevier	2017
4	Warren Levinson	Review of Medical Microbiology and Immunology	Mc Graw Hill Education	2016
5	Paul	Fundamental Immunology. 7th Edition	Lippincott Williams and Wilkins	2012
6	Louis Hawley Richard J Ziegler Benjamin L Clarke	BRS Immnology and Microbiology (6th Edition)	Lippincott Williams and Wilkins	2015

Reference Books

S. No	Author	Title	Publisher	Year of Publication
1	Abul K.Abbas, Andrew H.Lichtman Shiv Pillai	Basic Immunology. 6th Edition	Elseiver	2019
2	Jenni Punt, Sharon Stranford, Patrica Jones, Judith Owen	Kuby Immunology. 8th Edition	ML IE PRNT	2018
3	Peter , J.Delves,Seamus J.Martin, Dennis R.Burton, Ivan M.Roitt	Roitt's Essential Immunology. 1st Edition	Wiley Blackwell	2017
4	Kenneth Murphy, Casey Weaver	Janeway's Immunobiology. 9th Edition	Garland Science	2016
5	Kathy M.Durkin	Understanding the Vaccines and the Immune system.1st Edition	Nova Science.Pub.Inc	2010

Pedagogy

Power point presentation, Group Discussion, Seminar, Assignment

Weblinks

- https://youtu.be/Ktry4gGC2nA
- https://youtu.be/GY87mHuuwok
- https://youtu.be/edIPKRAKa-Y
- Immunology Link Home Page.

CORE PRACTICAL – IV

LAB IN IMMUNOLOGY

Semester – IV	**LAB IN IMMUNOLOGY**	**Hours / Week – 03**	
Core Practical – IV		**Credits – 03**	
Course Code - 19UBT4CC4P		**Internal 40**	**External 60**

Preamble

- To Study about the Identification of Blood Group.
- To Enumerate the Blood Cells
- To Study about the Immunoelectrophoresis Techniques
- Enable the students with diagnostic skills for identification of certain diseases and immunological techniques.

Course Outcomes

On Successful Completion of the Course, Students will be able to

CO Number	CO Statement	Knowledge Level
CO 1	Demonstrate the methods to Identify the Blood Cells	**K1**
CO 2	Experiments for Enumeration of Blood Cells	**K3**
CO 3	Techniques for Plasma and Serum Separation and Identify the Blood Groups	**K3**
CO 4	Apply the diagnostic skills for identification of certain diseases, immunological techniques.	**K3**

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	M	S	S
CO2	S	S	M	L
CO3	M	S	M	S
CO4	S	M	L	M

S – Strong, M – Medium, L - Low

CORE PRACTICAL – IV

LAB IN IMMUNOLOGY

1. Identification of Cells in a Blood Smear.
2. Blood Cell Counting using Haemocytometer
3. Separation of Serum and Plasma
4. Identification of Blood Group
5. Latex Agglutination Test
6. Single Radial Immunodiffusion
7. Precipitation Reaction – AGD
8. Rocket Immunoelectrophoresis.
9. Testing for Typhoid Antigens - Widal Test
10. AMES TEST
11. DOT ELISA
12. Pregnancy Test – HCG
13. Rapid Plasma Reagin Test
14. Route of Immunization by Virtual
15. Breeding and Maintenance of Laboratory Animals by Virtual

Reference books

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	Senthilkumar Balakrishnan, Karthik Kaliaperumal, Senbagam Duraisamy	Practical Immunology A Laboratory Manual	LAP LAMBERT Academic Publishing, Germany	2017
2	Wilmore C.Webley	Immunology Laboratory Manual	LAD Custom Publishing, Georgia.	2017
3	Barbara Detrick, John L Schmitz, Robert G Hamilton	Manual of Moleclar and Clinical Laboratory Immunology – 8th Edition	ASM Press, Washington, DC.	2016
4	Christine Dorresteyn Stevens	Clinical Immunology and Serology: A Laboratory Perspective	F.A.Davis Company, Philadelphia	2016
5	G.P.Talwar and S.K.Gupta	A Handbook of Practical and Clinical Immunology	CBS, Publications, Delhi, India	2012

SECOND ALLIED COURSE- III

PLANT ANATOMY AND PHYSIOLOGY

Semester – IV	PLANT ANATOMY AND PHYSIOLOGY	Hours/Week – 3	
Second Allied Course- III		Credits – 3	
Course Code –19UBT4AC4		Internal 25	External 75

Objectives

- To acquire knowledge about anatomical structure of plants
- To comprehend the biochemistry of plant metabolism
- To study about the application of plant growth regulators in agriculture
- To acquire complete knowledge about the biochemical pathways in plants

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Compare the account of anatomy of Dicot stem and Monocot stem	K2
CO 2	Classify the internal structure of Dicot root and Monocot root	K2
CO 3	Sketch the various pathway for translocation of minerals in plants	K3
CO 4	Analyse the utilization of plant hormones in agriculture	K4
CO 5	Design various biochemical pathways to characterize C3 and C4 plants	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4
CO1	M	S	L	M
CO2	M	S	S	S
CO3	S	S	S	S
CO4	L	L	M	M
CO5	M	S	M	M

S- Strong, M-Medium, L-Low

SECOND ALLIED COURSE- III

PLANT ANATOMY AND PHYSIOLOGY

Unit I - Plant anatomy **9 Hours**

Meristems: Characteristics, classification and theories of root - shoot apical meristem. The cambium: Types and functions. Simple Plant tissues: Types, Structure and functions. Comparative account of anatomy of Dicot stem (Sunflower) and Monocot stem (Maize), Dicot root (Sunflower) and Monocot root (Maize). Dicot Leaf and Monocot leaf

Unit II - Transportation in Plants **9 Hours**

Translocation of water in xylem and Translocation of food in Phloem. Water uptake: imbibitions, diffusion, osmosis, water potential and its components. Ascent of sap - Transpiration - Guttation. Stomatal physiology. Plant responses to Stress- biotic Stress-unwanted weeds, insects, bacteria, fungus, virus and abiotic Stress-Drought, high salinity, cold and heat.

Unit III - Plant Growth Development **9 Hours**

MS Medium and its composition in Plant tissue Culture for Plant Growth Development. Measurement of plant growth- growth curve. Plant growth regulators (PGR) - Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid. Plant growth regulators in agriculture – Merits and demerits of PGR in agriculture.

Unit IV - Morphogenesis **9 Hours**

Photomorphogenesis- Photoperiodism, Vernalisation, Phytochrome, Biological clock. Physiology of germination. Dormancy – causes and types of dormancy. Seed dormancy-Causes of Seed dormancy, Types of Seed dormancy-Innate, Enforced and Induced dormancy. Methods of Breaking Seed Dormancy. Importance of seed dormancy.

Unit V - Photosynthesis and Respiration **9 Hours**

Photosynthesis: Photosynthetic pigment systems - radiant energy - cyclic and noncyclic electron transport - C3 and C4 pathways - factors affecting photosynthesis - photorespiration Respiration: Aerobic - anaerobic, Glycolysis, Kreb's cycle, oxidation - reduction potential, ATP synthesis, Factors affecting respiration[#].

 # Self Study Topic

Text books

S.No.	Author	Title	Publisher	Year of Publication
1	Lincoln Taiz, Eduardo Zeiger , Ian Max Moller , Angus Murphy	Fundamentals of Plant Physiology-1 edition	Sinauer Associates is an imprint of Oxford University Press	2018
2	Crang, Richard, Lyons-Sobaski, Sheila, Wise, Rober	Plant Anatomy A Concept-Based Approach to the Structure of Seed Plants	Springer International Publishing	2018
3	Bhatla, Satish C, Lal, Manju A.	Plant Physiology, Development and Metabolism	Springer Singapore	2018
4	Ava Metcalfe	Integrative Plant Anatomy	Tritech Digital Media	2019
5	Alexander James	Plant Physiology, Biochemistry And Biotechnology	Tritech Digital Media	2019

Reference Books

S.No.	Author	Title	Publisher	Year of Publication
1	Neil Willey	Environmental Plant Physiology	Taylor and Francis Inc	2016
2	Clive Koelling	Plant Anatomy, Morphology and Physiology	Syrawood Publishing House	2016
3	Taiz.L, Zeiger.E, Moller.M and Murphy.A	Plant Physiology and Development (VI Edition)	Sinauer Associates,Inc.Publishers ,Massachusetts,USA	2015
4	Taylor A. Steeves and Vipen K. Sawhney	Essentials of Developmental Plant Anatomy	OUP USA	2017
5	Taiz.L, Zeiger.E, Moller.M and Murphy.A	Fundamentals of plant Physiology	Sinauer Associates, Inc	2018

6	Bob B.Buchanan, Wilhelm Gruissem, and Russell L.Jones	Biochemistry & molecular Biology of plants	John Wiley & Sons, Ltd	2015

Pedagogy

PowerPoint presentation, Video lectures, Group discussion, Seminar, Assignment

Web links

- https://swayam.gov.in/nd2_cec19_bt01/preview
- https://www.askiitians.com/biology/plant-physiology/
- https://biology.ufl.edu
- https://labs.eemb.ucsb.edu
- https://employees.csbsju..edu

NON MAJOR ELECTIVE – II

APPLIED BIOTECHNOLOGY

Semester – IV	APPLIED BIOTECHNOLOGY	Hours/Week – 2	
Non Major Elective – II		Credits – 2	
Course Code – 19UBT4NME2		Internal 25	External 75

Preamble

- To understand the fundamental principles of biotechnology
- To appreciate the techniques involved in the field of biotechnology
- To recognize the application of genetically modified organisms in various fields like agriculture, livestock, medicine and environment.
- To familiarize with the basic principles of biotechnology employed in forensic science and medicine.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge level
CO1	Define the importance of biotechnology in the field of life science	K1
CO2	Outline the principle and application of biotechnology in food industry	K2
CO3	Explain the efficiency of microbes in waste treatment and pollution control	K2
CO4	Apply the concept of DNA fingerprinting in forensic science	K3
CO5	Interpret regulations and guidelines for ensuring biosafety measures for protection of public health and environment.	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	M	L	M	M
CO2	M	M	L	M
CO3	S	M	S	M
CO4	M	L	L	M
CO5	L	M	L	M

S – Strong, M – Medium, L - Low

NON MAJOR ELECTIVE – II

APPLIED BIOTECHNOLOGY

Unit I **6 Hours**

Biotechnology in the field of Agriculture – History of Genetic modification in Agriculture - Genetically modified Crops – Advantages and Applications - Bt Cotton (Pest resistant), Flavr Savr Tomato (Shelf life improvement), Golden Rice (Rich in Vitamin A), Soybean (Rich in oleic acid content).

Unit II **6 Hours**

Introduction to Food Biotechnology, Principle of Fermentation process. Production of food products – Bread, Dairy, Confectionery and Beverages, Meat, Poultry and Fish products. Food processing and preservation.

Unit III **6 Hours**

Introduction to Environmental Biotechnology. Pollution – Source & types[#]. Health hazards due to pollution. Xenobiotics. Detection of Environmental pollutant - Biosensors. GMOs in Environmental clean-up. Health and Hygiene. Environmental standards and Quality monitoring.

Unit IV **6 Hours**

Importance of Biotechnology in Forensic science. Principle of DNA fingerprinting. Application of DNA profiling in forensic medicine - Solving violent crimes such as murder and rape – Blood & Semen Sample; solving maternal & paternal disputes. Forensic Science Laboratories in India.

Unit V **6 Hours**

Biosafety guidelines and regulations - Importance and Operation. Role of Biosafety Committees - IBSC, RDAC, RCGM, GEAC. Environmental release of GMOs, Risk assessment and management.

[#] **Self Study Portion**

Text books

S. No	Name of the Author(s)	Title of the book	Publishers name	Year of publication
1	Varsha Gupta, Manjistha Sengupta, Jaya Prakash and Baishnab Charan Tripathy	Basic and Applied aspects of Biotechnology	Springer	2017
2	Malik Zainul Abdin, Usha Kiran, Kamaluddin and Athar Ali	Plant Biotechnology: Principles and Applications	Springer	2017
3	Firdos Alam Khan	Biotechnology Fundamentals	CRC Press	2016
4	Ashish S. Verma, Anchal and Singh	Animal Biotechnology –Models in Discovery and Translation	Elsevier	2014
5	A. K. Chakravarthy	Introduction to Environmental Biotechnology – Second Edition	OUP, India	2013

Reference books

S. No	Name of the Author(s)	Title of the book	Publishers name	Year of publication
1	Pessarakli M	Handbook Of Plant And Crop Stress	Taylor and Francis	2020
2	Foster G. N.	Food Biotechnology	CBS Publishers	2020
3	Chawla H. S.	Introduction to Plant Biotechnology	Oxford and IBH Publishing	2017
4	Allen K	Environmental Biotechnology	CBS Publishers	2016
5	Petre M	Advances In Applied Biotechnology	INTECH	2016
6	Daniel Vallero	Environmental Biotechnology – A Biosystems Approach	Academic Press	2015

Pedagogy

Power point presentation, Group Discussion, Seminar, Assignment.

Web links

- https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=16
- http://www.goldenrice.org/Content2-How/how1_sci.php
- http://fsl.delhi.gov.in/wps/wcm/connect/doit_fsl/fsl/home/
- https://www.who.int/csr/resources/publications/biosafety/Biosafety7.pdf
- http://dbtindia.gov.in/guidelines-biosafety

SKILL BASED ELECTIVE-I (A)

INFORMATION IN OMICS AND APPLICATIONS

Semester – IV	**INFORMATION IN OMICS AND APPLICATIONS**	**Hours/Week – 2**	
Skill based Elective-I (A)		**Credits – 2**	
Course Code - 19UBT4SBE1A		**Internal 25**	**External 75**

Objectives

- To understand the basic Principles and techniques of OMICS
- To familiarize with the basic tools and techniques employed in OMICS
- To grow knowledge regarding the modern application of molecular tools in real life problems
- To apply knowledge of different omics technology for designing experiment

Course Outcomes

Upon successful completion of the course, the students will be able to

CO Number	**CO Statement**	**Knowledge level**
CO1	Develop knowledge on the basics of omics and their versatile applications	K1
CO2	Understand the omics data analysis	K2
CO3	Integration of omics approaches for improvement of life	K2
CO4	Technical skills and knowledge development on versatile techniques in omics	K3
CO5	Explore more advanced application based aspects in omics	K3

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	M	M	S	M
CO2	L	M	M	M
CO3	S	M	S	M
CO4	S	S	S	M
CO5	S	S	M	M

S – Strong, M – Medium, L – Low

SKILL BASED ELECTIVE-I (A)

INFORMATION IN OMICS AND APPLICATIONS

Unit I **6 Hours**

Overview and general principles of omics technologies in biotechnology. The data analysis workflow- from quantitative data to biological information.

Unit II **6 Hours**

Omics approaches: Genomics, Proteomics, Transcript omics and Metabolomics. Functional omics for discovery of novel organisms, enzymes, value added products.

Unit III **6 Hours**

Omics tools- DNA sequencing, Genome sequencing, Next generation sequencing methods. Genome annotation, Functional genomics. RNA Sequencing, Microarray.

Unit IV **6 Hours**

Basics concepts, Tools of proteomics- SDS PAGE, 2D PAGE, Liquid chromatography, Mass spectrometry (ESI and MALDI), Protein identification by peptide mass finger printing. Applications of proteomics.

Unit V **6 Hours**

Fundamental concepts and tools of metabolomics. Capillary electrophoresis, Gas chromatography. Application of omics in different field of biotechnology including agriculture, environment, pharmaceuticals, medicine and forensics

Text books

S. No	Name of the Author(s)	Title of the book	Publishers name	Year of publication
1	Debmalya Barh Vasco Azevedo	Omics Technologies and Bio-engineering	Academic press	2017
2	Wittmann,c. and Lee,S.Y.eds	Systems metabolic engineering	Springer science and Business Media	2012
3	Barh,D.,Zambare,V. and Azevedo,V.	Omics: applications in biomedical, agriculture and environment	Springer science and Business Media	2017
4	Kihara,D.	Protein function prediction for omics era	Springer science and business Media	2011
5	Debmalya Barth, Vasco Azevedo	Omics Technologies and Bio- Engineering	Academic press	2018

Reference books

S. No	Name of the Author(s)	Title of the book	Publishers name	Year of publication
1	Lawrence Baker	Bioinformatics: Tools and Techniques	Callisto Reference	2018
2	Jeremy W Dale, Malcolm van Schantz	From genes to genome	Willey – Blackwell	2011
3	Martins-de-souza,D.	Shotgun Proteomics	Humana Press	2014
4	Michael Agostino	Practical Bioinformatics	Garland Publishing	20013
5	Low, L and Tammi, M	A Practical Handbook of Next Generation Sequencing and Its Applications	World Scientific	2017
6	Mohammed Iftekhar	Bioinformatics Practical Manual	Create Space Independent Publishing Platform	2015

Pedagogy

Powerpoint presentation, Simulation, Animated videos, Lab and industrial visits, Group Discussion, Seminar and Assignment.

Web links

- www.sciencedirect.com
- https://www.ncbi.nlm.nih.gov/pubmed/
- https://nptel.ac.in/courses/102103045/
- http://www.nih.gov
- http://www.nas.edu

SKILL BASED ELECTIVE - I (B)

BIOINFORMATICS

Semester – IV	BIOINFORMATICS	Hours/Week – 2	
Skill Based Elective – I (B)		Credits – 2	
Course Code –19UBT4SBE1B		Internal 25	External 75

Objectives

- To get introduced to the basic concepts of Bioinformatics
- To familiarize with the available databases related to bioinformatics
- To learn the usage of basic online bioinformatics tools and techniques
- To apply the concepts and tools of bioinformatics in various fields

Course Outcomes

Upon successful completion of the course, the students will be able to

CO Number	CO Statement	Knowledge level
CO1	Understand the basic concepts and terminologies in bioinformatics	K1
CO2	Learn the basic online biological resources and databases	K2
CO3	Learn and apply the online softwares and tools for macromolecular structure prediction and sequencing	K2
CO4	Apply the bioinformatics tools in medicine for drug discovery and identification of novel drugs	K3
CO5	Apply the bioinformatics ideas in different fields and explore upcoming areas of interest in bioinformatics	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	L	M	M	S
CO2	M	M	S	M
CO3	S	M	S	M
CO4	S	M	S	M
CO5	S	S	S	M

S – Strong, M – Medium, L - Low

SKILL BASED ELECTIVE - I (B)

BIOINFORMATICS

Unit I **6 Hours**

History of Bioinformatics[#] – Introduction to concepts and terminology of Internet, Search Engines, Databases and Softwares

Unit II **6 Hours**

Review of basics about structure of macromolecules - DNA, RNA and Proteins. Online resources for Bioinformatics – Biological Databases – NCBI, Genbank, EMBL, Swissprot, PDB. Executing search and retrieval of data. Sequence alignment – Multiple sequence alignment – Pairwise alignment.

Unit III **6 Hours**

Bioinformatics in genomics and proteomics – gene sequencing tools traditional methods – Maxam and Gilbert's method, Sanger's sequencing – structure prediction tools – Nucleic acid and protein structure prediction – Gene and protein expression analysis – similarity search databases – FASTA, BLAST. Analysis of Phylogeny - Phylogenetic tree construction. Protein ligand interaction, Ramachandran Plot, PYMOL.

Unit IV **6 Hours**

Structure based drug discovery – Molecular docking of novel compounds – SAR and QSAR, Introduction to Simulation softwares in biology – Autodock, ADMET.

Unit V **6 Hours**

Applications of Bioinformatics in different fields – Medicine, Agriculture, Environmental monitoring - Emerging areas in bioinformatics[#].

 # Self Study Topics

Text books

S. No.	Name of the Author(s)	Title of the book	Publishers name	Year of publication
1	Manoj Kumar	Introduction to Bioinformatics	Notion press	2020

2	Ibrokhim Y. Abdurakhmonov	Bioinformatics: Updated Features and Applications	BoD – Books on Demand	2016
3	Paul M. Selzer, Richard J. Marhöfer, Oliver Koch	Applied Bioinformatics: An Introduction	Springer	2018
4.	Prakash S. Lohar	Bioinformatics	MJP Publisher	2019
5	Noor Ahmad Shaik, Khalid Rehman Hakeem, Babajan Banaganapalli, Ramu Elango	Essentials of Bioinformatics, Volume I: Understanding Bioinformatics: Genes to Proteins	Springer	2019

Reference books

S. No	Name of the Author(s)	Title of the book	Publishers name	Year of publication
1	Shoba Ranganathan, Kenta Nakai, Christian Schonbach	Encyclopedia of Bioinformatics and Computational Biology: ABC of Bioinformatics	Elsevier	2018
2	Hamid R Arabnia, Quoc Nam Tran	Emerging Trends in Computational Biology, Bioinformatics, and Systems Biology: Algorithms and Software Tools (Emerging Trends in Computer Science and Applied Computing)	Morgan Kaufmann; 1st Edition	2015
3	Asheesh Shanker	Bioinformatics: Sequences, Structures, Phylogeny	Springer	2018
4	Paola Lecca,	Systemic Approaches in Bioinformatics and Computational Systems Biology: Recent Advances	Business Science Reference	2011
5	Arthur Lesk	Introduction to Bioinformatics	Oxford University Press	2019
6	Jamil Momand, Alison McCurdy, Silvia Heubach	Concepts in Bioinformatics and Genomics	Oxford University Press	2016

Pedagogy

PowerPoint presentation, Video lectures, Demonstration and hands on teaching, Group discussion, Seminar and assignment.

Web links

- www.ncbi.nlm.nih.gov
- genbank https://nptel.ac.in/courses/102106065/
- www.ebi.ac.uk training › online › course › bioinformatics-terrified
- www.wwpdb.org
- www.bioinformatics.org

CORE COURSE – V

PLANT BIOTECHNOLOGY

Semester – V	PLANT BIOTECHNOLOGY	Hours/Week – 5	
Core Course – V		Credits – 5	
Course Code – 19UBT5CC5		Internal 25	External 75

Objectives

- To know the basic principles and techniques involved in plant tissue culture.
- To study the importance of plant models.
- To acquire knowledge absout the concepts of transformation in Plant Biotechnology.
- To understand the achievements of biotechnology in plant system.

Course Outcomes

CO Number	CO Statement	Knowledge Level
CO 1	Demonstrate the plant tissue culture, types and production of triploids.	K1
CO 2	Describe the plant nuclear, mitochondrial and chloroplast genome organization and genomic interactions.	K2
CO 3	Illustrate about the Genetic engineering of plants.	K2
CO 4	Outline the clear and concise idea about Plant products.	K3
CO 5	Obtain Knowledge in role of RFLP in plant breeding.	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	S	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	L	S	S

S- Strong, M- Medium, L-Low

CORE COURSE – V

PLANT BIOTECHNOLOGY

Unit I - Plant Tissue Culture **16 Hours**

Establishment of plant tissue culture: Culture media (types of media), Explant: selection and preparation, Types of culture (Callus, Suspension, Meristem, #Embryo, #Anther and Root). Regeneration of plants (Organogenesis and somatic embryogenesis), Somaclonal variations and applications. Production of triploids (Endosperm culture).

Unit II - Plant Genome Organization **14 Hours**

Genome Organization (*Arabiodopsis thaliana*): Nuclear Genome, Choloroplast and its Genome, Mitochondrion and its Genome, Cytoplasmic Male Sterility (CMS), Thermo sensitive genic Male sterility (TGMS), Genomic Interaction – Protoplast isolation, culture and fusion.

Unit III -Transgenic Plants **15 Hours**

Genetic engineering and crop improvement – Transgenic plants: Biotic stress resistance (Insect, Virus, Bacteria). Abiotic stress resistance (Herbicide, Drought). Crop Improvement (Flavr savr tamato, Golden Rice). Advantages and disadvantages of transgenic crops – Biosafety concerns and regulations of transgenic plants, Production of Organic food.

Unit IV - Biofertilizers and Molecular Pharming **18 Hours**

Crop production: Production of biofertilizers (Azolla): Criteria for strain selection, steps for preparing biofertilizers (Seed pelleting, inoculant carriers, quality standards for inoculants), Green manuring.

Transgenic plants as Bioreactors: Medical Pharming – Therapeutic proteins (Serum albumin, Hirudin, Collagen and Somatotrophin), Plantibodies, Edible Vaccines (Potato, Banana, Tomato, Lettuce and Alfalfa). Non medical Pharming – Industrial Enzymes (Cellulase and α-amylase), Bioplastics.

Unit V - Role of Molecular techniques in Plant Breeding **12 Hours**

Markers based on DNA Hybridization (RFLP) –Markers based on PCR amplification (RAPD, AFLP, STS, SNPs and Microsatllites). Genomic enabled breeding methods– Linkage analysis and Quantitative Trait Loci. Biosafety and bioethics in plant breeding.

 # Self Study

Text Books

S. No	Author	Title	Publisher	Year of Publication
1	KaporRenu, RanabhattHiru	Plant Biotechnology	Woodhead Publishing, India	2018
2	Neal Stewart Jr	Plant Biotechnology and Genetics : Principles, techniques and applications	John Wiley & Sons, Inc	2016
3	Shaileash Kumar, Sweta Mishra, Mishra A.P.	Plant Tissue Culture: Theory and Techniques	Scientific Publisher	2016
4	PalmiroPaltronieri, Yiguo Hong	Applied Plant Genomics and Biotechnology	Woodhead Publishing, India	2015
5	Muhammad SK, Iqrar AK, DebmalyaBarh	Applied Molecular Biotechnology. The Next Generation of Genetic Engineering.	CRC Press	2016

Reference Books

S. No	Author	Title	Publisher	Year of Publication
1	BishunDeo Prasad, SangitaSahini, Prashant Kumar, Mohammed WasinSiddih	Plant Biotechnology Vol I: Principles, Techniques and Applications	Apple Academic Press	2018
2	Abdin MZ,Kiran U, KamaluddinM, Ali A	Plant Biotechnolgy: Principles and Applications	Springer, Singapore	2017
3	Bahadur B, Rajam B, Sahijram MV, Krishnamoorthy KV	Plant Biology and Biotechnology	Springer, India	2015
4	Bob.B.Buchnan, Wilhelm and Cruissem and RusselL.Jones	Biochemistry and Molecular Biology of Plants	John Wiley and Sons, Ltd	2015
5	Hae Jong Koh and Michael Thomson	Current technologies in Plant Molecular Breeding	Springer	2016

Pedagogy

- Lecture (Chalk and Talk – OHP- LCD)
- Quiz, Seminar, Assignment, Group Discussion,
- Videos and Animations.

Web links

- https://www.z-lib.org
- https://www.pdfdrive.org
- https://nptel.ac.in/courses/102/103/102103016/#watch
- https://www..dcu.ie
- https://www.edx.org
- https://unacademy.com
- https://www.sciencedirect.com
- https://khanacademy.org

CORE COURSE - VI

ANIMAL BIOTECHNOLOGY

Semester – V	ANIMAL BIOTECHNOLOGY	Hours/Week - 5	
Core Course – VI		Credits - 5	
Course Code - 19UBT5CC6		Internal 25	External 75

Objectives

- To understand the basic requirements and techniques about Animal Cell Culture.
- To provide the knowledge about the manipulation of Embryo.
- To provide basic concepts about Cloning.
- To provide an overview and current developments in different areas of animal biotechnology.

Course outcome

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

CO No	CO statement	Knowledge level
CO1	Explain the fundamental scientific principles that underlie cell culture and its importance.	K1
CO2	Acquire knowledge for isolation, maintain and growth of cells.	K2
CO3	Develop techniques for the production of Growth Hormones, monoclonal antibodies etc.	K3
CO4	Explain proficiency in establishing and maintaining of cell lines.	K3
CO5	Analyze principles and applications of animal cloning and gene therapy along with ethical concerns.	K1

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	M	S	S	S
CO2	S	S	S	S
CO3	S	S	S	S
CO4	S	M	M	S
CO5	S	S	S	S

S-Strong, M-Medium, L-Low

CORE COURSE - VI

ANIMAL BIOTECHNOLOGY

Unit I - Animal Cell Culture **15 Hours**

Animal cell culture - Introduction and History. Lab Facilities – Infrastructure- Equipment – Culture Vessels. Media Composition – Types – Natural – Synthetic – Semisynthetic – Freezing Media. Reagents – Antibiotics – Trypsin – Indicators.

Unit II - Types of Animal Cell Culture **13 Hours**

Types of Cultures – Primary – Secondary – Established Cultures. Culture – Finite – Continuous Culture - Histotypic – Organotypic. Biology of Cultured Cells – Cell Synchronization – Cell Viability – Cytotoxicity – Cryopreservation.

Unit III - Gene transfer and Reproductive Cloning **17 Hours**

Gene transfer methods in Animals –Physical - Chemical - Biological methods. Biological vectors – Bacteria - Virus. Hybridoma technology. Gametogenesis. Stages of embryonic development – Morula, Blastulation, Gastrulation and Organogenesis. Cryopreservation - Sperm - Ova - Embryo of livestock. Artificial Insemination - Super ovulation - In vitro Fertilization- Culture of Embryos - Embryo transfer- Embryo Splitting- Embryo Sexing.

Unit IV- Trangenesis **15 Hours**

Animal Cloning - Basic Concepts. Cloning from Embryonic Cells - Adult cells. Cloning of different Animals - Transgenic Animals – Mice – Sheep - Fish. Products from Transgenic Animals – Insulin – Growth Hormones – Blood Clotting Factors. Merits - demerits.

Unit V- Gene Therapy **15 Hours**

Gene Therapy - Types of Gene Therapy- Somatic – Germline Gene Therapy. Approaches – Ex vivo – In vivo Gene Therapy. Gene knock out technology. #Global Ethical Challenges in Animal Biotechnology.

Self Study #

Text Books

S. No.	Author	Title	Publisher	Year of Publication
1	Ashish Verma and Anchal Singh	Animal Biotechnology – Models in Discovery and Translation 2nd Edition	Elsevier, India	2020
2	Birbal Singh Gorakh Mal Sanjeev K. Gautam Manishi Mukesh	Advances in Animal Biotechnology	Springer, Switzerland	2019
3	Daniel Scherman	Advanced Textbook On Gene Transfer, Gene Therapy And Genetic Pharmacology, 2nd Edition	World Scientific Europe Ltd	2019
4	Niemann H and Christine Wrenzycki	Animal Biotechnology 1 – Reproductive Biotechnologies	Springer International Publishing AG, Switzerland	2018
5	Inderbir Singh's	Human Embryology – 11th Revised Edition	Jaybee Brothers Medical Publishers, India	2017
6	B. Singh and S.K. Gautam	Textbook of Animal Biotechnology	The Energy and Resources Institute, TERI	2013

Reference Books

S. No.	Author	Title	Publisher	Year of Publication
1	U. satyanarayana, U. chakrapani	Biotechnology12th Edition	Books, India	2019
2	Uma Lakshmipathy&BhaskarThyagarajan	Primary And Stem Cells: Gene Transfer Technologies And Applications	Wiley,New Jersey.	2011
3	Glick, B.R. and Pasternak, J.J.	Molecular biotechnology- Principles and applications of recombinant DNA	ASM press, Washington, USA	2009
4	Myers, R.M., Caudy, A. and Witkowski, J.K.	DNAgenes and genomes- A short course	N.Y., USA	2007

Pedagogy

e-content, Lecture, Power Point Presentation, Seminar, Assignment, Quiz, Group Discussion, Video/Animation.

Web links

- www.whatisbiotechnology.org
- https:// youtu.be/ON2e1VsBhJk
- https:// youtu.be/UV7T9JsxdXA
- https:// youtu.be/UMdC6m_BxfM

CORE COURSE – VII

BIOSTATISTICS

Semester – V	BIOSTATISTICS	Hours/Week – 5	
Core Course – VII		Credits – 5	
Course Code –19UBT5CC7		Internal 25	External 75

Objectives

- To study the basic concepts of statistics and sampling design
- To equip analytical thinking to solve biological problems

Course Outcome

On the Successful completion of the course the student would be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the basic concepts of biostatistics, functions and limitations	K3
CO2	Classify the data and sampling deign	K3
CO3	Compute the measures of central tendency and measures of Dispersion	K3
CO4	Apply the concepts of skewness, moments, kurtosis, correlation and regression to solve the problems.	K4
CO5	Examine the various testing of hypothesis and also analysis of variance based on one-way classification and two-way classification	K4

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	S	S	S
CO2	S	S	S	S
CO3	S	S	M	S
CO4	S	S	S	S
CO5	S	S	S	S

S-Strong, M-Medium, L-Low

CORE COURSE – VII

BIOSTATISTICS

Unit I **15 Hours**

Introduction to biostatistics - definition, statistical methods, biological measurement, kind of biological data, functions of statistics and limitation of statistics - Collection of data, sampling and sampling design.

Unit II **15 Hours**

Tabulation and Frequency distribution, types of representations graphic-bar diagrams, pie diagrams and curves

Unit III **15 Hours**

Measures of central tendency- Mean, Median, Mode, Geometric mean, Harmonic mean - Measures of dispersion and variability changes- Mean deviation, standard deviation, co-efficient of variation

Unit IV **15 Hours**

Analysis Skewness, Moments and Kurtosis - Meaning - test of skewness, characteristics of dispersion and skewness. Measures of skewness, objectives - Karl Pearson's coefficient of skewness, Bowley's Coefficient of skewness- Correlation and regression

Unit V **15 Hours**

Testing of hypothesis for small samples-Students' T -Test- Chi square test- F-test or Fisher's F test – Analysis of Variance: Introduction – The Technique of Analysis of Variance- One-way Classification – Two-way Classification.

Text Books

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	P.N. Arora and P.K. Malhan	Biostatistics	Himalaya Publishing house	2008
2	Suranjan Saha	Mathematics and Statistics	New Central Book Agency (P) LTD	2009

Reference Books

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	R.S.N. Pillai and V.Bagavathi	Statistics Theory and Practice	S.Chand	2016
2	Bernard Rosner	Fundamentals of Biostatistics	Lengage learning	2006
3	Stephen Bernstein & Ruth Bernstein	Elements of Statistics	Tata McGraw – Hill Edition 2005	2005
4	Veer Bala Rastogi	Fundamentals of Biostatistics	Ane Books India	2006
5	Samuel Delvin	Biostatistics	Sarup and Sons	2007
6	John E. Freund	Mathematical Statistics	Pearson Education Asia	2002

Pedagogy

Power Point Presentation, Group Discussion, Seminar, Assignment

Web Links

- https://www.youtube.com/watch?v=_e4mwlqCQrc
- https://www.youtube.com/watch?v=AdH5vfobH5E
- https://www.youtube.com/watch?v=fNLeogEjMmM
- https://www.youtube.com/watch?v=0zZYBALbZgg

CORE PRACTICAL – V

LAB IN PLANT AND ANIMAL BIOTECHNOLOGY

Semester – V	LAB IN PLANT AND ANIMAL BIOTECHNOLOGY	Hours/Week – 4	
Core Practical V		Credits - 4	
Course Code - 19UBT5CC5P		Internal 40	External 60

Objectives

- To get trained in maintaining aseptic conditions in animal cell culture.
- To acquire hands-on training in formulation of specific media.
- To obtain skills pertaining to isolation procedures from plant and animal sources.
- To understand and learn the establishment of animal cell culture experiments.

Course Outcomes

On the Successful completion of the course the student would be able to

CO Number	CO Statement	Knowledge Level
CO1	Establish and maintain aseptic conditions in tissue culture lab	K1
CO2	Demonstrate the method of DNA isolation from various sources and identification in agarose gel electrophoresis.	K2
CO3	Select & formulate media based on requirement of animal cell culture.	K3
CO4	Enumerate the cells using haemocytometer	K3
CO5	Utilize the skills and basic techniques in culturing cells using primary and secondary methods	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	S	M	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	M	S	S

S-Strong, M-Medium, L-Low

CORE PRACTICAL – V

LAB IN PLANT AND ANIMAL BIOTECHNOLOGY

1. Introduction to safety and aseptic maintenance of tissue culture laboratory.
2. Isolation of Plant genomic DNA.
3. Isolation of *Rhizobium* species from root nodules of legumes.
4. Isolation of protoplast from spinach leaves by mechanical and enzymatic methods.
5. Protoplast fusion by using polyethylene glycol.
6. Isolation of VAM fungi from *Canna indica*.
7. Isolation of genomic DNA from animal liver tissue.
8. Quantification of DNA by Spectrophotometric method.
9. Identification of stages during chick embryo development.
10. Assessment of cell viability by cell counting in Haemocytometer.
11. Preparation of animal tissue culture media.
12. Establishment of Primary cell culture *
13. Establishment of Secondary cell culture *
14. Cryopreservation and thawing of cells*
15. Visit to Animal Cell Culture Lab.

* Practical by demonstration only

Reference books:

S. No.	Author	Title	Publisher	Year of Publication
1	R. Ian Freshney and Amanda Capes-Davis	Freshney's Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications	Wiley - Blackwell	2021
2	Cornelia Kasper, Verena Charwat and Antonina Lavrentieva	Cell Culture Technology	Springer	2018
3	Supriya Dash and Swagat Kumar Das H N Thatoi	Practical Biotechnology: Principles and Protocols	I K International Publishing House	2017
4	Ralf Pörtner	Animal Cell Biotechnology: Methods and Protocols (3rd Edition)	Humana Press	2016
5	R. Ian Freshney	Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 7th Edition	Wiley - Blackwell	2016

MAJOR BASED ELECTIVE – I (A)
PHARMACOGNOSY

Semester – V	**PHARMACOGNOSY**	**Hours/Week – 5**	
Major Based Elective – I (A)		**Credits – 5**	
Course Code – 19UBT5MBE1A		**Internal 25**	**External 75**

Objectives

- To know the fundamentals of Pharmacognosy like scope, classification of crude drugs, their identification and evaluation, phytochemicals present in them and their medicinal properties.
- To know the techniques in the cultivation and production of crude drugs
- To analyse the crude drugs, their uses and chemical nature
- To evaluate the techniques for the herbal drugs

Course Outcomes

CO Number	**CO Statement**	**Knowledge Level**
CO 1	Understand the importance of drugs in the treatment of Diseases	K1
CO 2	Demonstrate the. Physical, Chemical and sensory characters of crude drugs of plant and mineral origin	K2
CO 3	Outline the scope and importance of Ethnomedicine,	K2
CO 4	Design the Drug Preparation Methods from medicinal plants	K3
CO 5	Analyse the effects of drugs in allopathy with traditional systems of medicine	K3

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	S	S	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	S	S	S

S- Strong, M- Medium, L-Low

MAJOR BASED ELECTIVE – I (A)
PHARMACOGNOSY

Unit I- Introduction to Pharmacognosy **15 hours**

Definition, #History and Scope of Pharmacogonosy including indigenous system of medicine - Ayurveda, Siddha, Unani, Yoga, Homeopathy and Naturopathy. Various systems of classification of drugs and natural origin. Adulteration -Types of Adulteration: Intentional and Accidental adulteration. Drug evaluation - Organoleptic evaluation, Anatomical evaluation, Physical evaluation. Chemical evaluation, Biological evaluation, and organoleptic evaluation: significance of pharmacopoeial standards.

Unit II- Classification and Sources of Drugs **15 hours**

Classification of Crude drugs - Unofficial and non-official drugs. Based on Morphology, Taxonomy, Therapeutic application and Chemical Constituents. Alphabetical Classification of Crude drugs, biological Classification of Crude drugs, chemical Classification of Crude drugs, pharmacological Classification of Crude drugs-, taxonomical Classification of Crude drugs, chemo taxonomical Classification of Crude drugs and Serotaxonomical Classification of Crude drugs.

Unit III- Production of Natural drugs **15 hours**

Brief outline of occurrence, distribution, outline of isolation, identification tests, therapeutic effects of alkaloids, terpenoids, glycosides, volatile oils and tannins. Steps involved in Crude drug production- Cultivation, collection, Drying, Extraction, Isolation, Bioassaying, Quality control and preparation of crude drugs of natural origin.

Unit IV- Modern pharmacognosy **15 hours**

The development of modern pharmacognosy in organic chemistry - structure prediction using analytic chemistry techniques, including paper, HPTLC and Gas chromatography Mass spectrophotometry for pharmacologically bio-synthesised substances from the plants - Strychnine, Quinine, caffeine, Nicotine and Vinca alkaloids-vincristine and vinblastine

Unit V- Application of Pharmacognosy **15 hours**

Pharmaceutical applications of secondary metabolites like Alkaloids: Vinca, Rauwolfia.. Flavonoids: Lignans, Tea. Triterpenoids: Dioscorea. Volatile oils: Mentha, Clove, Cinnamon, Coriander. Tannins: Catechu, Pterocarpus.Resins: Ginger, Asafoetida, Glycosides: Senna, Aloes, Bitter Almond.

Self Study Topic #

Text Books

S. No.	Author	Title	Publisher	Year of Publication
1	Shagufta Perveen	Pharmacognosy Medicinal plants	eBook (PDF) ISBN:978-1-83880-874-7	2019
2	Mohammed Ali	Text Book of Pharmaceutical Chemistry-I	CBS Publishers& Distributors	2019
3	P Suresh Narayana D.Varalakshmi T.Pullaiah	Text Book of Pharmacognosy	CBS Publishers and Distributors	2016
4	Pathania JS	Text Book of Pharmacology for Paramedical students	CBS Publishers and Distributors	2020
5	Dr.Kuntal Das	Pharmacognosy and Phytochemistry -II	Nirali Publishers	2019
6	Veronika Butterweck and Robert furst	Planta Medica Journal of Medicinal Plant and Natural Product Research	Thieme.de	2020
7	Government of India	THE AYURVEDIC FORMULARY OF INDIA (PART - 1,2 AND 3)	Hand cover	2011

Reference Books

S. No.	Author	Title	Publisher	Year of Publication
1	J. S. Qadry	Pharmacognosy	CBS Publishers and Distributors	2018
2	Simone Badal McCreath and Rupika Delgoda	Pharmacognosy: Fundamentals, Applications and Strategies	Academic Press	2016
3	M. A. Iyengar and S.G.K. Nayak	Pharmacognosy Lab Manual	Pharma Med press	2018
4	M.S. Krishnamurthy and JV Hebbar	Easy Ayurveda Home Remedies: Based On Authentic, Traditional Ayurveda Practice Paperback – 1 January	Hand Cover	2018
5	Dr.Kuntal Das	Pharmacognosy and Phytochemistry –II	Nirali Publishers	2019

Pedagogy

e-content, Lecture, Powerpoint presentation, Seminar, Assignment, Quiz, Group Discussion, Video/Animation

Web links

- https://www.youtube.com/watch?v=MSabeRbl7fA
- https://www.youtube.com/watch?v=3_wo0H92sOU
- https://www.hrpatelpharmacy.co.in/pharmacognosy
- http://www.pharmacognosy.us/wp-content/uploads/ASPNL_53-1IX2017.pdf

MAJOR BASED ELECTIVE – I (B)

CANCER BIOLOGY

Semester – V	**CANCER BIOLOGY**	**Hours/Week – 5**	
Major Based Elective – I (B)		**Credits – 5**	
Course Code – 19UBT5MBE1B		**Internal 25**	**External 75**

Objectives

- To identify criteria for various staging of cancer.
- To learn the risks of cancer treatment (experimental and non-experimental)
- To prevent the occurrence of cancer and to get awareness about prevalence of cancer
- To Analyze how the stage of cancer impact goals of treatment, prognosis and progression.

Course Outcomes

CO Number	**CO Statement**	**Knowledge Level**
CO 1	Demonstrate the types of carcinomas.	K1
CO 2	Infer recent incidents and mortality of Global Cancer	K2
CO 3	Outline the clear and concise idea about Lifestyle& Dietary factors causing cancer.	K2
CO 4	Apply concepts of prevention of cancer, cancer-related deaths and cancer-related disabilities	K3
CO 5	Analyse the molecular mechanisms of cancer establishment and its progression by the process of metastasis and Angiogenesis	K3

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	S	S	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	S	S	S

S- Strong, M- Medium, L-Low

MAJOR BASED ELECTIVE – I (B)

CANCER BIOLOGY

Unit I- Introduction to Cancer **15 hours**

Historical and Basic Aspects of Cancer. Hallmarks of cancer. Biological properties of normal and cancer cells. Cancer - Benign and Malignant neoplasms. Types of cancer- Carcinoma, Sarcoma, Leukemia, Lymphoma and myeloma Global Cancer incidents and mortality#. Epidemiology studies.

Unit II- Causative Agents of Cancer **15 hours**

Biology - Genetic Factor, Viruses, Hormones. Lifestyle and Dietary factors - Tobacco, Alcohol and Ciggerette. Environmental and occupational Exposure - Chemical carcinogens and Mutagens.

Unit III- Biology of Cancer Cells **15 hours**

Cell Cycle Regulation in Cancer Cell. Cyclin Dependent Protein Kinase, CDK inhibitors. Apoptosis. Molecular Mechanism-Intrinsic and Extrinsic pathway. Oncogene and Tumor suppressor gene-p53.Metastasis and Angiogenesis.

Unit IV- Cancer Diagnosis **15 hours**

Clinical Examination-Biopsy, Blood Test, Bone marrow Aspiration, Pap Test. Imaging-X-ray, CT-Scan, MRI Scan, Endoscopy and Mammography

Unit V- Prevention and Treatment **15 hours**

Dietary Supplements- Retinoid, Carotenoids, Vitamin D, Soy Products, Lifestyle Practices-Yoga and Exercise. Treatment- Chemotherapy, Radiotherapy, Immunotherapy, Gene therapy, Stem Cell Therapy and Surgery.

Self Study Topic#

Text Books

S. No	Author name	Title of the book	Publishers name	Year of Publication
1	Gibbons J P	Khans the Physics of Radiation Therapy with Access Code 6ed (HB 2020)	LWW US Reprint	2020

2	Edward Chu , Vincent T. Devita Jr.	Physicians' Cancer Chemotherapy Drug Manual 2019	Jones and Bartlett Publishers, Inc; 19th edition	2018
3	Philip J. DiSaia MD William T. Creasman MD, Robert S Mannel MD	Clinical Gynecologic Oncology	Elsevier; 9th edition	2017
4	Clifford L. K. Pang	Hyperthermia in Oncology, 1st Edition	CRC Press	2015
5	Robert E. Bristow, BethY. Karlan, Dennis S. Chi	Surgery for Ovarian Cancer, 3rd Edition	CRC Press	2015

Reference Books

S.No	Author name	Title of the book	Publishers name	Year of Publication
1	Paul Scotting	Cancer: A Beginner's Guide	Beginner's Guides	2017
2	Klein smith	Principles of Cancer Biology	UBS Publishers	2016
3	Martha Robles-Flores	Cancer Cell Signaling: Methods and Protocols (Methods in Molecular Biology (1165)	Humana; Softcover reprint of the original 2nded. 2014 edition	2016
4	Sayan Paul	The Bethesda Handbook of Clinical Oncology	Wolters Kluwer India Pvt. Ltd.	2020
5	Devita V. T.	Evita hellman and Rosenbergs cancer principles and Practice of oncology 11ED (HB 2019)	LWW; 11th edition	2019

Pedagogy

e-content, Lecture, Power point presentation, Seminar, Assignment, Quiz, Group Discussion, Video/Animation

Web links

- https://nptel.ac.in/courses/108/108/108108124/
- https://www.youtube.com/watch?v=46Xh7OFkkCE
- https://www.youtube.com/watch?v=U5vAO_f2LDQ
- https://www.biologydiscussion.com/cancer/study-notes-on-cancer/27314

SKILL BASED ELECTIVE – II (A)

MOLECULAR DIAGNOSTICS AND THERAPEUTICS

Semester – V	MOLECULAR DIAGNOSTICS AND THERAPEUTICS	Hours/Week – 2	
Skill Based Elective – II (A)		Credits – 2	
Course Code – 19UBT5SBE2A		Internal 25	External 75

Objectives

- To know the basic concepts underlying in the pathogenesis of human diseases.
- To study the different techniques involved in the diagnosis of diseases.
- To understand the principle of therapeutics for the betterment of healthcare

Course Outcome

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

CO No.	CO Statement	Knowledge Level
CO1	Define the principle behind various types of human Diseases	K1
CO2	Outline the molecular markers and its sources	K2
CO3	Explain the molecular techniques involved in the disease diagnosis.	K2
CO4	Apply the approaches pertaining to the treatment of disease.	K3
CO5	Identify recombinant products that are made with the help of cell machinery.	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	L	L	L	M
CO2	L	M	M	S
CO3	L	M	M	M
CO4	L	M	M	M
CO5	S	S	M	M

S-Strong, M-Medium, L-Low

SKILL BASED ELECTIVE – II (A)

MOLECULAR DIAGNOSTICS AND THERAPEUTICS

Unit I - Overview of Human Diseases **6 Hours**

Types of Human Diseases: Microbial infections – Bacterial (Cholera and Tuberculosis), Viral (Chicken Pox and HIV) and fungal (Ringworm and Athletes foot), Genetic disease (Sickle cell anemia), Physiological disease (Diabetes), Immune system malfunction and disease (SCID & Rheumatoid arthritis).

Unit II - Biomarkers **6 Hours**

Biomarkers – Definition and Types. Biomarkers in disease diagnosis - Sweat chloride in Cystic Fibrosis, Blood Sugar or HbA1c in Type 2 Diabetes. Serum Creatinine in Kidney Disease, Bilirubin and Alkaline phosphate in Liver Disease, Cardiac troponin in Myocardial infarction and Bronchoalveolar lavage fluid containing C-peptide and Cytokeratin in Pulmonary fibrosis.

Unit III - Techniques in Molecular diagnostics **6 Hours**

Techniques in Molecular diagnostics – Random Amplified Polymorphic DNA (RAPD), Restriction Fragment Length Polymorphism (RFLP), Simple Sequence Repeats (SSR), Fluorescence *In situ* Hybridization (FISH), DNA Microarray, Metagenomics, Amniocentosis.

Unit IV- Introduction to therapeutics **6 Hours**

Introduction to therapeutics, Pharmacodynamics, Pharmacokinetics, Development of drug resistance. Cell based and Recombinant DNA therapies – Gene therapy and Stem cell therapy.

Unit V - Recombinant Products **6 Hours**

Applications of Recombinant products – Insulin[#], DNA Polymerase, Tissue Plasminogen Activator, Interferons, Erythropoietin, DNase I.

Self Study Topic[#]

Text Books

S. No	Author	Title	Publisher	Year of Publication
1	Nader Rifai, Andrea Rita Horvath & Carl T. Wittwer	Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics	Elsevier	2019
2	Barbara G Wells, Terry L Schwinghammer, Joseph T. DiPiro and Cecily V. DiPiro	Pharmacotherapy Handbook	Mc Graw Hill	2017
3	William B. Coleman, Gregory J. Tsongalis	Diagnostic Molecular Pathology: A Guide to Applied Molecular Testing	Academic Press	2016
4	Lela Buckingham	Molecular Diagnostics Fundamentals, Methods, and Clinical Applications – 2nd Edition	E.A.Davis Company, Philadelphia	2012
5	Roger Walker and Cate Whittlesea	Clinical Pharmacy and Therapeutics - Fifth Edition	Elsevier	2012

Reference Books

S. No.	Author	Title	Publisher	Year of Publication
1	R S Satoskar, Nirmala N. Rege, Raakhi K. Tripathi and Sandhya K. Kamat	Pharmacology and Pharmacotherapeutics, 26th Edition	Elsevier	2020
2	Arthur P. Bollon	Recombinant DNA Products	CRC Press	2018
3	Chao-Min Cheng, Chen-Meng Kuan and Chien-Fu Chen	In-Vitro Diagnostic Devices: Introduction to Current Point-of-Care Diagnostic devices	Springer	2016
4	Dr Jayanti Tokas	Immunology and Molecular Diagnostics	University Science Press	2015
5	Harald Seitz, Sarah Schumacher	Molecular Diagnostics (Advances in Biochemical Engineering/ Biotechnology Book 133)	Springer	2013

Pedagogy

Lecture, Power point presentation, Seminar, Assignment, Quiz, Group Discussion, Video/Animation

Web links

- https://www.cdc.gov/labquality/molecular-methods.html
- https://wyss.harvard.edu/keywords/Diagnostics/?section=technology
- https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod3.pdf

SKILL BASED ELECTIVE – II (B)

LAB IN BIOINFORMATICS

Semester – V	LAB IN BIOINFORMATICS	Hours/Week – 2	
Skill Based Elective – II (B)		Credits – 2	
Course Code - 19UBT5SBE2BP		Internal 40	External 60

Objectives

- To learn and execute various molecular analysis using bioinformatics tools.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Demonstrate nucleotide analysis from various databases	K1
CO 2	Analyze the structure of novel proteins	K2
CO 3	Perform basic phylogenic analysis for species identification	K2
CO 4	Apply the sequencing skills in various molecular analysis	K3
CO 5	Identify and analyze any disorders in a genome sequence	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	S	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	M	M	S	S

S-Strong, M-Medium, L-Low

SKILL BASED ELECTIVE – II (B)

LAB IN BIOINFORMATICS

1. Retrieval of Nucleotide Sequence from GenBank, EMBL, DDBJ database.
2. Retrieval of Protein Sequences from PIR, Swissprot/ Uniprot database.
3. Protein Structure database –PDB.
4. Motif and domain analysis using HOMER Motif database.
5. Pairwise Sequence analysis using BLAST.
6. Multiple Sequence analysis using ClustalW.
7. Construction of Phylogenetic tree.
8. Molecular visualization using Rasmol.
9. Pathway search using KEGG database.
10. Retrieval of Disease/ disorder genome sequence from OMIM database.
11. Homology Modeling using SWISS – MODEL Workspace.

Reference books

S. No.	Author	Title	Publisher	Year of Publication
1	Dr. Shashank Rana, Dr. Vartika Singh, Preeti Kashyap, Bhavya Sharma, Shilpi Tiwari	Bioinformatics Practical Manual	Manojvm Publishing House	2020
2	Lloyd Wai Yee Low, Martti Tapani Tammi	Bioinformatics: A Practical Handbook Of Next Generation Sequencing And Its Applications	World Scientific Publishing Company	2017
3	Noor Ahmad Shaik, Babajan Banaganapalli, Ramu Elango, Khalid Rehman Hakeem	Essentials of Bioinformatics, Understanding Bioinformatics: Genes to Proteins	Springer International Publishing	2019
4	Mohammad Yaseen Sofi, Afshana Shafi, Khalid Z. Masoodi	Bioinformatics for Everyone	Elsevier Science	2021
5	Kenta Nakai, Christian Schonbach	Encyclopedia of Bioinformatics and Computational Biology ABC of Bioinformatics	Elsevier Science	2018

SKILL BASED ELECTIVE – III (A)

DNA FINGERPRINTING

Semester – V	DNA FINGERPRINTING	Hours/Week – 2	
Skill Based Elective – III (A)		Credits - 2	
Course Code - 19UBT5SBE3A		Internal 25	External 75

Objectives

- To understand the basic concepts in DNA profiling
- To familiarise with analytical tools and sample preparation methods for DNA testing
- To apply the DNA fingerprinting technique to solve various research and real life problems

Course Outcomes

On the Successful completion of the course the students would be able to

CO No.	CO Statement	Knowledge Level
CO1	Understand the basis of DNA fingerprinting	K1
CO2	Demonstrate the sample preparation and processing from various specimens	K2
CO3	Familiarise with the available analytical tools and techniques for DNA fingerprinting	K2
CO4	Analyse various case studies based on DNA fingerprinting	K3
CO5	Apply the knowledge in various problem solving aspects	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	L	M	S
CO2	S	S	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	M	S	S

S-Strong, M-Medium, L-Low

SKILL BASED ELECTIVE – III (A)

DNA FINGERPRINTING

Unit I- Introduction to DNA fingerprinting **4 Hours**

Introduction and history of DNA Fingerprinting –Discovery and advancements, Basis of molecular genetics – Organization of human genome, Pedigree analysis, DNA Polymorphisms.

Unit II- Sample preparation for DNA fingerprinting **8 Hours**

Sample preparation techniques – extraction of DNA sample from various sources, isolation and quantification of DNA, Purity analysis of DNA and sample processing. Primer designing and applications. Application of PCR technology in Forensic DNA profiling. Amplification of variable regions using PCR Agarose gel Electrophoresis for amplified products.

Unit III- Analytical tools **6 Hours**

Analytical tools for studying DNA polymorphism –PCR amplifications; Single nucleotide polymorphism (SNuPs); Genetic linkage mapping; Physical mapping of the genome.

Unit IV- Applications of DNA fingerprinting **6 Hours**

Applications of DNA fingerprinting in genome research, medicine – diagnosis and drug development, forensic investigation – identification of suspects, kinship analysis, Agriculture – Plant varieties protection.

Unit V- Case studies **6 Hours**

Case study based on DNA fingerprinting[#]– Disputed property, paternity, criminal identification.

Self study Topic[#]

Text Books

S. No.	Author	Title	Publisher	Year of Publication
1	Jeremey W. Dale and Malcom von Schantz	From genes to genomes: Concepts and applications of DNA technology	Wiley	2002
2	MunisDundar	Current Applications of Biotechnology	European Biotechnology Thematic Network Association	2015

3	T. A. Brown	Gene Cloning and DNA Analysis: An Introduction.7th Edition	Wiley Blackwell	2016
4	Hoffman A	Wilson and Walkers Principles and Techniques of Biochemistry and Molecular Biology	Cambridge University Press	2018
5	Sue Carson Heather Miller Melissa Srougi D. Scott Witherow	Molecular Biology Techniques A Classroom Laboratory Manual, 4th Edition	Academic Press	2019

Reference Books

S. No	Author	Title	Publisher	Year of Publication
1	Hirakranjan Dash, Pankaj Shrivastava, Braja Kishore Mohapatra and Surajit das	DNA Fingerprinting: Advancements and endeavours	Springer	2018
2	Bernard R. Glick and Cheryl L. Patten	Molecular Biotechnology: Principles and Applications of Recombinant DNA. 5thEdition	ASM Press, Washington DC	2017
3	Nessacarey	Junk DNA: A Journey through the Dark Matter of the Genome	Columbia University Press	2017
4	Jo – Anne Bright and Michael Coble	Forensic DNA Profiling: A practical guide to assigning likelihood Rarios	CRC Press	2019
5	Pankaj Shrivastava, HirakRanjann Dash,	Forensic DNA typing: Principles, Applications and Advancements	Springer	2020

Pedagogy

Power point presentation, Group Discussion, Case study analysis, Seminar, Assignment, Animations and virtual lab.

Web Links

- https://www.genome.gov/genetics-glossary/DNA-Fingerprinting#:~:text=DNA%20fingerprinting%20is%20a%20laboratory,evidence%20came%20from%20that%20suspect.
- https://nptel.ac.in/courses/102/103/102103017/
- https://www.youtube.com/watch?v=AkBUriMK9u8
- https://www.nature.com/scitable/topicpage/forensics-dna-fingerprinting-and-codis-736/
- https://jolt.law.harvard.edu/assets/articlePDFs/v03/03HarvJLTech223.pdf

SKILL BASED ELECTIVE III (B)

LAB IN PLANT TISSUE CULTURE

Semester – V	LAB IN PLANT TISSUE CULTURE	Hours/Week – 2	
Skill Based Elective III (B)		Credits - 2	
Course Code - 19UBT5SBE3BP		Internal 40	External 60

Objectives

- To acquire hands-on training in maintaining aseptic conditions and formulation of specific media required for plant tissue culture.
- To get skilled in handling different explants for plant tissue culture experiments.
- To understand and learn the establishment of callus and propagation of plants.

Course Outcomes

On the Successful completion of the course the student would be able to

CO Number	CO Statement	Knowledge Level
CO1	Design and maintain aseptic environment and formulate required media and stock solutions based on requirement.	K1
CO2	Demonstrate the methods of preparing callus and suspension Cultures	K2
CO3	Handle and establish various explants and induce callus Formation	K2
CO4	Isolate and culture protoplast from plant sources	K3
CO5	Analyse the callus propagated through tissue culture	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	S	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	L	**S**	S

S-Strong, M-Medium, L-Low

SKILL BASED ELECTIVE III (B)

LAB IN PLANT TISSUE CULTURE

1. Design and aseptic maintenance of plant tissue culture laboratory.
2. Formulation and sterilization of various plant tissue culture media.
3. Preparation of stock solutions – hormones and growth regulators.
4. Choice of explants and surface sterilization.
5. Preparation of callus and suspension culture
6. Protoplast culture.
7. Cytological study of calli cells.
8. Hardening of tissue culture plants and acclimatization

* Practical by demonstration only

Reference books:

S. No.	Author	Title	Publisher	Year of Publication
1	Roberta H. Smith	Plant Tissue Culture: Techniques And Experiments, 3rd Edition	Elsevier	2013
2	Mohammad Anis, Naseem Ahmad	Plant Tissue Culture: Propagation, Conservation and Crop Improvement	Springer	2016
3	M.K. Razdan	Introduction To Plant Tissue Culture 3rd Edition	Oxford and IBH Publishing	2019
4	J. Reinert, M.M. Yeoman, P. MacDonald	Plant Cell and Tissue Culture: A Laboratory Manual	Springer	2012
5	Karl-Hermann Neumann, Ashwani Kumar, Jafargholi Imani	Plant Cell and Tissue Culture – A Tool in Biotechnology: Basics and Application	Springer	2020

PROFESSIONAL SKILLS

Semester – V	PROFESSIONAL SKILLS	Hours/Week – 2	
UGC Jeevan Kaushal Life Skills		Credits - 2	
Course Code - 19UGPS		Internal 25	External 75

Objectives:

- To prepare students to become viable entrepreneurs or employees with necessary professional skills.
- To enhance the comprehensive skills required for a work environment leading them competent and confident.

Prerequisite:

An open minded and assertive attitude to acquire the salient skills for a prospective career.

Course Outcomes

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

CO NUMBER	CO STATEMENT	KNOWLEDGE LEVEL
CO1	Identify and define professional communication skills and effective interaction.	K1
CO2	Examine and reproduce LSRW skills in professional development.	K2
CO3	Explain and express views and opinions in an assertive manner.	K2
CO4	Prepare and practise to communicate through digital mode.	K3
CO5	Employ and transfer the acquired skills in a practical approach	K3

Mapping with Programme Outcome

COS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	L	L	S
CO2	S	S	L	M	S
CO3	S	S	M	M	S
CO4	S	L	L	M	S
CO5	S	S	L	S	S

S- Strong M-Medium L-Low

PROFESSIONAL SKILLS

Unit I - Resume Skills **5 Hours**

- Preparation and Presentation.
- Avoiding Common Errors.
- Preparing Resumes for Specific Purposes.

Unit II- Interview Skills **8 Hours**

- Useful Vocabulary
- Preparation and Presentation.
- Dos and Donts
- Observation of a Simulated Interview.

Unit III - Body Language and Personal Grooming **5 Hours**

- Importance of Body Language (Postures, Eye Contact, Expressions and Etiquettes)
- Good Grooming is Being Clean

Unit IV- Social and Cultural Etiquettes **6 Hours**

- Good Manners and Etiquettes
- Table Manners
- Manners in Public

Unit V- Group Discussion Skills **6 Hours**

- Meaning and Methods of Group Discussion.
- Procedure of Group Discussion.
- Group discussion – Simulation.
- Common Errors – How to Avoid It

Pedagogy

Seminar, Simulation, Quiz and Assignment

Material for Teaching and Reference

- https://graphicdesign.sfcc.spokane.edu/dZine/projects/Q3typographic_resume/resume http://worldwideuniversity.org/library/bookboon/the-art-of-interview-skills.pdf
- https://www.tutorialspoint.com/positive_body_language/positive_body_language_tutorial.pdf
- https://oaktrust.library.tamu.edu/bitstream/handle/1969.1/160849/254/MP0254.pdf?sequence=8&isAllowed=y
- http://www.edudel.nic.in/welcome_folder/after12th/enrich_dt_11112014.pdf
- http://egyankosh.ac.in/bitstream/123456789/35846/5/Unit-10.pdf

CORE COURSE – VIII

MICROBIAL BIOTECHNOLOGY

Semester – VI	MICROBIAL BIOTECHNOLOGY	Hours/Week- 6	
Core Course – VIII		Credits – 6	
Course Code – 19UBT6CC8		Internal 25	External 75

Objectives

- To know the industrially important microbes and their metabolic pathways.
- To study the microbial fermentation processes and its types.
- To acquire knowledge about the types of bioreactors and recovery of fermentation product.
- To provide the knowledge about the industrially important products.

Course outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Demonstrate the isolation of industrially important microorganisms and their preservation	K1
CO 2	Outline a clear and concise idea about concepts and basic methods in fermentation process	K2
CO 3	Discuss the design and types of bioreactor and upstream processing	K3
CO 4	Illustrate the various methods of bioseparation	K4
CO 5	Obtain knowledge in applications of microbes in food processing and production	K5

Mapping with Programme outcomes

CO	PO1	PO2	PO3	PO4
CO1	S	S	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	L	S	S

S- Strong, M-Medium, L-Low

CORE COURSE – VIII

MICROBIAL BIOTECHNOLOGY

Unit I - Basic principles of Biochemical Engineering **16 Hours**

Introduction and historical developments in industrial microbiology, industrially important microbes and metabolic pathways- various microbial metabolites and their overproduction – Isolation and selection of industrially important microorganisms preservation and maintenance of microbial culture.

Unit II - Concepts of basic mode of fermentation processes **16 Hours**

Microbial substrates and media formulation; Components of microbial fermentation process; Types of fermentation processes- Solid state, static and submerged fermentation. Fermentation economics and fermentation media. Fermenter design - mechanically agitated, pneumatic and hydrodynamic fermenters. Design of laboratory bioreactor; Types of Bioreactor: Continous, semi continuous and fed batch bioreactors; Continuous Stirred tank bioreactors, Bubble column bioreactors, Air lift bioreactors, Fluidized bed bioreactors, Packed bed bioreactors and Photobioreactors.

Unit III - Upstream Processing **16 Hours**

Bioprocessing: Culture collections, Industrial strains and strain improvement: Natural recomibination, conjugation, Mutagenesis, Genetic engineering of Microorganisms, Strain stability. Media formulation, sterilization, aeration and agitation. Large scale animal and plant cell cultivation and air sterilization. Measurement and control of bioprocess parameters, scale up and scale down process.

Unit IV - Downstream processing **16 Hours**

Bioseparation - filtration, centrifugation, sedimentation, flocculation, microfiltration, sonication. Cell disruption – enzymatic lysis and liquid-liquid extraction.Purification by precipitation (ammonium sulfate, solvent), electrophoresis and crystallization. Extraction (solvent, aqueous two phase, super critical) and chromatographic techniques (Ion exchange chromatography, hydrophobic interaction chromatography, affinity chromatography and gel filtration chrromatography. Reverse osmosis and ultra filtration. Drying, crystallization, storage and packaging.

Unit V- Applications of Microbes in food processing and production 16 Hours

Production of Microbial Biomass – Baker's Yeast, Mushroom; Production of antibiotic; Penicillin and Streptomycin - Production of fermented foods; Alcoholic beverages - wine, beer. Production of ethanol[#], citric acid, amino acids and vitamins- Microbial enzymes for food – Biopesticides and biofertilizers.

 # - Self Study Topics

Text Books

S.No.	Author	Title of the book	Publishers	Year of publication
1	Joginder Singh, AshishVyas, Shanquanwang, Ram Prasad	Microbial Biotechnology: Basic Research and Applications	Springer Nature Singapore pvt.Ltd	2020
2	Jayanta Kumar Patra, Gitishree Das, Han-SeungShin	Microbial Biotechnology Application in Food and Pharmacology	Springer Nature Singapore pvt.Ltd	2018
3	Pradeep Kumar, Jayanta Kumar Patra, Pranjal Chandra	Advances in Microbial Biotechnology Current Trends and Future Prospects	Apple Academic Press	2019
4	Rita Kundu , Rajiv Narula	Advances in Plant and Microbial Biotechnology	Springer Nature Singapore pvt.Ltd	2019
5	Dr.R.C.Dubey	A Textbook of Biotechnology	Schand Publishing	5th Revised Edition,2014

Reference Books

S.No.	Author	Title of the book	Publishers	Year of publication
1	Lee Yuan kun	Microbial Biotechnology Principles and Applications	e- Book	Third Edition,2019
2	Bernard R.Glick, Jack J.Pasternak	Molecular Biotechnology Principles and Applications of Recombinant DNA	Wiley Publication	2017
3	P.Singh	Recent Trends in Microbial Biotechnology	CBS Publication	2013

4	Debabrata Das, SoumyaPandit	Industrial Biotechnology	CRC Press	2021
5	WimSoetaert, Erick J. Vandamme	Industrial Biotechnology: Sustainable Growth and Economic Success	Wiley VCH Publication	1st Edition,2019

Pedagogy

- Lecture (Chalk and Talk – OHP, LCD)
- Quiz, Seminar, Assignment, Group Discussion
- Videos and Animations

Web links

- https://www.z-lib.org
- https://www.pdfdirve.org
- https://www.dcu.ie
- https://www.edx.org
- https://unacademy.com
- https://www.sciencedirect.com
- https://khanacademy.org

CORE COURSE – IX

IPR, BIOETHICS AND BIOSAFETY

Semester – VI	IPR, BIOETHICS AND BIOSAFETY	Hours/Week – 6	
Core Course – IX		Credits – 6	
Course Code – 19UBT6CC9		Internal 25	External 75

Objectives

- To understand various aspects of IPR, biosafety regulations and bioethics concerns arising from the commercialization of biotech products.
- To give an idea about IPR, registration and its enforcement.
- To sensitize about the importance of Personnel Protective Equipment (PPE), general biosafety rules and different biosafety levels.

Course Outcomes

CO Number	CO Statement	Knowledge Level
CO 1	Define the fundamental aspects of Intellectual Property Rights for development and management of innovative projects in industries	K1
CO 2	Outline the current trends in IPR and Govt. steps in fostering IPR	K2
CO 3	Explain about the ethical issues involving biological material.	K3
CO 4	Utilize adequate knowledge in the use of genetically modified organisms and its effect on human health	K3
CO 5	Make use of critical thinking skills to analyze information and situations in order to respond and act ethically with regard to scientific research, practice, and technology.	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	S	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	L	S	S

S- Strong, M- Medium, L-Low

CORE COURSE – IX

IPR, BIOETHICS AND BIOSAFETY

Unit I- Introduction to Intellectual Property and Types of IPs **18 Hours**

Introduction to IPR, Basic concepts and need for Intellectual Property, types - Patents, Trademarks, Trade Secrete, Copyright, Geographical Indications- History of GATT and TRIPS Agreement. – World Intellectual Property Rights Organization (WIPO). IP rights in India and abroad (USA & Europe) - few Case Studies-patent-Turmeric Patent,GI- Darjeeling Tea.

Unit II - Patent Filing Procedures and Agreements **18 Hours**

Patent- Elements of Patentability: Novelty, Non Obviousness (Inventive Steps), patentable and non-patentable – patenting life, Registration Procedure, Rights and Duties of Patentee, Assignment and license, Patent infringement. IPR Agreements and Treaties: Madrid Agreement; Hague Agreement; Budapest Treaty; PCT; Indian Patent Act 1970.

Unit III - Biosafety **18 Hours**

Introduction, biosafety issues in biotechnology - historical background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; #Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals.

Unit IV- Biosafety Guidelines **18 Hours**

Biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations of Government of India; #Definition of GMOs and LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC, for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Unit V- Bioethics **18 Hours**

Introduction to ethics/ bioethics – purpose and principles of bioethics, Bioethics in medical – human cloning, Biotechnology and ethics, Benefits and risks of genetic engineering- ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and bio warfare; Ethical implications of cloning: Reproductive cloning, therapeutic cloning; Ethical, legal and socioeconomic aspects of gene therapy, germ line,

somatic, embryonic and adult stem cell research-GM crops and GMO's – biotechnology and biopiracy –ICMR Guidelines- Ethical implications of human genome project.

#- Self Study Topics

Text Books

S. No.	Author	Title	Publisher	Year of Publication
1	Tom Koch	Ethics in Everyday Places	Esri Press	2017
2	Nithyananda, K V.	Intellectual Property Rights: Protection and Management	Cengage Learning India Private Limited	2019
3	AdarshRamanujan	Patent Law Cases and Materials: A Synthesis For India	Wolters Kluwer India Pvt. Ltd	2020
4	Andrew F. Roberts, JoergRomeis, Karen Hokanson, Reynaldo Ariel Alvarez Morales	Biosafety of Genetically Modified Organisms, Volume II	Frontiers Media SA	2020
5	V. ScopleVinod	Managing Intellectual Property	Prentice Hall of India pvt Ltd	2012

Reference Books

S. No.	Author	Title	Publisher	Year of Publication
1	Anil Kumar H S and B. Ramakrishna	Fundamentals of Intellectual Property Rights	Notion Press	2017
2	Dr. S.V. Damodar Reddy	Intellectual Property Rights -- Law and Practice	ASIA LAW HOUSE	2019
3	Dawn P. Wooley and Karen B. Byers	Biological Safety: Principles and Practices	ASM Press; 5th edition	2017
4	Ahuja, V K.	Law relating to Intellectual Property Rights	Lexis Nexis	2017
5	Ramakrishna B & Anil Kumar H.S	Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers	Notion Press	2017

Pedagogy

- Lecture (Chalk and Talk) & Power Point Presentation
- Quiz, Seminar, Assignment & Group Discussion.
- Videos and Animations

Web links

- http://www.cbd.int/biosafety/backgrounds.html
- http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section
- http://www.cbd.int/biosafety/background.shtml
- http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html
- http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
- https://www.wipo.int/about-ip/en/

CORE PRACTICAL – VI

LAB IN MICROBIAL BIOTECHNOLOGY

Semester – VI	LAB IN MICROBIAL BIOTECHNOLOGY	Hours/Week - 5	
Core Practical – VI		Credits - 4	
Course Code - 19UBT6CC6P		Internal 40	External 60

Objectives

- To equip the students with skills pertaining to immobilization and genetic engineering techniques.
- To acquire hands-on exposure to fermentation techniques.
- To get skilled in the production techniques of Single Cell Protein, Biofertilizer and Bio- Enzymes.

Course Outcomes

On the Successful completion of the course the student would be able to

CO Number	CO Statement	Knowledge Level
CO1	Enumerate the industrially important microorganisms.	K1
CO2	Demonstrate various types Fermentation methods.	K2
CO3	Handle and establish the techniques of Immobilization.	K2
CO4	Produce Single Cell Protein, Biofertilizer and Bio -Enzymes.	K3
CO5	Understand the skills and basic techniques of Antibiotic Sensitivity Test of Microorganisms.	K3

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4
CO1	S	S	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	L	**S**	S

S-Strong, M-Medium, L-Low

CORE PRACTICAL – VI

LAB IN MICROBIAL BIOTECHNOLOGY

1. Isolation of industrially important microorganisms.
2. Isolation and of Lactic acid bacteria.
3. Immobilization of algal cells and enzymes by Sodium Alginate method.
4. Immobilization of algal cells and enzymes in agarose cubes.
5. Isolation of amylase producing organisms.
6. Wine production by yeast.
7. Pro - Mushroom Cultivation
8. Biofertilizer Production – Azolla and Vermicompost.
9. Production of Bio-Enzyme from Food waste.
10. Bioassay techniques for antibiotics - Test for Antibiotic sensitivity of microorganisms by Disc method and Agar well diffusion method.
11. Physical Mutagenesis – UV method.
12. Visit to Distillery unit; alcohol production and pharmacological industries. Pasteur Institute (Field visit).

Reference Books

S. No	Author	Title	Publisher	Year of Publication
1	Aneja.K.R	Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology. 5th Edition.	New Age International (P) Ltd, New Delhi, India.	2018
2	Fernanda Mozzi, Rahul.R.Raya, Graciela.M.Vignolo	Biotechnology of Lactic Acid Bacteria – Novel Applications. Second Edition.	Wiley – Blackwell, New Jersey, United States.	2015
3	FarshadDarvishiHarzevili, Hongzhang Chen	Microbial Biotechnology – Progress and Trends	Taylor & Francis/ Routledge, UK.	2014
4	Surajit Das, HirakRanjan Dash	Microbial Biotechnology – A Laboratory Manual for Bacterial System	Springer India.	2014

5	Singh.P	Recent Trends in Microbial Biotechnology.	CBS, Chennai, India.	2013
6	Thatoi .H.N, Mishra.B.B	Microbial Biotechnology - Methods and Applications.	Alpha Science International, UK	2012
7	El-Mansi.E.M.T, Bryce.C.F.A, Dahhou. B, Sanchez.S, Demain.A.L, Allman.A.R.	Fermentation Microbiology and Biotechnology, Third Edition	Taylor & Francis, UK	2012

Web Links

- https://youtu.be/oormRweSf3E
- https://youtu.be/HqbVca1elak
- https://youtu.be/4nNQEO8ZQR0
- https://youtu.be/9u-UEqiUZtk
- https://youtu.be/sIWADw9vFNM

MAJOR BASED ELECTIVE- II (A)

ENVIRONMENTAL BIOTECHNOLOGY

Semester – VI	**ENVIRONMENTAL BIOTECHNOLOGY**	**Hours/Week – 6**	
Major Based Elective-II (A)		**Credits – 6**	
Course Code-19UBT6MBE2A		**Internal 25**	**External 75**

Objectives

- To know the basic concept and scope of environmental biotechnology
- To study the Applications of biotechnology in environmental monitoring.
- To analyse Bio sensors in environmental protection.
- To understand the achievements of biotechnology in Environmental Management.

Course Outcomes

CO Number	**CO Statement**	**Knowledge Level**
CO 1	Demonstrate the utilization of microbial processes in waste.	K1
CO 2	Describe the concept of pollution management.	K2
CO 3	Apply the Green manuring technology for crop production.	K3
CO 4	Apply the concepts of Biotechnology in Environmental Management.	K3
CO 5	Apply the practical skills for entrepreneurial development in biofertilizer production	K3

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	S	M	M	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	S	S
CO5	S	S	S	S

S- Strong, M- Medium, L-Low

MAJOR BASED ELECTIVE- II (A)

ENVIRONMENTAL BIOTECHNOLOGY

Unit I - Introduction to Environmental Biotechnology **18 Hours**

Basic components of environment. Definition – concept and scope of ecosystem, abiotic and biotic components. Environmental pollution: Air - Types of Air Pollutants: Sources, Effects and control of Air pollution .Water pollution- Sources, Effects and control of Water pollution and Soil pollution- Sources, Effects and control of Water pollution. Liquid Waste management - Sewage water treatment – Process involved- Dilution, Mechanical treatments, Biological treatments, Chemical treatments.

Unit II - Role of Biotechnology in Waste management **18 Hours**

Solid waste management. Classification of Solid waste management- Municipal Solid Waste and Hazardous Solid Waste. Nitrification and denitrification – microbial fundamentals and application. Aerobic processes: Activated sludge, oxidation ditches, trickling filters, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic processes: Anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactor.

Unit III - Biodegradation and Bioremediation **18 Hours**

Principle and mechanism of biodegradation, Biodegradation of xenobiotic compounds (Lignin, Hydrocarbons, Detergents, Dyes and pesticides). Biodegradation of agro chemicals and other organic compounds – Biotransformation of xenobiotic compound; Bioremediation- Principles - Bioscrubbers – Biomining of metals - Biopulping. Phytoremediation: Use of plants for removal of organic and metallic pollutants.

Unit IV - Biotechnology and value addition **18 Hours**

Biofertilizers- Different types of biofertilizer -Rhizobium, Azotobacter, Azospirillum, cyanobacteria- Azolla .Production of biofertilizers (Azolla): Criteria for strain selection, steps for preparing biofertilizers (Seed pelleting, inoculant carriers, quality standards for inoculants), Green manuring for crop production. Application of biofertilizers. Algal Biomass- Chlorella and Spirulina. Factors Affecting Biomass Production. Mass Production of Spirulina. Types of Spirulina Production - Semi-natural lake system and artificially built cultivation system - Clean water system and Waste water system. Uses of Spirulina - Single Cell Protein - protein supplemented food, health food, therapeutic and natural Medicine, Cosmetics.

Unit V- Environmental Monitoring **18 Hours**

Environmental monitoring: environmental impacts and their assessments using bioindicators, Biomarkers, biosensors and toxicity testing Air, water and soil sampling. Merits and demerits Bio-tools for environmental monitoring – Role of biotechnology in environmental protection. Various environmental standards: air, water and noise quality. Environment protection Act: environmental laws, policies, ethics. #Global Environmental Current Issues. #Social responsibilities of Environmental protection and Monitoring.

#-Self-Study Topics

Text Books

S. No.	Author	Title	Publisher	Year of Publication
1	Pradipta Kumar Mohapatra	Textbook of Environmental Biotechnology	Dreamtech Press, Wiley India Pvt Ltd.	2020
2	Daniel Vallero	Environmental Biotechnology: A Biosystems Approach	Academic Press	2015
3	Pramod Kumar,Vipin Kumar and Pravin Kumar Sachan	Textbook of Environmental Biotechnology	WPI, India Pvt. Ltd	2018
4	Lakhveer Singh, Vipin Chandra Kalia	Waste Biomass Management - A Holistic Approach	Springer International Publishing	2017
5	Anonim	Environmental Biotechnology	I. K. International Pvt Ltd	2017

Reference Books

S.No	Author	Title	Publisher	Year of Publication
1	JeyabalanSangeetha	Environmental Biotechnology	CRC Press	2016
2	Roberto Adkins	Environmental Biotechnology	Scientific e-Resources	2019
3	Bruce E. Rittmann	Environmental Biotechnology Principles and Applications	McGraw-Hill Education	2020

4	IndhuShekhar Thakur	Environmental Biotechnology Basic Concepts and Applications	I. K. International Pvt Ltd	2021
5	Dilip Kumar Markandey	Environmental Biotechnology	APH Publishing	2021

Pedagogy

- Lecture (Chalk and Talk) & Power Point Presentation
- Quiz, Seminar, Assignment & Group Discussion.
- Videos and Animations

Web links

- https://www.digimat.in/nptel/courses/video/102105087/L01.html
- www.hydrosilintl.com
- https://www.youtube.com/watch?v=qs_oO0Nqvk8&t=26s
- https://www.digimat.in/nptel/courses/video/102105088/L01.html
- https://www.youtube.cov=qOshPABx9D4m/watch?
- https://www.youtube.com/watch?v=giJWzLQc15s
- https://www.youtube.com/watch?v=Tgiz4_i_2X4

MAJOR BASED ELECTIVE-II (B)

STEM CELL BIOLOGY

Semester – VI	**STEM CELL BIOLOGY**	**Hours/Week - 6**	
Major Based Elective – II (B)		**Credits - 6**	
Course Code - 19UBT6MBE2B		**Internal 25**	**External 75**

Objectives

- To understand the basic concepts of Stem cell biology
- To afford the knowledge about stem cell epigenetics
- To provide an overview of potential clinical use of stem cells

Course Outcome

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

CO Number	**CO statement**	**Knowledge level**
CO1	Define the fundamental scientific principles of embryonic and adult stem cells.	K1
CO2	Explain the techniques involved in isolation, maintain and growth of stem cells.	K2
CO3	Outline the basic concepts in stem cell epigenetics.	K2
CO4	Make use of the potential benefits and clinical applications of stem cells	K3
CO5	Utilize the clinical significance and ethical issues pertaining to stem cell research	K3

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	M	S	M	M
CO2	M	S	S	S
CO3	M	S	M	M
CO4	M	S	M	S
CO5	S	S	S	S

S-Strong, M-Medium, L-Low

MAJOR BASED ELECTIVE-II (B)

STEM CELL BIOLOGY

Unit I- Introduction to Stem cells **15 Hours**

Stem cell – Introduction, History, Properties, Potency – Totipotent, Pluripotent, Multipotent, Oligopotent, Unipotent; Types – Embryonic and Adult Stem cells. Stem cell niche - Components and function. Cell cycle regulation in stem cells.

Unit II- Stem cell culture **20 Hours**

Isolation of Embryonic stem cell and Adult stem cell – Blastocyst from IVF, Umbilical Cord, Somatic Cell Nuclear Transfer, Bone marrow. Culture Media – Feeder cell layers, Serum and feeder free media, growth factors. Stem cell expansion and differentiation. Cryopreservation and storage techniques of stem cells. Stem cell bank.

Unit III- Stem cell epigenetics **20 Hours**

Epigenetic mechanisms in normal development - DNA Methylation, histone modifications and Micro-RNAs. Cell Reprogramming – Induction and Maintenance of pluripotency and differentiation of pluripotency into various cell lineages.

Unit IV- Application of Stem Cells **20 Hours**

Application of stem cells in disease management and treatment - Neurodegenerative diseases, autoimmune disease, ocular disease, spinal cord injury, cardiovascular disease, Cancer, diabetes, burns and skin ulcers, muscular dystrophy, cell replacement and gene therapy.

Unit V- Stem Cell Ethics **15 Hours**

Ethical and legal issues in stem cell research and therapy[#]. Regulatory Guidelines from ISSCR (International Society for Stem Cell Research), CLAA (Central Licensing Approving Authority); FDA, National Guidelines for Stem Cell Research (NGSCR) and NAC-SCRT (National Apex Committee for Stem Cell Research and Therapy).

 # -Self-Study Topic

Text books

S. No.	Author	Title	Publisher	Year of Publication
1	Gian Paolo Bagnara, Laura Bonsi&Francesco Alviano	Stem Cells	SocietaEditriceEsculapio	2020
2	Gerd Klein and Patrick Wuchter	Stem Cell Mobilization – Methods and Protocols	Humana	2019
3	Jonathan M. W. Slack	The Science of Stem cells	Wiley Blackwell	2018
4	Jack Collins	Essentials of Stem cell biology	Foster Academics	2017
5	Rob Burgess	Stem Cells – A short course	Wiley Blackwell	2016

Reference books

S. No.	Author	Title	Publisher	Year of Publication
1	Mirna Perez-Moreno	Advances in Stem Cells and their Niches - Epidermal Stem Cell Niche Volume 3	Academic Press Inc	2019
2	Phuc Van Pham and AchimRosemann	Stem Cells in Clinical Applications - Safety, Ethics and Regulations	Springer	2017
3	Ahmed El-Hashash	Developmental and stem cell biology in health and disease	Bentham Science	2017
4	Neil H Riordan P A	Stem Cell therapy – A Rising tide	Zaccheus Entertainment	2017
5	TarikRegad, Thomas Sayers & Robert Rees	Principle of Stem cell Biology and cancer : Future Applications and Therapeutics	Wiley Blackwell	2015

Pedagogy

- Lecture (Chalk and Talk) & Power Point Presentation
- Quiz, Seminar, Assignment & Group Discussion.
- Videos and Animations

Web Links

- https://www.creative-diagnostics.com/stem-cell-epigenetics.htm
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4020242/
- https://maplespub.com/article/OVERVIEW-OF-CURRENT-REGULATORY-PRACTICES-CHALLENGES-GUIDANCE-FOR-REGULATION-OF-STEM-CELLS-AND-STEM-CELL-DERIVED-PRODUCTS-IN-INDIA
- https://stemcells.nih.gov/info/Regenerative_Medicine/2006Chapter1.htm
- https://stemcells.nih.gov/info/2001report/chapter4.htm

MAJOR BASED ELECTIVE – III (A)

BIOENTREPRENEURSHIP

Semester – VI	**BIOENTREPRENEURSHIP**	**Hours/Week - 6**	
Major Based Elective – III (A)		**Credits - 6**	
Course Code – 19UBT6MBE3A		**Internal 25**	**External 75**

Objectives

- To motivate students towards bioentrepreneurship and skill development
- To understand the basic marketing strategies from lab to store
- To expose the students to various technology and their commercialization
- To gain technological and financial knowledge for related to biotechnology

Course Outcomes

On the Successful completion of the course the students would be able to

CO Number	**CO Statement**	**Knowledge Level**
CO 1	Understand the basic concepts in entrepreneurship and marketing strategies related to biotechnology	K1
CO 2	Demonstrate the composting process using various methods	K2
CO 3	Learn apiculture concepts and methods	K3
CO 4	Analyse the techniques and methods in mushroom cultivation	K3
CO 5	Implement an integrated farming system with multiple Components	K3

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	S	S	S	S
CO2	M	M	S	S
CO3	M	S	S	M
CO4	S	S	M	S
CO5	S	S	S	S

S- Strong, M- Medium, L-Low

MAJOR BASED ELECTIVE – III (A)

BIOENTREPRENEURSHIP

Unit I- Introduction to Bioentrepreneurship **18 hours**

Introduction to bioentrepreneurship – basic concepts, marketing strategies, Entrepreneurship Traits and Motivation: Growth of entrepreneurship, steps involved in converting ideas to products – commercialization methods, Growth of entrepreneurship, Funding opportunities, IP and licensing, start-ups in biotechnology. Training, Institution in aid of entrepreneur, Risks and benefit.

Unit II- Compost and Vermicompost **18 hours**

Compost - Purpose of Composting. Decomposition of organics - Aerobic and Anaerobic Digestion. Factors Affecting Composting Process – Carbon – Nitrogen ratio – Moisture - Temperature – Aeration – Surface area – pH. Advantages of application of Organic Fertilizer. Limitations of Composting, Applications. Vermicompost – Earthworm – Biology of Earthworm – Life cycle – Classification – Species Suitable for processing organic wastes. Microbial biomass responsible during the vermicomposting.

Unit III- Apiculture **20 hours**

Introduction to Beekeeping. History of apiculture. Importance of honey bees. Different species of honey bees. Morphology, anatomy, colony organization and life cycle of honey bees. Beekeeping equipment. Beekeeping in India. Benefits of beekeeping. Social behaviour. Queen rearing. Collection and preservation of bee pasture. Seasonal management. Diseases affecting honey bees and their control measures. Handling of bee colonies and manipulation for honey production. Potential market of honey. Economics of beekeeping.

Unit IV- Mushroom cultivation **20 hours**

Mushroom culture – historical background, current status of mushroom culture in India. Nutritional values – cultivation methods; Obtaining a pure culture preparation of spawn; formulation and preparation of composts; spawning, spawn running and cropping; cultivation of paddy straw mushrooms - cultivation of Dhingri (*Pleurotussajorcaju*) medicinal value of mushrooms – Ganoderma, antiviral value, antibacterial, antifungal and antitumour effect. Recipes of mushroom (Mushroom soup, pulav)[#], preservation and packaging of mushrooms – economics of mushroom production.

Unit V- Integrated Farming System (IFS) **14 hours**

Integrated Farming System - introduction, principles, Components of IFS, advantages of IFS, Farming System Research, IFS for Different Agroclimatic Zones, Production and Economics of IFS, Resource Flow – Wetland – Gardenland – Dryland.

#-Self-Study Topics

Text Books

S. No	Author	Title	Publisher	Year of Publication
1	Craig Shimasaki	Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech	Academic Press	2014
2	Matei, Florentina, Zirra, Daniela	Introduction to Biotech Entrepreneurship: From Idea to Business: A European Perspective	Springer	2019
3	R. Gogoi, Y. Rathaiah, T.R. Borah	Mushroom Cultivation Technology	Scientific Publishers	2019
4	Dr. Ashok K. Rathour, Dr. Pawan Kumar 'Bharti', Dr. Jaswant Ray,	Vermitechnology Farmand Fertilizer	Discovery publishing House Pvt Ltd, New Delhi, India.	2020
5	A. Zaman	Integrated Farming System and Agricultural Sustainability	New India Publishing Agency	2019

Reference Books

S. No	Author	Title	Publisher	Year of Publication
1	HeidrunFlaadtCervini, JörgDogwiler	Bio- and MedTech Entrepreneurship From Start-up to Exit	StämpfliVerlag	2020
2	Tavis Lynch	Mushroom Cultivation An Illustrated Guide to Growing Your Own Mushrooms at Home	Quarry Books	2018

3	John Tyler	Essential Guide to Mushroom Cultivation A Definite Guide to Cultivation and Self Use	Independently Published	2019
4	Rhonda Sherman	The Worm Farmer's Handbook Mid- to Large-Scale Vermicomposting for Farms, Businesses, Municipalities, Schools, and Institutions	Chelsea Green Publishing	2018
5	Shawn Jadrnicek, Stephanie Jadrnicek	The Bio-integrated Farm A Revolutionary Permaculture-based System Using Greenhouses, Ponds, Compost Piles, Aquaponics, Chickens, and More	Chelsea Green Publishing	2016

Pedagogy

- Lecture (Chalk and Talk) & Power Point Presentation
- Quiz, Seminar, Assignment & Group Discussion.
- Videos and Animations

Web links

- https://www.nationalbioentrepreneurship.in/
- https://www.acs.edu.au/courses/mushroom-production-86.aspx
- https://onlinecourses.swayam2.ac.in/nos20_ge07/preview
- https://www.youtube.com/watch?v=4nNQEO8ZQR0
- https://agritech.tnau.ac.in/agriculture/agri_majorareas_smmf03.html

MAJOR BASED ELECTIVE – III (B)

DRUG DISCOVERY AND DEVELOPMENT

Semester – VI	**DRUG DISCOVERY AND DEVELOPMENT**	**Hours/Week - 6**	
Major Based Elective – III (B)		**Credits - 6**	
Course Code - 19UBT6MBE3B		**Internal 25**	**External 75**

Objectives

- To study about the Basic techniques, methods and applications involved in Drug Designing.
- To understand the drug metabolism, mechanism of action including its kinetics and the principles of pharmacokinetics.
- To understand about the different regulatory aspects and novel drug delivery systems.

Course Outcomes

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

CO Number	**CO Statement**	**Knowledge Level**
CO 1	Classify drugs based on their source, nature, nomenclature and dosage and routes of administration.	K1
CO 2	Interpret the current approaches of drug discovery with their advantages and limitations.	K2
CO 3	Summarize the fate of drug in the biological system.	K2
CO 4	Interpret the regulatory aspects and stages of drug development.	K3
CO 5	Impart the concepts of novel drug systems.	K3

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	M	M	S	S
CO2	M	M	S	S
CO3	S	S	S	S
CO4	S	S	M	S
CO5	S	M	S	S

S-Strong, M-Medium, L-Low

MAJOR BASED ELECTIVE – III (B)

DRUG DISCOVERY AND DEVELOPMENT

Unit I - General Pharmacology **18 Hours**

Drugs – Definition, sources and nature, types of classification, nomenclature, dosage, dose response curve and LD50. Role of drugs, Drug – Protein interactions and routes of administration. Mechanism of action. Pharmacokinetics and Pharmacodynamics. Protein therapeutics. Drug toxicity - definition, classification. Factors affecting toxicity.

Unit II - Stages in Drug Design **18 Hours**

Target Identification and validation: Drug targets – Membrane Proteins, DNA, RNA and enzymes. Lipinski's rule of five. Lead selection and optimization, drug candidate confirmation. Types of Receptors – Hormone, developmental - protein, carbohydrate and lipid receptors. Biological role and significance of each receptor. Neurotransmitters.

Unit III - ADME PROFILING **18 Hours**

Drug metabolism - Drug metabolizing enzymes and their induction- absorption, bioavailability, distribution, metabolism and Elimination Pathways. Efficacy assessment, Toxicology/safety pharmacology assessment.

Unit IV- Stages of Drug Development **18 Hours**

Drug development- Target identification, Target validation, Lead discovery and Optimization- Role of FDA. #Drug regulatory bodies in India –CDSCO, MHFW, IPC, ICMR, NPPA, The Drugs (Prices Controls) Order,1955. The Indian Patents and Designs, Act 1970, Magic Remedies and Objectionable advertisements Act. Intellectual property rights. Computer aided drug designing (CADD), structure based drug design, QSAR, HTP screening, molecular docking.

Unit V- Novel Drug Delivery Systems **18 Hours**

Novel Drug delivery systems – Carrier based Drug Delivery System, Liposomes, Nanoparticles, Microspheres, Monoclonal antibodies, Niosomes, Resealed erythrocytes as drug carriers. Transdermal Drug Delivery Systems, Sonophoresis, Osmotic drug delivery systems, Microencapsulation.

 # Self Study Topics

Text books

S. No.	Author	Title	Publisher	Year Publication
1	H. L. Sharma and K. K. Sharma	Principles of Pharmacology	Paras Medical Publishers	2017
2	Donald J. Abraham	Burger's Medicinal Chemistry, Drug Discovery and Development	Wiley	2021
3	Sakthivel Lakshmana Prabu, Appavoo Umamaheswari	Computer Applications in Drug Discovery and Development	IGI Global	2018
4	Ansel, H.C.	"Pharmaceutical Dosage Forms and Drug Delivery Systems"	Lippincott Williams and Wilkins	2018
5	Ranabir Chanda, Alugubelli Gopi	Textbook of Novel Drug Delivery System	AITBS Publishers	2019

Reference books

S. No.	Author	Title	Publisher	Year of Publication
1	Laurence Gilman S	"The Pharmacological Basis of Therapeutics"	McGraw-Hill Education / Medical	2017
2	Tom Brody	Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines	Academic Press	2016
3	Donald J. Abraham	Burger's Medicinal Chemistry, Drug Discovery and Development	Wiley	2021
4	John Somberg, Vincent Idemyor, James T. O'Donnell	Drug Discovery and Development, Third Edition	CRC Press	2019
5	Binghe Wang, Longqin Hu, Teruna J. Siahaan	Drug Delivery: Principles and Applications	Wiley Blackwel, 2nd Edition	2016

Pedagogy

Lecture, Power Point Presentation, Assignment, Seminar, Quiz, Group Discussion, Video

Web links

- https://www.fda.gov/patients/drug-development-process/step-1-discovery-and-development https://www.nebiolab.com/drug-discovery-and-development-process/
- https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod15.pdf
- https://nptel.ac.in/courses/102/106/102106070/
- https://www.abdn.ac.uk/study/postgraduate-taught/degree-programmes/55/drug-discovery- and-development/