DEPARTMENT OF BIOTECHNOLOGY

COURSE STRUCTURE & SYLLABI
(For the students admitted from year 2023-2024 onwards)

Programme : B.Sc. Biotechnology

Since 1951

JAMAL MOHAMED COLLEGE (AUTONOMOUS)
Accredited with A++ Grade by NAAC (4th Cycle) with CGPA 3.69 out of 4.0
(Affiliated to Bharathidasan University)
TIRUCHIRAPPALLI – 620 020

B.SC. BIOTECHNOLOGY

Sem	Course Code	Part	Course Category	Course Title	Ins. Hrs/ Week	Credit	Marks		Total
							CIA	ESE	
I	23U1LT1/LA1/ LF1/LH1/LU1	I	Language - I		6	3	25	75	100
	23UCN1LE1	II	English - I	English for Communication - I	6	3	25	75	100
	23UBT1CC1	III	Core - I	Fundamentals of Botany and Zoology	5	5	25	75	100
	23UBT1CC2P		Core - II	Fundamentals of Botany and Zoology - Practical	3	3	20	80	100
	23UBT1AC1		Allied - I	Biochemistry I : General Biochemistry	5	4	25	75	100
	23UBT1AC2P		Allied - II	Biochemistry I : General Biochemistry - Practical	3	2	20	80	100
	23UCN1AE1	IV	AECC - I	Value Education	2	2	-	100	100
				Total	**30**	**22**			**700**
II	23U2LT2/LA2/LF2/ LH2/LU2	I	Language - II		6	3	25	75	100
	23UCN2LE2	II	English - II	English for Communication - II	6	3	25	75	100
	23UBT2CC3	III	Core - III	Cell Biology	6	6	25	75	100
	23UBT2CC4P		Core - IV	Cell Biology - Practical	3	3	20	80	100
	23UBT2AC3		Allied - III	Biochemistry II: Bioenergetics and metabolism	4	4	25	75	100
	23UBT2AC4P		Allied - IV	Biochemistry II: Bioenergetics and metabolism - Practical	3	2	20	80	100
	23UCN2SS	IV	Soft Skills Development	Soft Skills Development	2	2	-	100	100
	23UCN2CO	V	Community Outreach	JAMCROP	-	@	-	-	@
	23U2BT1 / 23U2AT1		Basic Tamil - I / Advanced Tamil - I	எழுத்தும் இலக்கியமும் அறிமுகம் - I / தமிழ் இலக்கியமும் வரலாறும் - I	-	-	-	100 #	-
	@Only grades will be given			**Total**	**30**	**23**			**700**
III	23U3LT3/LA3/LF3/ LH3/LU3	I	Language - III		6	3	25	75	100
	23UCN3LE3	II	English - III	English for Communication - III	6	3	25	75	100
	23UBT3CC5	III	Core - V	Genetics	4	4	25	75	100
	23UBT3CC6P		Core - VI	Genetics - Practical	3	3	20	80	100
	23UBT3AC5		Allied - V	Microbiology I: General Microbiology	4	4	25	75	100
	23UBT3AC6P		Allied - VI	Microbiology I: General Microbiology - Practical	3	2	20	80	100
	23UBT3GE1	IV	Generic Elective - I		2	2	-	100	100
	23UCN3AE2		AECC - II	Environmental Studies	2	2	-	100	100
				Total	**30**	**23**			**800**
IV	23U4LT4/LA4/LF4/ LH4/LU4	I	Language - IV		6	3	25	75	100
	23UCN4LE4	II	English - IV	English for Communication - IV	6	3	25	75	100
	23UBT4CC7	III	Core - VII	Molecular Biology	5	5	25	75	100
	23UBT4CC8P		Core - VIII	Molecular Biology - Practical	3	3	20	80	100
	23UBT4AC7		Allied - VII	Microbiology II: Applied Microbiology	5	4	25	75	100
	23UBT4AC8P		Allied - VIII	Microbiology II: Applied Microbiology - Practical	3	2	20	80	100
	23UBT4GE2	IV	Generic Elective - II		2	2	-	100	100
	23UCN4EL		Experiential Learning	Field Visit	-	2	-	100	100
	23UCN4EA	V	Extension Activities	NCC, NSS, etc.	-	1	-	-	-
	23U4BT2 / 23U4AT2		Basic Tamil - II / Advanced Tamil - II	எழுத்தும் இலக்கியமும் அறிமுகம் - II/ தமிழ் இலக்கியமும் வரலாறும் - II	-	-	-	100 #	-
				Total	**30**	**25**			**800**
V	23UBT5CC9	III	Core - IX	Plant Biotechnology	5	5	25	75	100
	23UBT5CC10		Core - X	Enzymology and Enzyme Technology	5	5	25	75	100
	23UBT5CC11		Core - XI	Immunology and Immunotechnology	5	5	25	75	100
	23UBT5CC12P		Core - XII	Plant Biotechnology, Enzymology and Enzyme Technology, Immunology and Immunotechnology - Practical	6	6	20	80	100
	23UBT5DE1A/B		Discipline Specific Elective - I		5	4	25	75	100
	23UBT5SE1	IV	Skill Enhancement Course - I	Evolution and Developmental Biology	2	1	-	100	100
	23UBT5SE2		Skill Enhancement Course - II	Industrial Fermentations	2	1	-	100	100
	23UBT5EC1		Extra Credit Course - I*	Online Course	-	*	-	-	-
				Total	**30**	**27**			**700**
VI	23UBT6CC13	III	Core - XIII	Animal Biotechnology	5	5	25	75	100
	23UBT6CC14		Core - XIV	Environmental Biotechnology	6	6	25	75	100
	23UBT6CC15P		Core - XV	Animal Biotechnology and Environmental Biotechnology - Practical	6	6	20	80	100
	23UBT6PW		Project Work	Project Work	3	2	-	100	100
	23UBT6DE2A/B		Discipline Specific Elective - II		5	4	25	75	100
	23UBT6DE3A/B		Discipline Specific Elective - III		4	4	25	75	100
	23UCN6AE3	IV	AECC - III	Gender Studies	1	1	-	100	100
	23UBT6EC2		Extra Credit Course - II*	Online Course	-	*	-	-	-
	23UBTECA		Extra Credit Course for all**	Online Course	-	**	-	-	-
	23UCN6ECA1		Extra Credit Course for all+	Entrepreneurship Development	-	+	-	-	-
	*** Programme Specific Online Course for Advanced Learners** **** Any Online Course for Enhancing Additional Skills** **+ Course for Enhancing Entrepreneurial Skills**			**Total**	**30**	**28**			**700**
				Grand Total		**148**			**4400**

GENERIC ELECTIVE COURSES

Semester	Course Code	Course Title
III	23UBT3GE1	Edible Mushroom Cultivation Technology
IV	23UBT4GE2	Biofertilizer and Organic Farming

*** Self-Study Course – Basic and Advanced Tamil**

(Applicable to the candidates admitted from the academic year 2023 -2024 onwards)

Semester	Course Code	Course Title
II	23U2BT1	Basic Tamil – I (எழுத்தும் இலக்கியமும் அறிமுகம் - I)
	23U2AT1	Advanced Tamil – I (தமிழ் இலக்கியமும் வரலாறும் - I)
IV	23U4BT2	Basic Tamil – II (எழுத்தும் இலக்கியமும் அறிமுகம் - II)
	23U4AT2	Advanced Tamil – II (தமிழ் இலக்கியமும் வரலாறும் - II)

Mandatory

Basic Tamil Course - I and II are offered for the students who have not studied Tamil Language in their schools and college.

Advanced Tamil Course - I and II are offered for those who have studied Tamil Language in their schools but have opted for other languages under Part - I.

DISCIPLINE SPECIFIC ELECTIVES

Semester	Course Code	Course Title
V	23UBT5DE1A	Bioinformatics and Biostatistics
	23UBT5DE1B	Pharmacology and Nanomedicine
VI	23UBT6DE2A	Bioanalytical tools
	23UBT6DE2B	Plant and Animal physiology
	23UBT6DE3A	IPR, Biosafety and Bioethics
	23UBT6DE3B	Cancer and Stem Cell Biology

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23UBT1CC1	Core – I	5	5	25	75	100

Course Title	Fundamentals of Botany and Zoology

SYLLABUS

Unit	Contents	Hours
I	**Algae and Fungi:** Algae - General characteristics and economic importance of algae, Algae life cycle (Oscillatoria, Chlorella, Oedogonium and Sargassum). Fungi -General characteristics of Fungi; *Economic importance of Fungi*. Fungal life cycle (Yeast, Plasmodiophora, Puccinia and Cercospora).	**15**
II	**Bryophytes and Pteridophytes:** Bryophytes - General characteristics and economic importance of Bryophytes, Bryophytes life cycle (Funaria and Usnea). Pteridophytes - General characteristics and economic importance of Pteridophytes, *Pteridophytes life cycle (Lycopodium and Marsilea)*.	**15**
III	**Gymnosperms and Angiosperms:** Gymnosperms - General characters and economic importance of Gynosperm (Cycas, Araucaria and Gnetum). Angiosperms - Taxonomy – Classification – Artificial (Linnaeus system) – Natural (Bentham and Hooker's system). Binomial Nomenclature - *Herbarium Preparation*.	**15**
IV	**Animal Diversity:** Outline classification of kingdom Animalia; Study of invertebrates upto class level for Mollusca, Annelida, Echnodermata and Arthropoda. General classification and characteristics of vertebrates: Fishes, amphibians, Reptiles, Aves, *Mammals and minor phyla*.	**15**
V	**Insect Diversity:** Outline of classification of Insects, characters and types; Apis (Honeybee) – Bombyx (Silkworm) – Termites (White ants) – Lepidoptera (Butterfly) and Musca (House fly), Beetle (Rhinoceros), key pest of paddy. Economic importance of insects. *Integrated pest management (IPM)*.	**15**
VI	**Current Trends (For CIA only):** Bio-insecticide and Bio pesticides. Local field visit report and study.	

…… Self Study

Text Book(s):

1. John Merle Coulter, Charles Reid Barnes, Henry Chandler Cowles, A Textbook of Botany for Colleges and Universities: Morphology and physiology, Palala Press, 2018.
2. Cleveland Hickman, Susan Keen, David Eisenhower, Allan Larson, Integrated Principles of Zoology, Mc Graw Hill, 2019.
3. Stephen Miller Todd A. Tupper, Zoology, Mc Graw-Hill Education, 2018

Reference Book(s):

1. Dr. Kunal Sen, Dr. Pranab Giri, Fundamental Botany, Santra Publication, 2022.
2. T Jeffery Parker, William A Haswell, "A Text-Book of Zoology", Vol 1, Alpha Edition, 2019.
3. Renuga Gupta, Fundamental of Zoology, Elite Publishing House, 1st Edition, 2015.

Web Resource(s):

1. https://onlinecourses.nptel.ac.in/noc23_bt25/preview
2. https://onlinecourses.nptel.ac.in/noc20_bt42/preview
3. https://www.classcentral.com/course/swayam-basics-of-biology-58410

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Expand knowledge on the basic concepts of classification of algae and fungi.	K1
CO2	Classify and compare the evolutionary relationship of plants and animals.	K2
CO3	Examine and relate the fundamental knowledge about plants and their classification.	K3
CO4	Comprehend the basic concepts of animal science, classification and behaviour.	K4
CO5	Determine and appraise the conservation strategies for improvement of natural resources.	K5

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	2	2	2	2	2	2.0
CO2	2	1	2	1	2	2	1	2	2	2	1.7
CO3	2	1	1	2	2	2	2	2	2	2	1.8
CO4	2	2	2	3	3	2	2	2	2	2	2.2
CO5	3	2	2	3	3	3	3	3	3	3	2.8
Mean Overall Score											2.1
Correlation											Medium

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. J. Sebastin Raj

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23UBT1CC2P	Core- II	3	3	20	80	100

Course Title	Fundamentals of Botany and Zoology – Practical

SYLLABUS		
S.NO	Contents	Hours
1	Algae: Oscillatoria and Chlorella	45
2	Fungi: Yeast and Plasmodiophora	
3	Lichen: Funaria and Usnea	
4	Bryophytes: Marchantia and Anthoceros	
5	Pteridophytes: Lycopodium, Equisetum and Marsilea.	
6	Gymnosperms: Cycas and Gnetum.	
7	Angiosperm*:* Orchidaceae and Asteraceae	
8	**Study of Vertebrates Specimens: Agnatha**– Hagfishes (Jawless fish), Placodermi (Jawed fish), Chondrichthyes -(Sharks), Osteichthyes (Common carp), Amphibia (Salamander), Reptilia - (Turtle), Aves - (*Phoenicopterus*), Mammalia (*Platypus*)	
9	**Study of Invertebrates Specimens:** Leech, Peripatus, Daphnia, Millipede, Beetle, Octopus, Euglena, Noctiluca, Physalia, Taenia, Ascaris, Nereis.	
10	Dissections/ Virtual Demonstration: Mosquito Mouth Parts; Dissection of Frog	

Text Book(s):

1. John Merle Coulter, Charles Reid Barnes, Henry Chandler Cowles, A Textbook of Botany for Colleges and Universities: Morphology and physiology, Palala Press, 2018.
2. Cleveland Hickman, Susan Keen, David Eisenhower, Allan Larson, Integrated Principles of Zoology, Mc Graw Hill, 2019.
3. Stephen Miller Todd A. Tupper, Zoology, Mc Graw-Hill Education, 2018.

Reference Book(s):

1. Prashant Wagh, Botany Practical Handbook Paperback – February 10, 2019
2. Anand Dede, Handbook of Practical Zoology Paperback – November 5, 2020
3. Allaby, Michael.” The Concise Oxford dictionary of botany”, 1992.
4. M. Ingrowille, Diversity and Evolution of land plants, Chapman and Hall, 2012.
3. T Jeffery Parker, William A Haswell, “A Text-Book of Zoology”, Vol 1, 2012.

Web Resource(s):

1. https://nptel.ac.in/courses/102104068/
2. https://onlinecourses.nptel.ac.in/noc23_bt25/preview
3. https://archive.nptel.ac.in/content/storage2/courses/122103039/pdf/mod1.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Acquire basic knowledge on animal and plant organization.	K1
CO2	Describe the significance of evolutionary relationship of living organisms.	K2
CO3	Apply the knowledge of the concept of biodiversity and its advantages.	K3
CO4	Analyse the status of endangered flora and fauna.	K4
CO5	Assess the importance of biodiversity conservation through field visit to a botanical garden and zoological park.	K5

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	2	2	1	2	3	2.0
CO2	2	2	2	1	2	2	2	2	2	1	1.8
CO3	2	2	2	2	2	2	2	2	3	3	2.2
CO4	3	2	2	2	3	2	2	2	3	3	2.4
CO5	3	2	1	3	3	2	1	2	3	3	2.3
Mean Overall Score											2.3
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. J. Sebastin Raj

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23UBT1AC1	Allied-I	5	4	25	75	100

Course Title	Biochemistry I: General Biochemistry

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Chemical composition of life:** Branches of Biochemistry, Origin& Chemical Composition of Life. Elements of Life- Atoms, Atomic number, atomic weight, Molecules, Chemical Compounds-Isotopes, Electrolytes & Non-Electrolytes. Hydrogen Ion concentration- pH Buffers, Colloids, Diffusion (Passive Transport)- *Osmosis- Surface Tension*.	**15**
II	**Inorganic and organic compounds of Biomolecules:** Historical Survey and Scope of Biochemistry. Inorganic and Organic compounds. Water, Acids, Bases, Salts, Gases, Minerals. Organic Compounds-classification of organic compounds, Major Characteristics of Biomolecules, Carbon as the Main Component of Biomolecules, *Carbon, the backbone of Organic Compounds*. Functional groups of Biomolecules.	**15**
III	**pH and buffer system:** Definition, principle and theories of pH, p^H meter, pH Measurement, Uses of pH meter, pH of Biological Fluids and Tissues, Hydrogen ion concentration, Importance of pH and pH regulations. Buffer system-Definition, mechanism of buffer action, Bicarbonate, Phosphate, Haemoglobin and Protein buffer system, *Significance of Buffers*.	**15**
IV	**Redox reaction:** Redox reaction-Introduction, oxidation, reduction, oxidizing agent, reducing agent, redox reaction, and redox potential. Theories of biological oxidation-Oxygen activation theory, Hydrogen activation theory, Hydrogen acceptors and carriers-Nicotinamide nucleotides, *Flavin nucleotides and the cytochromes*.	**15**
V	**Applications of Biochemistry:** Application of Biochemistry in Agriculture biochemical fertilizers, Medicine - Importance of Enzymes in Medicines, Nutrition-Food Metabolomics, Applications of Biochemistry in Biotechnology, Pharmacology, Microbiology and Environmental Health, aquaculture, *textile industry and poultry*.	**15**
VI	**Current Trends (For CIA only) –** Discovery of novel biomolecule – glycol RNA	

…… Self Study

Text Book(s):

1. Harper's, Illustrated Biochemistry,Victor W. Rodwell , David Bender , Kathleen M. Botham , Peter J. Kennelly , P. Anthony Weil, 31st Edition, 2018.

2. D. Voet and J.G. Voet, "Biochemistry", John Wiley & Son,4th Edition, 2021.

3. Lehninger, Principles of Biochemistry, Nelson& Cox, Macmillan Worth Publishers,8th edition 2021.

Reference Book(s):

1. Robert Haeper's, Biochemistry, Mc Graw Hill, 32nd edition, 2022.

2. Donald Voet, J.G.Voet, John Wiley, Biochemistry, Stryer W.H Freeman. John Wiley P & Publisher Kaye Pace, 8th edition, 2023.

3. A.L.Jain, Essentials of Biochemistrty, S. Chand publications, 7th edition, 2016.

Web Resource(s):

1.https://nptel.ac.in/content/syallabus_pdf/104105040.pdf

2.https://nptel.ac.in/content/storage2/courses/126104004/LectureNotes

3. https://nptel.ac.in/courses/104103121

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Remember the scope of biochemistry	K1
CO2	Illustrate the chemical composition of life	K2
CO3	Identify the inorganic and organic compounds of Biomolecules	K3
CO4	Examine the pH and buffer system of human body	K4
CO5	Evaluate the applications of Biochemistry in various fields	K5

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	3	2	1	1	2	3	2.4
CO2	3	1	2	1	3	2	1	1	2	1	1.7
CO3	3	1	1	2	3	2	2	2	3	3	2.2
CO4	3	1	1	2	3	2	2	2	3	3	2.2
CO5	3	1	1	3	3	2	1	2	3	3	2.2
										Mean Overall Score	**2.14**
										Correlation	**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. T. Nargis Begum

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23UBT1AC2P	Allied-II	3	2	20	80	100

Course Title	Biochemistry I: General Biochemistry - Practical

SYLLABUS		
S.NO	**Contents**	**Hours**
1	General guidelines and laboratory safety measure for working in Biochemistry laboratory	45
2	Units of volume, weight and concentration, measurements and their range in biological measurements	
3	Verification of beer-Lambert's law using colorimeter	
4	Determination of concentration of potassium Dichromate solution	
5	Determination of complementary colours	
6	Determination of pH of acid /base using pH meter	
7	Preparation of percentage solution	
8	Preparation of Normality and Molarity solution	
9	Preparation of phosphate and acetate buffer	
10	Preparation of Tris-Hcl buffer	

Text Book(s):

1. Dr. J. Jayaraman, Manuals in Biochemistry, New Age International Pub, Bangalore, 1st edition, 2011.
2. Dr. S. Sadasivam & A manickam, Biochemical Methods, 3rd edition, 2018
2. Plummer, Practical Biochemistry, New Delhi: Tata Mcgraw Hill Publishing Company, 3nd edition, 2017.
3. Dr. G. Sattanathan, Dr. S.S. Padmapriya, Dr. B. Balamurali Krishnan, Practical Manual of Biochemistry, Skyfox Publishing Group Skyfox Press, 1st edition, 2020.

Reference Book(s):

1. S.Sadasivam,V.A Manickam , Biochemical methods - New Age International Publishers, 3rd edition, 2018.
2. Anil Kumar, Sarika Garg and Neha Garg, Biochemical Tests- Principles and Protocols. Vinod Vasishtha Viva Books Pvt Ltd, 2st edition, 2017.
3. Prem Prakash Gupta, Neelu Gupta, Essentials of Practical Biochemistry, Jaypee Publishers,1st edition, 2017.

Web Resource(s):

1. https://nptel.ac.in/content/storage2/courses/102103044/module/lec1/1.htm
2. https://nptel.ac.in/content/storage2/coureses/102103047/pdf/modl.pdf
3. https://archive.nptel.ac.in/courses/104/105/104105102/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Remember the general guidelines and laboratory safety measure for working in biochemistry laboratory	K1
CO2	Understand the principles of colorimeter	K2
CO3	Apply the laboratory safety measures for working in Biochemistry laboratory	K3
CO4	Analyze the preparation and standardization of various solutions	K4
CO5	Assess the techniques to evaluate biomolecules in human sample	K5

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	3	2	2	1	2	3	2.5
CO2	3	2	2	1	3	2	2	2	2	1	2.0
CO3	3	2	2	2	3	2	2	2	3	3	2.4
CO4	3	2	2	2	3	2	2	2	3	3	2.4
CO5	3	2	1	3	3	2	1	2	3	3	2.3
Mean Overall Score											**2.32**
Correlation											**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. T. Nargis Begum

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23UBT2CC3	Core – III	6	6	25	75	100

Course Title	Cell Biology

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Fundamentals of cell biology, cell cycle and cell division:** History and Discovery of cells, physiological properties of cells, Cell theory, cell biology in 20th century. Different class of cells, Prokaryotic and Eukaryotic Cells, Virus cells, Cell cycle and its regulation; Cell division: mitosis; meiosis, binary fission,*Cell death – Apoptosis and Aging*.	**18**
II	**Cellular membranes, matrices and cytoskeleton**: Trilaminar model, lattice model, fluid mosaic model, Micellar model, chemical composition of membranes; specialization of plasma membrane, function of cell membrane- active and passive transport, extracellular matrices – structure and function; Cytoskeleton – structure and function of microtubules, microfilaments.*Cytoskeletal architecture*.	**18**
III	**Cellular organelles and its function: S**tructure and functions of cytoplasm, ribosomes, endoplasmic reticulum – smooth & rough; golgi complex, Lysosomes, peroxisomes, centrosome, vacuoles, microbodies, Mitochondria – structure and function; plastids, chloroplast – structure and function.*Cell locomotion - cilia and flagella*	**18**
IV	**Nucleus and Chromosomes:** Introduction**,** Structure of the interphase nucleus and function of Nucleus, chemistry of the nucleus and nucleolus; chromosome - structure and function, *Special type of chromosome*.	**18**
V	**Tools and techniques in cell biology:** Microtome, cytochemical staining of cells and tissues, micrometry, Microscopy –Bright field, Dark field, Phase contrast Microscopy – Fluorescent Microscope, Electron microscopy - Scanning Electron Microscope, Atomic Force Microscope.	**18**
VI	**Current Trends (For CIA only) – Cryomicrotomy**	

…… Self Study

Text Book(s):

1. Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell, Molecular Cell Biology, W.H. Freeman and Company, 9th edition, 2021.
2. N.Arumugam, Cell Biology, SARAS Publication, 5rd edition, 2017.
3. Aruna Sarangi, Principles of Cell Biology, Pacific Publication, Delhi, 5rd edition, 2010.

Reference Book(s):

1. T. A. Brown, Introduction to genetics: A molecular approach Garland Science, 2nd Edition. 2016.
2. J. D. Watson Tania, A. Baker, Stephen P. Bell, Michael Levine and Richard Losick. Molecular Biology of the Gene. Benjamin/Cummings Publ. Co., Inc., 7th Edition, 2015.
3. Benjamin Lewin. Genes XI. Jones & Bartlett Learning, 9th Edition, 2011.

Web Resource(s):

1. https://ocw.mit.edu/courses/biology/7-06-cell-biology-spring-2007/
2. https://swayam.gov.in/nd1_noc20_me04/preview
3. https://cellbiology.med.unsw.edu.au

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Remember the basic concepts of cell biology and properties of cells.	K1
CO2	Summarize the cell cycle, Cellular membranes and matrices.	K2
CO3	Identify the sub cellular organelles and describing their structure and functions.	K3
CO4	Analyze and interpret the behaviour of cells in their microenvironment in multi-cellular organisms with emphasis on cell-cell interactions.	K4
CO5	Evaluate the chemical and molecular processes that occur inside cells.	K5

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	2	3	2	2	3	3	2.5
CO2	3	2	2	2	3	2	3	2	2	2	2.3
CO3	3	3	1	1	2	3	1	1	2	1	1.8
CO4	3	3	2	2	3	2	3	1	2	2	2.3
CO5	3	3	2	1	3	2	1	2	2	3	2.2
Mean Overall Score											2.2
Correlation											**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. S. Deborah

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23UBT2CC4P	CORE – IV	3	3	20	80	100

Course Title	Cell Biology - Practical

SYLLABUS		
S.No.	**Contents**	**Hours**
1	Microscopy–Observation of a typical plant (onion peel) and animal cell (Cheek cells with a cotton swab) by Simple and compound microscope	45
2	Measurement of cells using ocular and stage micrometer	
3	Study of structure of cell: Structure observation of Prokaryotic and Eukaryotic cell	
4	Analysis of transverse sections of stem, root and leaf for Parenchyma, Collenchyma and Sclerenchyma cells	
5	Total cell count of WBC and RBC	
6	Differential count of WBC and RBC	
7	Cell Staining and Cytochemical methods-Demonstration of Cellular and sub-cellular	
8	Staining of fresh tissues like Squamous Epithelium/ Ciliated Epithelium	
9	Experiment on Haemin Crystals.	
10	Cell division: Study of different stages of meiosis by temporary / permanent preparation	
11	Cell division: Study of different stages of mitosis by temporary / permanent preparation	
12	Cell division: Binary fission of yeast	

Text Book(s):

1. Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. Molecular Cell Biology, W.H. Freeman and Company, 9th edition, 2021.
2. N. Arumugam, Cell Biology, SARAS Publication, 5rd edition, 2017.
3. Aruna Sarangi, Principles of Cell Biology, Pacific Publication, Delhi, 5rd edition, 2010.
4. KARA WEBER, CYTOLOGY March 13, 2023.
5. Bal Ram Singh and Raj Kumar Practical Techniques in Molecular Biotechnology, Jul 28, 2022

Reference Book(s):

1. P.Gunasekaran. Laboratory Manual in Microbiology.2nd edition, New Age International, 2007.
2. Zsolt Fazekas, Cell Biology Laboratory Manual, 8th edition, university press, 2011.

Web Resource(s):

1. https://www.youtube.com/watch?v=wMgXsrpVrJg
2. https://www.youtube.com/watch?v=k1O9jBHgsxs
3. https://www.youtube.com/watch?v=5V52RzM84TM

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Remember the terms WBC and RBC	K1
CO2	Understand the working principle of Microscopy	K2
CO3	Identify the structure of cells using microscopy and other analytical techniques.	K3
CO4	Discover their skills in the preparation and identification of cell structures and their functions using staining techniques.	K4
CO5	Deduct the Cytochemical methods	K5

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	3	3	2	2	3	3	2.8
CO2	3	2	2	2	3	2	3	2	2	2	2.3
CO3	3	2	2	2	3	3	1	1	2	1	2.0
CO4	3	3	2	2	3	2	3	1	2	2	2.3
CO5	3	3	2	1	3	2	1	2	2	3	2.2
Mean Overall Score											**2.32**
Correlation											**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. S. Deborah

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23UBT2AC3	Allied - III	4	4	25	75	100

Course Title	Biochemistry II: Bioenergetics and metabolism

SYLLABUS

Unit	Contents	Hours
I	**Bioenergetics:** Free energy and entropy changes in biological system, coupling of endergonic and exergonic processes. High energy phosphate compounds -Structure and importance of ATP. Biological oxidation-Enzymes involved in oxidation and reduction- oxidases, dehydrogenases, *Hydro peroxidase and oxygenases*.	12
II	**Mechanism of oxidative phosphorylation:** Introduction of Electron transport chain Components of ETC, Inhibitors of ETC, Oxidative phosphorylation uncouplers, inhibitors, ionophores. *Chemiosmotic theory*.	12
III	**Carbohydrates metabolism**: Introduction, classification of carbohydrates - Monosaccharides, Disaccharides and polysaccharides, Biological functions of carbohydrates. Glycolysis and its energetic, s, oxidation of pyruvate to acetyl CoA, TCA cycle and its energetic, *glycogenesis and glycogenolysis*.	12
IV	**Lipid metabolism: Introduction, classification of lipids-simple, compound and derived lipids.** Biosynthesis of fatty acids,β Oxidation of fatty acids, plasma lipoproteins, *Biological importance of lipids*.	12
V	**Amino acids and Nucleic acid metabolism:** Classification of amino acids, catabolism of amino acids - Deamination, decarboxylation, transamination - Glycogenic and ketogenic amino acids, urea-biosynthesis. *Structure of protein*, Metabolism of purine and pyrimidine nucleotides.	12
VI	**Current Trends (For CIA only) –** Metabolism Research in the fields of diabetes and obesity, Uric acid as an antioxidant.	

…… Self Study

Text Book(s):

1. Harper's, Illustrated Biochemistry,Victor W. Rodwell , David Bender , Kathleen M. Botham , Peter J. Kennelly , P. Anthony Weil, 31st Edition, 2018.
2. D. Voet and J.G. Voet, "Biochemistry", John Wiley & Son,4th Edition, 2021.
3. Lehninger, Principles of Biochemistry, Nelson& Cox, Macmillan Worth Publishers,8th edition 2021.

Reference Book(s):

1. Robert Haeper's, Biochemistry, Mc Graw Hill, 32nd edition, 2022.
2. Donald Voet, J.G.Voet, John Wiley, Biochemistry, Stryer W.H Freeman. John Wiley P & Publisher Kaye Pace, 8th edition, 2023.
3. J.L.Jain, Essentials of Biochemistrty, S. Chand publications, 7th edition, 2016.

Web Resource(s):

1.https://nptel.ac.in/content/syallabus_pdf/104105040.pdf
2.https://nptel.ac.in/content/storage2/courses/126104004/LectureNotes/week-1_06-Carbo.pdf
3. https://archive.nptel.ac.in/content/storage2/courses/104103071/pdf/mod12.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Remember the terms involved in Bioenergetics	K1
CO2	Understand the mechanism of oxidative phosphorylation	K2
CO3	Construct the energy transformation in living system	K3
CO4	Examine the metabolism of carbohydrates	K4
CO5	Examine the adequate exposure in aminoacid and nucleic acid metabolism	K5

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	
CO1	3	3	3	3	3	3	1	1	2	3	2.5
CO2	3	0	2	0	3	2	0	1	2	1	1.4
CO3	3	1	1	3	3	2	2	3	3	3	2.4
CO4	3	1	1	3	3	2	2	2	3	3	2.3
CO5	3	1	1	3	3	2	1	2	3	3	2.2
Mean Overall Score											**2.16**
Correlation											**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. T. Nargis Begum

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23UBT2AC4P	Allied - IV	3	2	20	80	100

Course Title	Biochemistry II: Bioenergetics and Metabolism - Practical

SYLLABUS		
S.NO	Contents	Hours
1	Qualitative tests for carbohydrates	45
2	Qualitative analysis of amino acids	
3	Paper and thin layer chromatography (separation of amino acids)	
4	Column chromatography	
5	Preparation of starch from potato	
6	Preparation of casein from milk	
7	Preparation of albumin from egg	
8	Estimation of reducing sugar by DNS method	
9	Estimation of protein by Lowry's method	
10	Estimation of amino acid by Ninhydrin method	

Text Book(s):

1. Dr. S. Sadasivam & A manickam, Biochemical Methods, 3rd edition, 2018
2. Plummer, Practical Biochemistry, New Delhi: Tata Mcgraw Hill Publishing Company, 3nd edition, 2017.
3. Dr. G. Sattanathan, Dr. S.S. Padmapriya, Dr. B. Balamurali Krishnan, Practical Manual of Biochemistry, Skyfox Publishing Group Skyfox Press, 1st edition, 2020.

Reference Book(s):

1. S.S adasivam, V.A Manickam , Biochemical methods - New Age International Publishers, 3rd edition, 2018.
2. Anil Kumar, Sarika Garg and Neha Garg, Biochemical Tests- Principles and Protocols. Vinod Vasishtha Viva Books Pvt Ltd, 2st edition, 2017.
3. Prem Prakash Gupta, Neelu Gupta, Essentials of Practical Biochemistry, Jaypee Publishers,1st edition, 2017.

1. https://nptel.ac.in/content/storage2/courses/102103044/module/lec1/1.htm
2. https://nptel.ac.in/content/storage2/coureses/102103047/pdf/modl.pdf
3. https://archive.nptel.ac.in/courses/104/105/104105102/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Remember the basic terms involved in separation and purification techniques.	K1
CO2	Understand the working principles of TLC and Column chromatography	K2
CO3	Experiment with the qualitative analysis of carbohydrates, aminoacids and lipids.	K3
CO4	Analyze and isolate amino acid using chromatographic techniques.	K4
CO5	Estimate the carbohydrate, protein and amino acids in different food samples	K5

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	3	2	2	1	2	3	2.5
CO2	3	2	2	1	3	2	2	2	2	1	2.0
CO3	3	2	2	2	3	2	2	2	3	3	2.4
CO4	3	2	2	2	3	2	2	2	3	3	2.4
CO5	3	2	1	3	3	2	1	2	3	3	2.3
Mean Overall Score											2.3
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. T. Nargis Begum

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23UBT3CC5	Core – V	4	4	25	75	100
Course Title	GENETICS						

SYLLABUS		
UNIT	**CONTENTS**	**HOURS**
I	**Introduction to Genetics:** Introduction and brief history of genetics -Mendel's Law of inheritance - Mono and Dihybrid cross, Tri and Poly hybrid crosses, Incomplete dominance, Back cross, Test cross, Phenotype and Genotype; Interaction of Genes– Complementary factors, supplementary factors, inhibitory and lethal factors, *Multiple Alleles in *Drosophila**.	**12**
II	**Experimental evidence for DNA as the genetic material**: Chromosome organization, fine structure of gene, structure of Prokaryotic and Eukaryotic gene, maternal inheritance - cytoplasmic genetic systems- mitochondria and chloroplast DNA, genetics of bacteria and viruses- conjugation, transduction, transformation *bacterial viruses*	**12**
III	**Linkage and Crossing Over**: Introduction, Coupling and repulsion hypothesis, Linkage in maize and Drosophila – Morgan's experiments, theories of linkage, factors affecting linkage, Mechanism of crossing over and its importance. Types, and mechanisms, Cytological evidence for crossing over and significance. *Sex determination in plants and animals*.	**12**
IV	**Transposon and transposable elements:** IS elements, composite transposons- Tn5- Tn9- Tn10 elements- eukaryotes, Ac and Ds elements in mice, P elements in Drosophila. *Genetic and evolutionary significance of transposable elements*.	**12**
V	**Human Genetics:** Karyotype in man, inherited disorders – Allosomal (Klinefelter syndrome and Turner's syndrome) and Autosomal (Down syndrome and Cri-Du-Chat Syndrome). Population genetics: Single and multi-locus inheritance and Hardy-Weinberg principle, genetic drift and natural selection. *Mutations in plants, animals and microbes for economic benefit of man.*	**12**
VI	Current Trends (For CIA only): Molecular diagnostics of hereditary metabolic disorders, mitochondrial mutations that lead to cancer	

***…….* Self-study**

Text Books:

1. T.A. Brown, Genetics. A Molecular Approach, Chapman Hall, London, 2010.
2. E.J. Gardner, M.J. Simmons, and D.P. Snusted. Principles of Genetics, John Wiley and Sons, New York, 2001.
3. J.W. Saunders. Developmental Biology – Patterns and Principles, Macmillan, New York, 2005.

Books for Reference:

1. M.W. Strick Berger. Genetics, Macmillan publishing Co., New York, 2008.
2. P.S. Verma and V.K. Agarwal. Genetics, S. Chand & Company Ltd, New Delhi, 2003.
3. R.F. Weaver and, P.W. Hedrick. Genetics, W.M.C. Brown Publishers, London, 2005.
4. P.Hotter. Textbook of Genetics, IVY Publishing House, New Delhi, 2002.
5. W.S. Klug, M.R. Cummings, C.A. Spencer and M.A. Palladino. Concepts of Genetics, 10th Edition, Pearson International Publishers, 2015.

Web Source:
1. https://nptel.ac.in/courses/102/104/102104052/ 2. https://swayam.gov.in/nd1_noc20_bt06/preview 3. https://swayam.gov.in/nd2_cec20_bt06/preview

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO NO.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Illustrate the basic knowledge in genetics and Mendelian theory	K3
CO2	Analyse evidence for DNA as a genetic material	K4
CO3	Explain about the linkage and crossing over in genetics studies of living organisms.	K5
CO4	Develop skills associated with transposons and transposable elements	K5
CO5	Explain about Human Genetics and its inherited disorders	K6

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	3	3	2	3	3	3	2.8
CO2	3	2	3	2	2	2	2	2	3	2	2.3
CO3	2	3	2	3	3	2	2	3	3	2	2.5
CO4	2	3	2	3	2	2	2	3	2	3	2.4
CO5	3	3	2	3	2	3	2	2	3	2	2.5
									Mean Overall Score		**2.5**
									Correlation		**High**

Mean Overall Score	**Correlation**
<1.5	**Low**
>-1.5 and <2.5	**Medium**
>-2.5	**High**

Course Coordinator: Dr. R. Shalini

Semester	Course Code	Course Category	Hours/Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23UBT3CC6P	Core – VI	3	2	80	20	100
Course Title	GENETICS – PRACTICAL						

SYLLABUS		
S. No	Contents	Hours
1.	Watson and Crick double helical DNA model.	45
2.	Linkage Mapping	
3.	Use of micrometer and calibration	
4.	Study of divisional stages in mitosis from onion root tips	
5.	Study of divisional stages in meiosis in grasshopper testes/or Rhoeo flower buds.	
6.	Karyotype analysis - Human and Onion	
7.	Experiments to determine Mendel's law.	
8.	Extraction of human genomic DNA from saliva.	
9.	Human Karyotypes: Normal, Down's, Klinefelters and Turner's syndrome.	
10.	Sex chromatin (buccal smear) identification.	
11.	Isolation and display of polytene chromosomes	

Text Books:

1. T.A. Brown, Genetics. A Molecular Approach, Chapman Hall, London, 2005.
2. E.J. Gardner, M.J. Simmons, and D.P. Snusted. Principles of Genetics, John Wiley and Sons, New York, 2005.
3. J.W. Saunders. Developmental Biology – Patterns and Principles, Macmillan, New York, 2001.

Books for Reference:

1. M.W. Strickberger. Genetics, Macmillan publishing Co., New York, 2008.
2. P.S. Verma and V.K. Agarwal. Genetics, S. Chand & Company Ltd, New Delhi, 2003.
3. R.F. Weaver and, P.W. Hedrick. Genetics, W.M.C. Brown Publishers, London, 2001.
4. Weaver R.F. and Hedrick PW. Genetics, 3rd Edition, W.M.C. Brown Publishers, London, 2004.
5. P. Hotter. Textbook of Genetics, IVY Publishing House, New Delhi, 2002.
6. W.S. Klug, M.R. Cummings, C.A. Spencer and M.A. Palladino. Concepts of Genetics, 9th Edition, Pearson International Publishers, 2009.

Web Source:

1. https://nptel.ac.in/courses/102/104/102104052/
2. https://swayam.gov.in/nd2_cec20_bt17/preview

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO NO.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Acquire knowledge about the tools used for genetic analysis -Micro-meter calibration.	**K2**
CO2	Explicate about the detailed processes of cell division.	**K4**
CO3	Illustrate Mendel's Law through practical experiments.	**K4**
CO4	Explore the techniques for isolation of human genomic DNA from saliva.	**K5**
CO5	Expertise in techniques for Sex chromatin identification from buccal smear and use in various applications.	**K5**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	3	3	2	3	3	3	2.8
CO2	3	2	3	2	2	2	2	2	3	2	2.3
CO3	2	3	2	3	3	2	2	3	3	2	2.5
CO4	2	3	2	3	2	2	2	3	2	3	2.4
CO5	3	3	2	3	2	3	2	2	3	2	2.5
									Mean Overall Score		**2.5**
									Correlation		**High**

Mean Overall Score	Correlation
<1.5	**Low**
>-1.5 and <2.5	**Medium**
>-2.5	**High**

Course Coordinator: Dr. R. Shalini

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23UBT3AC5	**Allied – V**	4	4	25	75	100
Course Title	**Microbiology I: General Microbiology**						

SYLLABUS		
Unit	**Contents**	**Hours**
I	**History and Classification:** History of Microbiology, Concepts of Domain: Haeckel's three kingdom, * Whittaker's five kingdom*, Cavalier-Smith's six kingdom and outline of Bergey's Manual of Systematic Bacteriology. Early development of Virology, Nomenclature and Taxonomy of Eukaryotic viruses, Principles of virus taxonomy. Classification of Fungi (Alexopoulos).	**12**
II	**Structure and Organization:** Overview of Prokaryotic & Eukaryotic cell structure - Inclusion bodies – Endospores - Cell wall – Flagella & Pili – Glycocalyx. General properties of viruses, Structure of viruses, Capsids, Viruses with capsids of complex symmetry, viral envelopes, Classification of Bacterial and Archaeal viruses.	**12**
III	**Cultivation of Bacteria and Virus:** Basic sterilization techniques- wet heat (autoclaving), dry heat- flaming, baking, filtration, disinfection and radiation, gas sterilization. Macronutrients and micronutrients, nutritional types of microorganisms and growth factors. Culture media - chemical and physical types; functional types; *Isolation of pure culture*; Growth curve and Mathematics of Growth; Measurement of microbial growth – cell number and cell mass. Factors affecting growth. Cultivation of viruses, Virus purification and assays.	**12**
IV	**Bacterial / Viral Detection & Antimicrobial agents: Staining techniques:** Antimicrobial Susceptibility Testing – Kirby-Bauer method, Multidrug-resistant organisms. Viral Serological assay, Nucleic Acid Amplification Tests (NAATs), and Immunofluorescence Assay. *Antibacterial drug: penicillin and cephalosporin*. Antiviral drug: Acyclovir and Tamiflu. Antimicrobial chemotherapy – Tests for sensitivity to antimicrobial agents**.** Acid-Fast Staining, Capsule Staining and Flagella Staining,	**12**
V	**Disease and Treatment:** Airborne diseases – Bacterial diseases- Diphtheria and Mycobacterium tuberculosis; Food-borne and waterborne diseases – Typhoid Fever, Staphylococcal Food Poisoning, Cholera and Botulism; Viral diseases- Influenza (Flu), AIDS; Viroids and virusoids; prion diseases. *Control of Microorganisms*	**12**
VI	**Current Trends (For CIA only):** Dimethyl sulfonic propionate and its catabolites are important chemical signals mediating marine microbial interactions.	

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Text Book(s):

1. M. Joanne, Willey, M. Linda, Sherwood and J. Christopher, Woolverton, Prescott, Harley, and Klein's Microbiology, 7th edition, McGraw Hill, Colin Wheatley/Janice Roerig-Blong, 2008.
2. Stuart Hogg, Essential Microbiology, John Wiley & Sons, Ltd, 2005.
3. Uma Shankar Singh and Kiran Kapoor, Microbial Biotechnology, Oxford Book Company, 2010

Reference Book(s):
4. J.M. Pelczar, E.C.S. Chan, and N.R. Krieg, Microbiology, 5th Edition Tata McGraw Hill Publishing Company, 2006. 5. R. Anantha Narayanan and C.K.J. Panikar, 6th Edition, General Microbiology, Orient Longman Pvt. Ltd., 2002.
Web Resource(s):
1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1182391/* 2. https://nptel.ac.in/courses/102103015/* 3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6428495/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Develop an understanding on the different aspects of Bacteria, fungi, Virus and its history.	K2
CO2	Relate, identify and discriminate among Prokaryotic and Eukaryotic organisms.	K4
CO3	Classify the properties, structure and cultivation of Bacteria and Virus.	K5
CO4	Gain expertise in the handling of bacteria and viruses and detecting their presence through various tests.	K5
CO5	Examine the different aspects of viral, bacterial diseases and research findings in the areas of Bioinformatics in microbial technology	K5

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcome (PSOs)**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	2	2	2	2	2	2.0
CO2	2	1	2	1	2	2	1	2	2	2	1.7
CO3	2	1	1	2	2	2	2	2	2	2	1.8
CO4	2	2	2	3	3	2	2	2	2	2	2.2
CO5	3	2	2	3	3	3	3	3	3	3	2.8
										Mean Overall Score	**2.1**
										Correlation	**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: M .Habibunisha

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23UBT3AC6P	Allied – VI	3	2	20	80	100

Course Title	Microbiology I: General Microbiology – Practical

SYLLABUS

S.No	Contents	Hours
1	Basic Sterilization techniques used in the Microbiology lab.	45
2	Media preparation: Liquid media, Solid media, Agar slants, Agar Plates.	
3	Cultural characteristics of microorganisms: Growth on different media, growth characteristics and description	
4	Isolation & Enumeration of Microorganism from air.	
5	Isolation & Enumeration of Microorganism from water and soil.	
6	Pure culture techniques - Pour plate; Spread plate, Streak plate.	
7	Staining Techniques – Gram's staining, Negative staining, Spore's staining	
8	Motility - Hanging drop method	
9	Biochemical characterization of microorganisms – carbohydrate utilization and IMViC tests, catalase and oxidase test.	
10	Measurement of Growth – Spectrophotometry	
11	Isolation of Bacteriophage (that infect *E. coli*) from sewage.	
12	Quantitation of phage in sewage sample by phage plaque Assay.	
13	Demonstration of mechanical transfer of viruses in plants by sap inoculation.	
14	Study of virus infected plant samples.	

Text Book(s):

1. Cappuccino and Sherman. Microbiology – A Laboratory Manual. 7th Edition, Dorling Kindersley (India) Pvt. Ltd., New Delhi. 2012.
2. P. Gunasekaran, Laboratory Manual in Microbiology, New Age International (P) Ltd. Publishers, New Delhi. 2008.

Reference Book(s):

1. 1. W. Harry, J.R. Seeley, J. Paul, Van Demark and John J Lee, Microbes in Action – A Laboratory Manual of Microbiology. W.H.Freeman and Company, New York. 1997.
2. Kanika Sharma. Manual of Microbiology – Tools and Techniques.2nd edition, Ane Books Pvt. Ltd., New Delhi. 2009.

Web Resource(s):

1. https://microbiologysociety.org/static/uploaded/23cbf9c5-f8c8-4f91-b092a4ad819e6357.pdf
2. https://cevre.erciyes.edu.tr/upload/M6Z30UUmicrobiology-laboratory-manual.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Describe the basic principles of sterilization and media preparation.	K1
CO2	Differentiate organisms based on structural and biochemical properties.	K2
CO3	Develop skills associated with isolating and enumerating microorganisms from various sources.	K4
CO4	Evaluate the current understanding of Bacteria and Viruses and their related applications in industry.	K5
CO5	Explicate knowledge and skills gained in this course to be useful in further research.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	2	2	1	2	3	2.0
CO2	2	2	2	1	2	2	2	2	2	1	1.8
CO3	2	2	2	2	2	2	2	2	3	3	2.2
CO4	3	2	2	2	3	2	2	2	3	3	2.4
CO5	3	2	1	3	3	2	1	2	3	3	2.3
Mean Overall Score											**2.3**
Correlation											**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. M. Habibunisha

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23UBT3GE1	Generic Elective - I	2	2	-	100	100

Course Title	EDIBLE MUSHROOM CULTIVATION TECHNOLOGY

SYLLABUS

Unit	Contents	Hours
I	**Introduction** - History - scope of edible mushroom cultivation - Types of edible wild and poisonous mushrooms available in Tamil Nadu and India, widely cultivated varieties in Tamil Nadu- structure and characteristics features of *Pleurotus citrinopileatus* and *Agaricus bisporus.* *Magic mushroom and its chemical properties*.	6
II	**Pure culture** – Substrates used for mushroom cultivation- Preparation of medium (PDA and Oatmeal agar medium) sterilization - preparation of test tube slants to store mother culture – culturing of *Pleurotus* mycelium on Petriplates, *preparation of mother spawn in saline bottle and polypropylene bag and their multiplication*.	6
III	**Cultivation Technology**: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Mushroom bed preparation - paddy straw, sugarcane trash, marine straw and banana leaves. *Factors affecting the mushroom bed preparation - Low cost technology*.	6
IV	**Storage and nutrition**: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - *Vitamins*.	6
V	**Food Preparation:** Types of foods prepared from mushroom; Soup, Cutlet, Omelette, Samosa, Pickles, Curry. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, *Export Value*.	6

***……..* Self-study**

Text Books:

1. T. Marimuthu, A.S. Krishnamoorthy, K. Sivaprakasam, and R. Jayarajan. Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore, 2001.
2. M. Swaminathan. Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore, 2005

Reference Book(s):

1. Tewari and S.C. Pankaj Kapoor. Mushroom cultivation, Mittal Publications, Delhi. 2001.
2. Nita Bahl. Hand book of Mushrooms, II Edition, Vol. I &Vol.II. 1984-1988.

Web Resource(s):

1. https://swayam.gov.in/nd2_cec19_ag03/preview
2. https://sites.google.com/site/bscmicrobiologycbcs/microbiology-courses-in-swayam-portal

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Analyse the commercial importance of edible mushroom cultivation.	K4
CO2	Assess the medicinal and nutritional value of mushroom.	K5
CO3	Determine the marketing value and research findings of mushroom cultivation technology.	K5
CO4	Gain understanding on the different source of raw material for aseptic cultivation and mass production of mushroom.	K6
CO5	Identify and discriminate edible mushroom from poisons.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	3	3	2	1	3	3	2.4
CO2	3	3	3	3	3	2	3	0	3	3	2.3
CO3	3	3	3	2	3	2	2	3	3	3	2.8
CO4	3	3	3	3	2	2	2	3	3	3	3.0
CO5	3	3	2	2	3	2	0	3	3	3	2.6
Mean Overall Score											2.62
Correlation											**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. K. Gobalan

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23UBT4CC7	Core – VII	5	5	25	75	100

Course Title	MOLECULAR BIOLOGY

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Basic concepts of genome and its organisation:** Nucleic acid as the genetic material (Griffith's experiment), central dogma of Molecular Biology, Structure and functions of Nucleic acids: Nucleosides & Nucleotides, purines and pyrimidines. Watson and Crick model of DNA structure, types of DNA, denaturation and renaturation of DNA, melting temperature (Tm), *hyperchromic effect*	**15**
II	**Replication and transcription in eukaryotes and prokaryotes**: Semi-conservative replication, coding and non-coding DNA, satellite DNA, junk DNA, palindromes; supercoiling of bacterial DNA, topoisomerases and DNA Gyrase, Gene as the unit of expression- *Co linearity*, Transcription in prokaryotes and eukaryotes, post transcriptional modifications (mRNA, tRNA, rRNA).	**15**
III	**Gene expression and regulation-** Genetic code and Wobble hypothesis. Translation: promoter structure and functions. Components of Protein synthesis machinery: mRNA, tRNA structure and function, ribosome structure and assembly , protein synthesis- Initiation, elongation, termination (prokaryotes & eukaryotes) and *post translational modifications*. Principles of gene regulation- negative and positive regulation, Regulation of gene expression in bacteria : operon concept (lac operon, arabinose and trp operon)	**15**
IV	**DNA damage and repair mechanisms-** Mutation and genetic analysis of mutants: Mutation definition, types of mutations, Spontaneous and induced, Mutagens: physical and chemical, isolation of mutants and mutagenesis. DNA damage and repair mechanism: Photo reactivation, direct repair of nicks, excision repair, mismatch repair, recombination repair, *****SOS repair, double strand repair*****.	**15**
V	**Introduction to genetic recombination:** Introduction to Restriction/Modification of DNA, ligation, Cloning Vectors, PCR and DNA sequencing techniques ***** Blotting techniques – Southern, Northern, Western *****	**15**
VI	**Current Trends (For CIA only) –** Nucleic acid chip analysis, genetic manipulation and genetic engineering approval committee regulations.	

***…….* Self-study**

Text Book(s):

1. David P. Clark, Nanette J. Pazdernik, Michelle R. McGehee Molecular Biology, 3rd Edition, 2018.
2. A. Lizabeth, Allison, Fundamental Molecular Biology, Blackwell Publishing, 3rd Edition, 2021.
3. W. D.Jeremy and Malcom von Schantz, From Genes to Genomes: Concepts and Applications of DNA Technology, John Wiley & Sons, Ltd. 2011.

Reference Book(s):

1. T.A. Brown, Gene cloning and DNA analysis: an Introduction. John Wiley & Sons. 2016.
2. S.B. Primrose and R.M. Twyman, Principles of gene manipulation and genomics. 2016.
3. James. D. Watson Recombinant DNA technology, 2nd edition, WH Freeman and company, New York, 2001.
4. V.A Saunders, Microbial Genetics Applied to Biotechnology: Principles and Techniques of Gene Transfer and Manipulation. Springer Science & Business Media. 2012.
5. D. Freifelder, Molecular Biology, 2nd Edition, Jones and Bartlett Publishers, USA. 2004.

Web Resource(s): 1

1. https://geneticscertificate.stanford.edu/courses/genetic-engineering-and-biotechnology
2. https://genomebiology.biomedcentral.com/articles/10.1186/s13059-018-1586-y
3. SWAYAM - Genetic Engineering: Theory And Application By Prof. Vishal Trivedi | IIT Guwahati in the current MOOCs course
4. NPTEL Certification course - Gene Therapy by Sachin Kumar https://nptel.ac.in/courses/102/103/102103041/

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apprehend the genetic makeup of an organism, their structural organisation and functions.	K4
CO2	Appraise about the mechanism of action of genes and how they are involved in regulating biological functions.	K4
CO3	Arrange and apply the tools of genetic manipulation, types of vectors and gene transfer techniques.	K5
CO4	Analyse the mechanisms associated with regulation of gene expression at the level of transcription and translation.	K6
CO5	Explain and employ the techniques involved in amplification and sequencing of genes and genomes.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	1	3	3	2	3	2	2	3	2.5
CO2	3	3	1	3	2	3	3	2	3	3	2.6
CO3	3	2	1	3	2	3	3	3	3	2	2.5
CO4	3	3	2	3	2	3	3	3	3	3	2.8
CO5	3	3	1	3	2	3	3	2	3	2	2.5
Mean Overall Score											**2.5**
Correlation											**High**

Course Coordinator: Ms. S. Geet Andrea

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23UBT4CC8P	Core – VIII	3	3	20	80	100

Course Title	MOLECULAR BIOLOGY - PRACTICAL

SYLLABUS		
S.NO	**Contents**	**Hours**
1.	Isolation of genomic DNA from *E. coli.*	**45**
2.	Isolation of plasmid DNA from *E. coli.*	
3.	Analysis of genomic DNA by agarose gel electrophoresis.	
4.	DNA extraction from agarose gel.	
5.	Restriction digestion and ligation of DNA.	
6.	Transformation.	
7.	Selection / screening of transformants - Blue White screening.	
8.	Primer designing- demonstration	
9.	Amplification of DNA by Polymerase Chain reaction (PCR)	
10.	Western Blotting	

Text Book(s):

1. Joseph Sambrook, Michael R Green, Molecular cloning: A Laboratory Manual by. Cold Spring Harbor publication. 2015.
2. J. Saxena, M. Baunthiyal, I. Ravi, Laboratory Manual of Microbiology, Biochemistry and Molecular Biology, Scientific Publishers. 2012.
3. James G. Cappuccino and Natalie Sherman. Microbiology: A laboratory Manual, Benjamin Cummings, 10 th Edition 2013.

Reference Book(s):

1. B. John, Laboratory manual for Genetic Engineering, PHI Learning publication. 2010.
2. Ashok Kumar,Molecular Biology and Recombinant DNA Technology: A Practical Book. Narendra Publishing House. 2011.
3. K. V. Chaitanya, Cell and Molecular biology : A Lab Manual – 1st edition, 2013.
4. Hans Bisswanger, Practical EnzymologyWiley-VCH Verlag GmbH & Co, Second Edition. 2012.
5. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten, Molecular Biotechnology- principles and applications of Recombinant DNA, 4 th edition, ASM press, Washington DC, 2010.

Web Resource(s):

1. https://nptel.ac.in/content/storage2/courses/102103044/module/lec1/1.htm
2. https://nptel.ac.in/content/storage2/coureses/102103047/pdf/modl.pdf
3. https://archive.nptel.ac.in/courses/104/105/104105102/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Comprehend the skills involved in isolation of genomic and plasmid DNA.	**K3**
CO2	Compare the development skills associated with isolation, restriction and ligation of the isolated DNA	**K4**
CO3	Experiment the bacterial transformation techniques by suitable principle and protocols.	**K4**
CO4	Acquire skills on selection of recombinants and analysis of cloned genes by sequencing methods.	**K5**
CO5	Explain the principles and applications of Polymerase Chain Reaction (PCR).	**K5**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	3	1	3	2	3	2	2.5
CO2	3	3	2	3	2	2	2	2	2	2	2.3
CO3	3	3	2	3	2	2	2	3	3	3	2.6
CO4	3	3	1	3	2	3	3	2	3	3	2.6
CO5	3	3	3	3	2	2	2	2	2	2	2.4
									Mean Overall Score		**2.4**
									Correlation		**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. S. Geet Andrea

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23UBT4AC7	Allied – VII	5	4	25	75	100

COURSE TITLE	MICROBIOLOGY II: APPLIED MICROBIOLOGY

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Soil Microbiology**: Introduction to soil microorganisms – bacteria, algae, fungi, protozoans, nematodes and viruses. Role of microorganisms in biogeochemical cycling - carbon cycle, nitrogen cycle and sulphur cycle. Organic and inorganic nutrients in soil - phosphorous uptake, *nitrogen fixation*, bio fertilizers – definition, importance – types and their application methods. Environmental factors such as pH, temperature, and how land management practices influence the composition.	15
II	**Food Microbiology**: Food as a substrate for microorganisms – microorganisms important in food microbiology: Molds, Yeasts and Bacteria. Principles and methods of food preservation - high temperature, low temperature, drying, *Irradiation and chemical preservatives*. Spoilage of fruits, vegetables, meat, poultry, fish and sea food. Microbes as foods - SCP production.	15
III	**Industrial Microbiology**: Industrial products derived from microbes: Production of yeast, ethyl alcohol, beer and vinegar. Citric acid production, lactic acid production. Production of antibiotic – Penicillin and Streptomycin, Vitamin production – Riboflavin, *Vitamin C and vitamin B12, absorption and bioavailability of vitamins*. Role of microbes in biogas production, Petroleum Industry and Mining.	15
IV	**Clinical Microbiology**: Epidemiology of infectious diseases, Hospital acquired infections, Infections of various organs and systems of the human body, Rapid diagnostic techniques for microbial diseases, Vaccinology: principle, methods of preparation, administration of vaccines, Biological warfare. *Multidrug- Resistant Pathogens*.	15
V	**Pharmaceutical microbiology**: Key challenges and opportunities facing the pharmaceutical industry - Probiotics and neutraceuticals – economic and legal considerations in pharmaceutical biotechnology, advantages and disadvantages. Chemical and physicochemical deterioration of pharmaceuticals, Preservation of medicines using antimicrobial agents. Types of sterile pharmaceutical products. * Quality control and quality assurance of sterile products*.	15
VI	**Current Trends (For CIA only) –** Personalized Microbiome Medicine	

***.....*Self Study**

Text Book(s):

1. Moshrafuddin Ahmed, Basumatary S.K., Applied Microbiology, MJP Publishers, 2006.
2. Lansing M Prescott, John P Harley and Donald A Klein, Microbiology, 7th Edition, McGraw Hill Publishers, New York, 2007.
3. A. H. Patel, Industrial Microbiology, Lakshmi publications, New Delhi, 2005.

Reference Book(s):

1. David Greenwood, Richard C.B. Slack and John. F. Peutherer; Medical Microbiology, 7th Edition, Elsevier India Private Ltd., New Delhi,2008.
2. Bernard R. Glick and Jack J. Pasternak. Molecular Biotechnology. Indian edition. Panima Publishing Corporation. 2002
3. R. Y. Stainer, J. L. Ingra Ham, M. L. Wheelis and P. R. Painter. General Microbiology. Macmillan, 1992.
4. Hugo and Russells, Pharmaceutical Microbiology, edited by Stephen P. Denyer, Norman A. Hodges, Sean P. Gorman, Brendan F. Gilmore, 8th edition, Wiley-Blackwell publications, 2008.

Web Resource(s):

1. https://link.springer.com/book/10.1007/0-306-46888-3
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1529671/

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Describe the basics of soil microbes and their role in biogeochemical cycle.	K2
CO2	Discuss the domains of microbiology and their applications in various industries.	K3
CO3	Evaluate methods of microbial control and apply the proper methods necessary in a given scenario.	K5
CO4	Explain about the medical and practical uses of microorganisms for the production of pharmaceutical products.	K4
CO5	Employ basic laboratory skills for research in microbiology using scientific methods to explore natural phenomena.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	3	2	1	1	2	3	2.4
CO2	3	1	2	1	3	2	1	1	2	1	1.7
CO3	3	1	1	2	3	2	2	2	3	3	2.2
CO4	3	1	1	2	3	2	2	2	3	3	2.2
CO5	3	1	1	3	3	2	1	2	3	3	2.2
Mean Overall Score											2.14
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. M. Habibunisha

Semester	Course Code	Course Category	Hours/ WeeK	Credits	Marks for Evaluation		
					CIA	ESE	TOTAL
IV	23UBT4AC8P	ALLIED – VIII	3	2	20	80	100
Course Title	MICROBIOLOGY II: APPLIED MICROBIOLOGY – PRACTICAL						

SYLLABUS		
S.NO	Contents	Hours
1	Isolation of VAM from the soil.	45
2	Study of Rhizobium from legume root nodules.	
3	Isolation and identification of SCP	
4	Isolation and identification of Actinomycetes.	
5	Isolation and identification of bacteria and fungi from vegetables.	
6	Isolation of lactic acid bacteria from curd.	
7	Isolation of probiotic bacteria from Old rice.	
8	Detection of Bacteria in milk by Methylene blue reductase test.	
9	Detection of Bacteria in milk by Phosphatase test.	
10	Antibiotic sensitivity test: Kirby Bauer's method.	
11	Antifungal tests.	
12	Media formulation.	
13	Wine production by yeast.	
14	Yeast Production	
15	Isolation and identification of enzyme producing micro-organisms from soil - (Amylase, Protease, Lipase).	

Text Book(s):

1. James G. Cappuccino and Natalie Sherman. Microbiology: A laboratory Manual. 10th Edition. Benjamin Cummings. 2013.
2. R. H. Baltz, A. L. Demain and J. E. Davies, Manual of Industrial Microbiology and Biotechnology, 3rd edition, ASM Publishers, 2010.

Reference Book(s):

1. K.R. Aneja., Laboratory Manual of Microbiology & Biotechnology, 2nd edition, Scientific International Pvt. Ltd, New Delhi, 2013.
2.Charles Welsh, James Cappucino, Microbiology a lab maual, 2018, 12th edition

Web Resource(s):

1. https://www.tandfonline.com/doi/full/10.1080/21553769.2015
2. https://microbiologyonline.org/file/7926d7789d8a2f7b207.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Describe the versatile techniques in applied microbiology based practical.	K3
CO2	Employ the designing and conducting experiments involving microbes.	K3
CO3	Analyse the safe methods for isolation of bacteria, fungi and determination of their antibacterial and antifungal activity.	K4
CO4	Construct the application of microbes in industries.	K5
CO5	Formulate the technical skills necessary to support microbiology research study	K5

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	3	2	2	1	2	3	2.5
CO2	3	2	2	1	3	2	2	2	2	1	2.0
CO3	3	2	2	2	3	2	2	2	3	3	2.4
CO4	3	2	2	2	3	2	2	2	3	3	2.4
CO5	3	2	1	3	3	2	1	2	3	3	2.3
Mean Overall Score											**2.32**
Correlation											**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. M. Habibunisha

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23UBT4GE2	Generic Elective-II	2	2	-	100	100
Course Title	BIOFERTILIZER AND ORGANIC FARMING						

SYLLABUS		
UNIT	**CONTENT**	**HOURS**
I	Soil – Physical and chemical properties. Soil fertility- essential nutrients- function, deficiency and toxicities. Concept and methods of soil fertility evaluation. defects of using synthetic fertilizer and pesticides to soil and living organisms.	**6**
II	Bio-fertilizers - classification, nitrogen fixers-*Rhizobium*, *Azotobacter*, *Cyanobacteria*, *Azolla*, *Frankia*, *Azospirillum* and *Vasicular Mycorrhizae*.	**6**
III	Organic farming-definition, basic concept of organic farming, integrated plant nutrient supply management, integrated insect pest management- sustainable agricultural practice, crop rotation, crop diversification, mixed cropping, *biological nitrogen fixation*.	**6**
IV	Management of organic waste and green manure- Farm manures, composts, Mulches, Tillage and control. Organic manures-organic residue, chemical nature of organic manure, *green manure and its importance*.	**6**
V	Animal based organic manure-cow dung, poultry waste, Production of vermicompost and *Panchakavya Production* and commercialization of Organic products – conversion period, Inspection and certification (National and International Level).	**6**

***……* Self Study**

Text Books:

1. A.K.Sharma, Biofertilizers for sustainable agriculture, Agrobios. (2003).
2. Aravind Kumar, Verms and Vermitechnology, APH Publishing Corporation, New Delhi, (2005)

Books for Reference:

1. G.K.Veeresh, Organic Farming, Foundation Pvt.Ltd., (2006).
2. NIIR Board, The Complete Technology Book on Biofertilizer and organic farming, National Institute of Industrial Research, (2004).

Web Source:

1. http://ec.europa.eu/agriculture/organic/organic-farming/what-organic-en.
2. http://attra.ncat.org/organic.html*list

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO NO.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Employ the knowledge on the properties of soil and soil pollution.	**K3**
CO2	Examine the knowledge of different types of biofertilizer.	**K4**
CO3	Explain the organic farming and kinds integrated Pest Management.	**K5**
CO4	Develop the knowledge by using manure and waste management practice for soil fertility.	**K5**
CO5	Generate the animal based organic manure production and its importance.	**K5**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	2	3	3	2	3	3	3	2.8
CO2	3	2	3	2	2	2	2	2	3	2	2.3
CO3	2	3	2	3	3	2	2	3	3	2	2.5
CO4	2	3	2	3	2	2	2	3	2	3	2.4
CO5	3	3	2	3	2	3	2	2	3	2	2.5
Mean Overall Score											**2.5**
Correlation											**High**

Mean Overall Score	Correlation
<1.5	**Low**
>-1.5 and <2.5	**Medium**
>-2.5	**High**

Course Coordinator: Dr. R. Shalini

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
V	23UBT5CC9	Core – IX	5	5	25	75	100
Course Title	PLANT BIOTECHNOLOGY						

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Introduction to Plant tissue culture:** History of plant tissue culture – lab facility and operation – aseptic techniques – nutritional requirements - Murashige and Skoog medium preparation– Plant Growth hormones and Regulators - Types of cultures – Solid and Liquid, Germplasm conservation and Cryopreservation – cold storage, low pressure and low oxygen storage, Application of germplasm storage, Limitation of germplasm storage. *Green house and green home technology*.	15
II	**Direct and Indirect organogenesis:** Micropropagation – Shoot tip, Node, Axillary bud culture, Rapid production of plantlets with suitable hormone supplemented medium – meristem culture for virus elimination - *hardening and mist chambers* – techniques for maintaining plantlets in the field – Callus induction – somatic embryogenesis and artificial seed production – production and exploitation of haploids and triploid – embryo rescue – protoplast culture, Soma clonal variations, somatic hybridization and cybridization.	15
III	**Genetic Engineering of Plants**: Gene transfer methods - Physical and chemical methods of gene transfer, vector mediated gene transfer - Agrobacterium mediated DNA transfer- Ti plasmid - Technique of hairy root disease - Ri plasmid, Direct or vectorless DNA transfer. *DNA imbibition by cells/tissues*.	15
IV	**Transgenic plants:** Insect (pest) resistance - Plant pathogen interaction, genetic engineering for extended shelf life of fruits - Transgenic plants with improved nutrients - Golden rice - *increase vitamins and minerals* - Application and Limitation of genetically modified plants - Ethical Concerns in Plant Biotechnological Research. Status of transgenic plant in the Globe.	15
V	**Molecular Marker aided Plant Breeding:** Molecular markers – basic principles of molecular marker detection - markers based on DNA hybridization, RFLP, PCR amplification, *RAPD, AFLP*, molecular marker assisted selection. CRISPR-gene editing in plant (crop improvement, nutritional enhancement and herbicides tolerance).	15
VI	**Current Trends (For CIA only) –** Biotechnology in Ancient India: Practices and modern application. Plant Based Biotechnology in Ayurveda and Siddha.	

***..... *Self-Study**

Text Book(s):

1. Kalyankumar De. An Introduction to Plant Tissue Culture Techniques. New Central BookAgency, Kolkata. 2020.
2. Adrian Slater, Nigel W. Scott and Mark R. Fowler., Plant Biotechnology (The geneticmanipulation of plants). Oxford University press, UK. 2023.
3. Samriti Sharma, Abhishek Kumar, Ankita Sharma, Dalpat Lal Text Book Of Advances In Plant Molecular Biology And Biotechnology, Kalyani Publishers, 2023.
4. HS. Chawla, "Introduction to Plant Biotechnology". CBS publishers and Distributors pvt Ltd. March 2024 .

Reference Book(s):

1. Donald Grierson and S.V. Convey. Plant Molecular Biology. Blackie and Son Limited. New York, 2020.
2. M.J. Chrispeels and D.F. Sadava. Plants, genes and agriculture, sustainability through Biotechnology Oxford University Press, 2023.
3. S.H. Mantell, and H. Smith. Plant Biotechnology by. Cambridge University press, UK. 2021.
4. Mathews and Mickee. An introduction to genetic engineering in plants, Blackwell Scientific Publishers. London. 2019.

Web Resource(s):
1. https://nptel.ac.in/courses/102/103/102103016/ 2. https://nptel.ac.in/courses/102/103/102103013/ 3. https://swayam.gov.in/nd2_cec19_bt01/preview

Cours Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Demonstrate the basic principles and techniques involved in plant tissue culture Laboratory.	**K2**
CO2	Analyze the skills associated with conservation and the importance of cell culture techniques in plant tissue culture research.	**K4**
CO3	Explain the applications of plant biotechnology in agricultural field.	**K5**
CO4	Develop the gene transformation techniques in modern agricultural practices and beneficiaries in genetically modified foods.	**K6**
CO5	Discuss the achievements in modern agriculture industry.	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes**					**Programme Specific Outcomes**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	2	3	3	2	2	2	2.5
CO2	3	3	1	3	2	3	3	2	2	2	2.4
CO3	3	3	1	3	2	3	3	2	2	2	2.4
CO4	3	3	1	3	2	2	3	2	2	2	2.4
CO5	3	3	1	3	3	3	3	3	2	2	2.6
Mean Overall Score											**2.4**
Correlation											**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. J. SEBASTIN RAJ

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
V	23UBT5CC10	Core– X	5	5	25	75	100
Course Title	ENZYMOLOGY AND ENZYME TECHNOLOGY						

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Enzymes:** Nomenclature, classification, chemical nature and UNITs of enzyme activity. Structure, properties and functions of coenzymes-NAD, FAD, CoA. Metallo enzymes and metal activated enzymes. Isoenzymes of lactate dehydrogenase. Multienzyme complex-pyruvate dehydrogenase complex and fatty acid synthase complex enzyme. *****Non protein enzymes-Ribozymes and abzymes***.**	**15**
II	**Mechanism of Enzyme Action:** Active site, models of enzyme-substrate complex formation- Lock and Key model, induced fit model and Substrate strain model. Mechanism of enzyme catalysis: Acid-Base catalysis covalent catalysis, Substrate strain and Entropy effect. *****Enzyme specificity-group specificity and optical specificity*. Mechanism of action of chymotrypsin and lysozyme.	**15**
III	**Enzyme Kinetics:** Theories of enzyme kinetics- Derivation and significance of Michaelis-Menton equation. Transformation of MM equation - Line Weaver-Burk plot, the Eadie-Hofstee plot and the Hanes Woolf plot. Factors influencing enzyme activity. *****Enzyme inhibition- types of inhibition - Competitive, Noncompetitive, Uncompetitive* Feedback and Allosteric inhibition.	**15**
IV	**Characterization of Enzymes:** Identification of sources of enzymes, methods of isolation of enzymes- use of hydrolytic enzymes, homogenization by homogenizer, use of hypotonic solutions, ultrasonic vibrations. Methods of purification- methods depending on size or mass, methods depending upon charge, methods based on changes in solubility and methods based on specific binding sites. *****Criteria of purity of enzymes. Preservation of purified enzymes*****.	**15**
V	**Enzyme technology and applications:** Immobilization of enzymes-methods and applications. Enzyme in medicine and diagnostics – Enzymes as biomarker in diagnosing diseases, Enzymes as drugs and enzyme replacement therapy, Enzyme engineering – Protein engineering for enhanced enzyme stability, activity, and specificity. Industrial applications of enzymes – Food, textile, leather and pharmaceuticals. Environmental applications *****Biosensors and Biochips*.	**15**
VI	**Current Trends * (For CIA only):** Enzyme Discovery from Extremophiles, Computational Enzymology – *In-silico* enzyme modelling and design, Role of AI and machine learning in enzyme discovery.	

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Text Book(s):

1. Veer Bala Rastogi and K R Aneja, Zubay Principles of Biochemistry – Publication,4th edition, 2020
2. Lehninger: Principles of Biochemistry (Textbook) David Nelson and Michael Cox, Macmillan Learning, 9th edition, 2021.
3. Nicholas C. Price, Fundamentals of Enzymology. The Cell and Molecular Biology of Catalytic Proteins - 3rd Edition, 2019.

Reference Book(s):

1. Donald Voet and Judith G. Voet. Fundamentals of Biochemistry, John Wiley, New York, 5th Edition. 2019.
2. Allan Fersht, Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding: Vol 9, 2017.
3. Cornish-Bowden, A., Fundamentals of Enzyme Kinetics (4th ed.), Wiley Library, 2018.
4. Enzyme: Catalysis, kinetics and mechanisms. N.S. Punekar. ISBN 978-981-13-0784-3.4th edition. 2020.

Web Resource(s):

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/104105076/lec8.pdf
2. https://onlinecourses.nptel.ac.in/noc23_bt05/preview
3. https://archive.nptel.ac.in/courses/102/102/102102033/

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Understand the fundamental principles of enzyme structure and function	K2
CO2	Explain the mechanisms of enzyme action and kinetic models	K2
CO3	Analyze enzyme inhibition and regulatory mechanisms.	K4
CO4	Justify techniques for enzyme isolation, purification, and characterization.	K5
CO5	Invent the advancements in enzyme technology and applications in industry.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	3	2	3	2	3	2	3	2.5
CO2	3	2	2	3	2	2	1	3	2	2	1.9
CO3	3	1	2	3	2	2	2	3	2	2	2.2
CO4	3	2	3	3	2	3	2	3	3	2	2.6
CO5	3	3	3	3	2	3	2	3	3	3	2.8
										Mean Overall Score	2.4
										Correlation	**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥1.5 and <2.5	Medium
≥2.5	High

COURSE COORDINATOR: MS. A. MEHER NISHA

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
V	23UBT5CC11	Core – XI	5	5	25	75	100

Course Title	IMMUNOLOGY AND IMMUNOTECHNOLOGY

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Overview of the Immune system:** Historical perspectives in development of immunology, immune system - innate and adaptive immunity and, Haematopoiesis, Cells of the immune system and their role - lymphoid cells (T and B lymphocytes,NK cells), Macrophages, Dendritic cells, Eosinophils, Basophils, Neutrophils, Mast cells, Antigen presenting cells and Platelets *Organs of the immune system - Primary and secondary lymphoid organs*	**15**
II	**Antigen and antibodies:** Antigens- structure, Types of antigens – factors of antigenicity. T cell and B cell epitopes, hapten, *adjuvants and super antigens*. T-dependent and independent antigens, antigenic determinants. Immunogens and chemical nature. Antibodies: Ultra structure, its types and functions. *Organization and expression of immunoglobulin genes*.	**15**
III	**Immune Response and Cell Activation:** Activation of B cell, T cell and Complement: B cell - Activation, proliferation and humoral response, T cell - Activation, differentiation and Cell mediated response, *Cytokines*, Complement - Functions and activation pathways.	**15**
IV	**Antigen Presentation, Hypersensitivity and Immune response to infectious diseases:** Major Histocompatibility complex - class I and class II, T cell receptors, Processing and Presentation pathways - Cytosolic and Endocytic, Hypersensitive reactions - types, HLA antigens Histocompatibility testing, HLA typing, application of transplantation immunology. *Immune response to viral (HIV), bacterial (Tuberculosis) and protozoan (Malaria) infections*.	**15**
V	**Antigen-Antibody Interactions and Vaccine Development:** Precipitation and Agglutination reactions, Blood grouping, ELISA and its types, RIA, Western blotting and FACS, FISH technique. Autoimmune Disorders, Vaccines – active and passive, purified, recombinant, subunit, DNA and RNA vaccines *COVID Vaccines (Covaxin and Covishield)*.	**15**
VI	**Current Trends (For CIA only) –** Microbiota and cancer immunity, Immune Predictive and Prognostic Biomarkers in Immuno-Oncology	

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Text Book(s):

1. R. A. Goldsby, T. J.Kindt, B.A.Osborne, J. Kuby. Immunology, W.H. Freeman and Comp, New York, 10th Edition, 2017.
2. K. Abbas, A. H. Lichtman, S. Pillai. Cellular and Molecular Immunology, 10th Edition, Elsevier Health Sciences.,2021.
3. P. M. Latha. A Text Book of Immunology, S. Chand& Company Ltd, New Delhi,, Revised Edition, 2020.

Reference Book(s):

1. Kuby, Immunology, Macmillan learning, 8th edition, 2019.
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Essential Immunology, Wiley-Blackwell Scientific Publication, 13th Edition, 2017.
3. Male, Peebles, S., & Male, V., Immunology, Eds.; 9th edition, Elsevier, 2021.

Web Resource(s):
1. https://www.nature.com/subjects/immunology
2. https://www.immunology.org/public-information/bitesized-immunology
3. https://nptel.ac.in/courses/102105083

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Outline the functions of major immune components and mechanisms of immunity against pathogens.	K4
CO2	Compare types of antigens and antibodies while understanding nonspecific vs. specific immunity and polyclonal vs. monoclonal antibodies.	K4
CO3	Explain lymphocyte structure and function, emphasizing clonal selection and their roles in immune responses.	K5
CO4	Evaluate the significance of immune responses in therapy and vaccine design for various illnesses.	K6
CO5	Adapt immunological techniques for the detection of various diseases.	K5

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. S.GEET ANDREA

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
V	23UBT5CC12P	Core – XII	6	6	20	80	100

Course Title	PLANT BIOTECHNOLOGY, ENZYMOLOGY AND ENZYME TECHNOLOGY, IMMUNOLOGY AND IMMUNOTECHNOLOGY – PRACTICAL

SYLLABUS		
S.NO	**Contents**	**Hours**
1	Organizing plant Tissue Culture Laboratory and Preparation of Tissue Culture Media.	**90**
2	Propagation of plantlets by direct and indirect organogenesis.	
3	Somatic embryogenesis and Artificial seed preparation.	
4	Haploid plant production - Anther and Pollen culture.	
5	Protoplast isolation and culture by Mechanical and enzymatic methods.	
6	Transformation of leaf discs with Agrobacterium.	
7	Extraction and estimation of enzymes from animal/ plant/ microbial source	
8	Determination of effect of pH and temperature on the activity of enzyme (Salivary amylase).	
9	Determination of effect of substrate and enzyme concentration on the activity of enzyme (Salivary amylase).	
10	Blood Grouping and agglutination.	
11	Total count, Differential count (RBC & WBC)	
12	Immunodiffusion- Radial immunodiffusion and Ouchterlony Double Diffusion.	
13	Immunoelectrophoresis- Counter current and Rocket Immunoelectrophoresis	
14	ELISA	

Text Book(s):

1. **Immunology (9th Edition, 2021)** by David Male, Stokes Peebles, and Victoria Male, published by Elsevier.
2. **Kuby Immunology (8th Edition, 2019)** by Judith Owen, Jenni Punt, and Sharon Stranford, published by Macmillan Learning.Kuby, Immunology, Macmillan learning, 8th edition, 2019.
3. **Essential Immunology (13th Edition, 2017)** by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt, published by Wiley-Blackwell.

Reference Book(s):

1. **Janeway's Immunobiology" (10th Edition, 2022)** by Kenneth Murphy, Casey Weaver, published by Garland Science.
2. **"Cellular and Molecular Immunology" (10th Edition, 2022)** by Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai, published by Elsevier.
3. **The Immune System" (5th Edition, 2021)** by Peter Parham, published by Garland Science.

Web Resource(s):

1. https://www.kau.edu.sa/Files/0016333/Subjects/Enzymology%20BIOC231.pdf.
2. https://nptel.ac.in/courses/102/103/102103016/
3. https://alison.com/course/immunology-techniques#google_vignette

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Demonstrate the basic principles and techniques involved in plant tissue culture.	K4
CO2	Analyse the skills associated with single cell culture techniques and soma clonal variation techniques for production novel plants in plant breeding program.	K4
CO3	Apply the fundamentals of enzymes, the substances that make them up, and the ways in which they function.	K3
CO4	Analyse the activity of various enzymes and their various applications in the future.	K4
CO5	Familiarize the current immunological techniques used for various diagnostic and therapeutic purposes.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	3	1	3	2	3	2	2.5
CO2	3	3	2	3	2	2	2	2	2	2	2.3
CO3	3	3	2	3	2	2	2	3	3	3	2.6
CO4	3	3	1	3	2	3	3	2	3	3	2.6
CO5	3	3	3	3	2	2	2	2	2	2	2.4
Mean Overall Score											**2.4**
Correlation											**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. S. GEET ANDREA

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
V	23UBT5DE1A	DSE-I	5	4	25	75	100
Course Title	BIOINFORMATICS AND BIOSTATISTICS						

SYLLABUS		
UNIT	**CONTENT**	**HOURS**
I	**Structural Biology:** Introduction to Bioinformatics scope and history, factors determining primary – secondary- tertiary and quaternary structure of proteins - protein information resources- primary. *secondary database and Composite protein sequence database*, ADME and Schrodinger.	**15**
II	**Databases Management System:** Introduction to databases - Types of databases. Flat file database - Relational databases - Object oriented databases - Database software- Overview of Sequence Retrieval System – Oracle - MySQL. Database design. *visualization of databases and software*.	**15**
III	**Programming C & Perl:** C-language-Introduction - variables- input output statements- control statements- function- arrays- pointers- structures- unions- file handling and case studies. Introduction to PERL- variables- strings and numbers- lists conditional loops- strings- pattern matching- *applying PERL to bioinformatics*.	**15**
IV	**Biological Sequence analysis**: FASTA, and BLAST. Multiple sequence alignments - Phylogenetic alignment. Protein structure visualization tools - RasMol, Swiss PDB Viewer Protein identification programs- Mascot. Proteininteraction. *Molecular docking - Auto Dock-.NGS*	**15**
V	**Biostatistics:** Measures of central Tendency - mean arithmetic's- harmonic and geometric median and mode - measures of dispersion - standard deviation and standard error; correlation coefficient- simple linear regress- *Basic idea of significance test- hypothesis test – SPSS Packages*.	**15**
VI	**Current Trends (For CIA only) -** Recent trends in Bioinformatics: Integration of artificial intelligence (AI) and machine learning (ML) techniques.	

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Text Book(s):

1. **Statistics – Theory and Practice** by R.S.N. Pillai and V. Bagavathi remains as is from **2016**.
2. **Bioinformatics: Genes, Proteins and Computers"** by Daniel P. D'Amico and et al. (2021)
3. **An Introduction to Biostatistics** by M. Glovery and Mitchell is now updated in its **2nd edition**, published in **2022** (Barnes & Noble).

Reference Book(s):

1. R.R.Miller and G.S.A. Myers (Eds.). Internet for the Molecular Biologist, Horizon ScientificPress, 2000.
2. **"Bioinformatics: From Genomes to Drugs"** by Michael D. Johnson (2023).
3. **"Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins"** by Andreas D. Baxevanis and et al. (2021)
4. AP Kulkarani basics of biostatistics (Second Editor) 2022.

Web Resource(s):

1. https://scholar.cu.edu.eg/wafaaabdelghany/files/basics_of_bioinformatics.pdf
2. https://www.uou.ac.in/sites/default/files/slm/MSCZO-603.pdf
3. https://scholar.cu.edu.eg/wafaaabdelghany/files/basics_of_bioinformatics.pdf
4. https://onlinecourses.nptel.ac.in/noc21_bt06/preview
5. https://onlinecourses.nptel.ac.in/noc19_bt19/preview

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO NO.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Demonstrate the basic of bioinformatics scope and protein structure.	K2
CO2	Analyze the skill working in tools and biological database.	K4
CO3	Explain the data base management system and biostatistics analysis.	K5
CO4	Develop the molecular modeling tools to understand the programming language.	K6
CO5	Discuss the concept of partition Measures of central Tendency correlation coefficient techniques.	K6

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes**					**Programme Specific Outcomes**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	2	3	3	2	2	2	2.5
CO2	3	3	1	3	2	3	3	2	2	2	2.4
CO3	3	3	1	3	2	3	3	2	2	2	2.4
CO4	3	3	1	3	2	2	3	2	2	2	2.4
CO5	3	3	1	3	3	3	3	3	2	2	2.6
Mean Overall Score											**2.4**
Correlation											**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. K. GOBALAN

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
V	23UBT5DE1B	DSE - II	5	4	25	75	100
Course Title	PHARMACOLOGY AND NANOMEDICINE						

SYLLABUS		
UNIT	CONTENT	HOURS
I	**General Pharmacognosy:** Introduction - Definition, Nature & sources of drugs, dosage forms, drug Nomenclature; Complementary Alternative Medicine; Generic name, trade name. *Fixed dose combinations, Posology*.	15
II	**Pharmacokinetics**: Drug absorption, distribution, metabolism, and excretion, bioavailability, First Pass metabolism, excretion and kinetics of elimination, Bioavailability, Biological half-life of drug and its significance, Drug-drug interactions**.**	15
III	**Pharmacodynamics**: Principles and mechanism of drug action, Factors affecting drug action. General considerations, pharmacological classification, mechanism of action.	15
IV	**Nanomedicine:** Basic concepts in the design of nanomedicine, specification and desired features of nanomedicine, nanomaterials and general process steps involved in the preparation of nanomedicines. Nanomedicines for various disease conditions.	15
V	**Nanotoxicology:** Basics of cellular and organ level toxicity, effect of nanosize, shape, surface properties and composition on toxicity of nanomedicines,: Au, Ag, ZnO, TiO2, Quantum dots, carbon-based nanomaterials, polymeric, protein and lipid nanoparticles	15
VI	**Current Trends (For CIA only) -** Theranostic nanomedicines: Basic concept, multifunctional nanomedicines for the ranosis.	

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Text Book(s):

1. Basic & Clinical Pharmacology **by Bertram Katzung: The latest edition is the** 15th edition**, published in** 2021**.**
2. An Introductory Textbook **by Rob Burgess: The** 2nd edition **was released in** 2020**.**

Reference Book(s):

1. **Nanotoxicology: Materials, Methodologies, and Assessments** by Nelson Durán: The **2nd edition** was published in **2023**.
2. **Biopharmaceuticals: Biochemistry and Biotechnology** by Gary Walsh: The **3rd edition** was released in **2020**.

Web Resource(s):

1. https://www.classcentral.com/subject/pharmacology

2. https://onlinelearning.hms.harvard.edu/hmx/courses/hmx-pharmacology/

3. https://elearninguoa.org/course/health-nanotechnology-nanomedicine/nanotechnology-andnanomedicine.

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO NO.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Apply pharmacognosy and drug sources to describe drug types, nomenclature, and fixed-dose combinations.	**K3**
CO2	Analyze drug pharmacokinetics, including absorption, metabolism, excretion, and factors affecting bioavailability and drug interactions.	**K4**
CO3	Analyze drug pharmacodynamics, focusing on drug action mechanisms and factors influencing efficacy and classifications.	**K5**
CO4	Create nanomedicines for various diseases, addressing specifications and preparation processes.	**K6**
CO5	Create nanotoxicology assessments by evaluating toxicity effects of nanomedicines based on size, shape, surface properties, and composition.	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (Pos)					Programme Specific Outcomes(PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	3	3	2	3	3	3	2.8
CO2	3	2	3	2	2	2	2	2	3	2	2.3
CO3	2	3	2	3	3	2	2	3	3	2	2.5
CO4	2	3	2	3	2	2	2	3	2	3	2.4
CO5	3	3	2	3	2	3	2	2	3	2	2.5
Mean Overall Score											**2.5**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. R. SHALINI

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
V	23UBT5SE1	Skill Enhancement Course-I	2	1	-	100	100

Course Title	EVOLUTION AND DEVELOPMENTAL BIOLOGY

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Evolution:** Introduction – chemical Origin of Life, Urey and Miller experiment, formation of first cell. Evolution of life forms, Adaptive radiation, Biological evolution; Geological time scale, Lamarckism, Darwinism, mutation theories of De Vries – Bottle neck theory, natural selection, variation – genetic variation; genetic drift, isolation, geographical, reproductive, ecological, seasonal ethological.	4
II	**Evolutionary Biology Mechanisms and Evidence**: Hardy Weinberg equilibrium, gene pool and frequency, specialization, mimicry, colouration, various types of adaptation, orthogenesis, evolution of man, trends in Human evolution, Fossils: Lead and Carbon Method, Living fossils, *Fossil Record*. Animal Distribution, biogeography, zoogeography and its pattern	4
III	**Developmental Biology:** Definition and scope, Gametogenesis-Spermatogenesis and oogenesis- Role of gametes in fertilization. Fertilization and Early Development - Cleavage and Blastula Formation-Types of cleavage (holoblastic, meroblastic), Formation of the blastula. *****Gastrulation - Processes and significance, Formation of germ layers (ectoderm, mesoderm, endoderm)*.	4
IV	**Organogenesis:** Cell Differentiation and its stages, *Mechanisms of cell fate* Determination - Role of transcription factors and signaling pathways – Morphogenesis -Processes of tissue and organ formation (e.g., limb, heart, nervous system).	4
V	**Genetic Regulation of Development**: Developmental Genetics - Model organisms (e.g., Drosophila, zebrafish, mouse). Epigenetics and Development. *Techniques in Developmental Biology (IVF)*.	4
VI	**Current Trends (For CIA only):** Regenerative medicine; Developmental disorders and congenital anomalies.	

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Text Book(s):

1. McKinney, M. L., & McNamara, K. J. "*Heterochrony: The Evolution of Ontogeny"*. 1st edition, March 2013.
2. Dr. Alice Roberts, "*Evolution"* (Revised edition), May, 2023.
3. Arumugam, N., & Meyyan, R. P. "*Genetics and Evolution*. January, 2015.

Reference Book(s):

1. Mark Ridley. "*Evolution"* (2nd edition) March, 2020.
2. Claybourne, A. (2019). "*Amazing Evolution: The Journey of Life* "(Illustrated edition), April, 2019.
3. Darwin, S., Sadowski, E. M., & Baumert, O. "*Evolution"*. August, 2024.

Web Resource(s):

1. https://onlinecourses.nptel.ac.in/noc23_ce54/preview
2. https://onlinecourses.nptel.ac.in/noc21_bt43/preview
3. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/154
4. https://bgc.ac.in/pdf/study-material/developmental-biology-7th-ed-sf-gilbert.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Explain the chemical origin of life and the Urey-Miller experiment**.**	K2
CO2	Illustrate the Hardy-Weinberg equilibrium and its role in genetic variation and evolution	K3
CO3	Examine the processes of gametogenesis, fertilization, and early embryonic development	K4
CO4	Critically assess the mechanisms of cell differentiation and morphogenesis during tissue and organ formation**.**	K5
CO5	Create a comprehensive analysis of genetic regulation in development, model organisms, epigenetics, and advanced techniques like IVF.	K6

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	2	2	2	2	2	2.0
CO2	2	3	2	2	2	2	2	2	2	3	2.2
CO3	2	2	2	2	2	2	2	2	2	2	2.0
CO4	2	2	2	3	3	2	3	2	2	3	2.4
CO5	3	3	2	3	3	3	3	3	3	3	2.9
										Mean Overall Score	2.3
										Correlation	**Medium**

MEAN OVERALL SCORE	**CORRELATION**
< 1.5	Low
≥1.5 and <2.5	Medium
≥2.5	High

COURSE COORDINATOR: Dr. S. DEBORAH

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
V	23UBT5SE2	Skill Enhancement course-II	2	1	-	100	100

Course Title	INDUSTRIAL FERMENTATION

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Introduction and Microbiology of Fermentation:** Fermentation Microbiology - Historical Perspectives, Upstream Processing: selection of industrial microbes, Microbial biomass, Microbial enzymes and metabolites, Growth cycle, Diauxic growth, cultivation of microbes, Current advances and innovations in fermentation industry. Kinetic models - Unstructured, Compartment, Single-cell, Molecular mechanistic models.	4
II	**Bioreactors:** - Batch operation, Continuous operation, Fed - batch culture, Oxygen transfer, Different types of bioreactors, components of bioreactors, Aeration and Agitation systems, controlling and monitoring, Selection of the reactor, *Reactors in Industry*.	4
III	**Microbial synthesis of Primary metabolites:** Technical Processes, Control of Primary metabolism - Induction, Catabolite repression, Source regulation, Feedback regulation, Secondary metabolites and Strain Improvement: Process, Nutrient limitation, Strain Improvement, *Media formulation*.	4
IV	**Downstream Processing and Enzyme Production:** Product Recovery and Purification -Microbial cell removal, Foam Separation, Precipitation, Filtration, Centrifugation, Cell disruption, Chromatography, Ultrafiltration, Crystallization. Challenges during Fermentation. Enzymes - sources, surface and submerged cultures, Industrial enzymes , *Challenges in Fermentation process*.	4
V	**Applications of Bioreactors:** Pharmaceuticals- produce antibiotics (e.g., penicillin, cephalosporins), *vaccines Production*. Food and Beverage-Biofuels - Enzyme Production (proteases and amylases) - organic acids: citric acid	4
VI	**Current Trends * (For CIA only): Ancient fermentation technique, Curd, Idle Dosa batter and wine.** Reactor for Bioplastics production**.**	

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Text Book(s):

1. Minj, E. S. (2024). *Handbook on Fermentation Technology: Industrial Microbiology*. 14 March 2024.
2. Allen, M. S. P., & Paul, W. (2021). *Industrial Fermentations*. 9 September 2021.
3. **"Fermentation Microbiology and Biotechnology" (4th Edition, 2019)** - Edited by E.M.T. El-Mansi, Jens Nielsen, David Mousdale, and Ross P. Carlson

Reference Book(s):

1. Okeke, B. C., & Okafor, N. (2021). *Modern Industrial Microbiology and Biotechnology*. 31 March 2021.
2. Stanbury, P. F., Whitaker, A., et al. (2016). *Principles of Fermentation Technology*. 31 August 2016.
3. Saha, G. (2000). *Bioreactors*. 31 December 2000.
4. Mandenius, C.-F. (2016). *Bioreactors: Design, Operation and Novel Applications*. 7 April 2016.

Web Resource(s):		
1.https://archive.nptel.ac.in/courses/102/105/102105058/ 2.https://onlinecourses.nptel.ac.in/noc21_bt28/preview 3.https://biokamikazi.wordpress.com/wp-content/uploads/2013/09/principles_of_fermentation_technology-stanburry_whittaker.pdf		
Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Describe fermentation microbiology and analyze upstream processing.	**K2**
CO2	Explain bioreactor operations and evaluate reactor selection factors	**K3**
CO3	Illustrate microbial synthesis processes for metabolites.	**K4**
CO4	Assess downstream processing techniques and challenges.	**K4**
CO5	Evaluate bioreactor applications in various industries.	**K5**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	3	2	3	2	2	3	2	2.4
CO2	3	3	2	3	2	2	3	2	2	2	2.4
CO3	2	3	3	2	2	3	3	2	2	2	2.4
CO4	2	2	2	3	3	2	3	3	3	3	2.6
CO5	3	2	2	3	3	3	3	3	3	3	2.8
										Mean Overall Score	2.52
										Correlation	**High**

MEAN OVERALL SCORE	**CORRELATION**
< 1.5	Low
≥1.5 and <2.5	Medium
≥2.5	High

COURSE COORDINATOR: Dr. S. DEBORAH

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
VI	23UBT6CC13	Core – XIII	5	5	25	75	100
Course Title	ANIMAL BIOTECHNOLOGY						

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Basic techniques in animal cell culture and organ culture**: Cell lines - different types and isolation, Culture media - types and supplements, Cell fusion, Cell differentiation, Equipment's and materials for animal cell culture technology. Laboratory design and practice. Aseptic Technique for cell cultures- Identification and characterization of contaminations. *Maintenance and preservation of cell lines- Cryopreservation*.	**15**
II	**Genetic engineering in animals**: Methods of DNA transfer into animal cells-calcium phosphate coprecipitation, micro-injection, electroporation, Liposome encapsulation, Biological vectors - Plasmid, λ-phage, shuttle vectors, Expression vector, Bacterial artificial chromosome and Yeast artificial chromosomal vector. Hybridoma technology, Vaccine production. *CRISPR/Cas9-mediated TYRP1 modification in indigenous Chinese chickens*.	**15**
III	**Transgenic animal production and application**: Transgenic animal as models for human disease, Applications of transgenic animals in livestock improvement and industries, chimera production, xenografting.*Ethical issues in transgenic animal*	**15**
IV	**Embryo Technology and Animal Breeding:** In vitro fertilization, Embryo transfer, ICSI, Embryo splitting, Fertility control and regulation, test tube babies. Animal cell cloning, *Transgenic animals-sheep, goat, Mice, fish*.	**15**
V	**Sericulture and Aquaculture:** Types of silk, Stages of Production, life cycle of silkworm and Biotechnological applications in sericulture. Aquaculture, principles, methods and cultural species, Freshwater and marine Aquaculture, Aquaculture nutrition- live and supplementary nutrition, Value added fishery products, *Genetic modifications in aquaculture*.	**15**
VI	**Current Trends (For CIA only) -** PGC-based cryobanking, regeneration through germline chimera mating.	

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Text Book(s):

1. P.K Gupta., Animal Biotechnology, 1st Edition, Rastogi Publications (2017).
2. **"Animal Biotechnology 2: Emerging Breeding Technologies"** (2020). Edited by Ashish Verma and Anchal Singh
3. **Animal Biotechnology: Models in Discovery and Translation"** (2021) Edited by Ashish S. Verma
4. **"Nanotechnology in Modern Animal Biotechnology: Recent Trends and Future Perspectives"** (2019) Edited by Sanjay Singh and Pawan Kumar Maurya,

Reference Book(s):

1. **Animal Biotechnology for Livestock Production"** by Vinod Kumar Yata and Ashok Kumar Mohanty (2022)
2. **Nanotechnology in Modern Animal Biotechnology: Recent Trends and Future Perspectives"** edited by Sanjay Singh and Pawan Kumar Maurya (2020)
3. **Sustainable Animal Biotechnology"** by Vinod Kumar Yata et al., (2022)

Web Resource(s):

1. https://nptel.ac.in/content/storage2/courses/102103045/download/mod6.pdf
2. https://nptel.ac.in/courses/102/104/102104059/

Course Outcomes		
U**pon successful completion of this course, the student will be able to:**		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Make use of basic techniques in animal cell culture and organ culture.	**K3**
CO2	Examine the knowledge on genetic engineering in animals.	**K4**
CO3	Deduct the production of transgenic animal and its significance.	**K5**
CO4	Develop an understanding on embryo technology and animal breeding.	**K6**
CO5	Discuss the significance of sericulture and aquaculture.	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	2	3	3	2	2	2	2.5
CO2	3	3	1	3	2	3	3	2	2	2	2.4
CO3	3	3	1	3	2	3	3	2	2	2	2.4
CO4	3	3	1	3	2	2	3	2	2	2	2.4
CO5	3	3	1	3	3	3	3	3	2	2	2.6
										Mean Overall Score	2.4
										Correlation	**Medium**

Mean Overall Score	**Correlation**
<1.5	Low
≥1.5 and <2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. T. NARGIS BEGUM

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
VI	23UBT6CC14	Core-XIV	6	6	25	75	100
Course Title	ENVIRONMENTAL BIOTECHNOLOGY						

SYLLABUS		
UNIT	CONTENT	HOURS
I	**Basic Concepts and Issues:** Types of pollution, methods for measurement of pollution, methodology of environmental management- the problem solving approach and its limitations. Global environmental problems; Ozone depletion, climate change, *Greenhouse effect, Acid rain, global warming*, sea level raising, El Nino Southern Oscillation.	**18**
II	**Water Pollution Treatment Methods:** Primary, secondary and tertiary methods for water pollution treatment. Waste water treatment of some industries: Waste water treatment for tannery, dairies, distillery, textile, pulp, *paper and medical waste treatment, e-waste*	**18**
III	**Biodegradation:** Biodegradation and xenobiotics in environment: Ecological considerations, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants. superbug and its role, Biodegradation of plastics, *Biosensors*.	**18**
IV	**Phytoremediation:** Process of phytoremediation - Rhizofiltration, Phytostabilization, phytodegradation, phytovolatilization, phytoaccumulation, phytochelation, biotransformation, Cellular and subcellular compartmentalization. Phytoremediation of heavy metals from soil and water, *phytoremediation of soil polluted with herbicides and pesticides*. Uses of Traditional plants in environmental detoxification.	**18**
V	**Bioleaching:** Leaching of ores by microorganisms (gold, copper and uranium). Environmental significance of genetically modified (GM) microbes, plants and animals. *Waste disposal and management, legislation of environmental problems*. Microbial association in environment.	**18**
VI	Current Trends for CIA: Environmental toxicology – Toxicants , Detoxification of hazardous chemicals., effect of Micro-plastics in the environments.	

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Text Book(s):

1. "Environmental Microbiology: From Genomes to Biogeochemistry" **by Jorge A. A. B. de Brito, Rami H. B. Abujabal, et al. (2023)**
2. "Biotechnological Innovations in Environmental Bioremediation" **edited by Inamuddin and Mohd Imran Ahamed (2021)**
3. "Microbial Processes for Synthesizing Nanomaterials" **edited by Naga Raju Maddela, Joan Manuel Rodríguez Díaz, and Maria Conceição Branco da Silva Montenegro (2023)**

Reference Book(s):

1. "Environmental Science and Biotechnology: Theory and Techniques" by A.G. Murugesan and C. Rajakumari was updated and published on **December 16, 2023**.

2. Environmental Science and Biotechnology: Theory and Techniques" by A.G. Murugesan & C. Rajakumari (2023)

3. Advances in Environmental Biotechnology" by Raman Kumar and Anil K. Sharma (2020) - Covers recent trends in environmental biotechnology.

4. Biotechnological Innovations in Environmental Bioremediation" by Inamuddin and Mohd Imran Ahamed (2021).

Web Resource(s):

1. https://www.environmentalbiotechnology.ca/course/15958/environmental/-distance
2. https://nptel.ac.in/courses/120/108/120108004/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO NO.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Apply concepts of pollution and environmental management to global issues like ozone depletion and climate change. *(K3)*	K3
CO2	Analyze water pollution treatment methods for industries such as tannery, distillery, and textile. *(K4)*	K4
CO3	Evaluate how pollutants like xenobiotics, hydrocarbons, and plastics biodegrade. *(K5)*	K5
CO4	Evaluate phytoremediation methods for cleaning heavy metals and pesticides from soil and water. *(K5)*	K5
CO5	Evaluate bioleaching and GMOs to solve waste management issues within environmental laws. *(K5)*	K5

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (Pos)					Programme Specific Outcomes(PSOS)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	3	3	2	3	3	3	**2.8**
CO2	3	2	3	2	2	2	2	2	3	2	**2.3**
CO3	2	3	2	3	3	2	2	3	3	2	**2.5**
CO4	2	3	2	3	2	2	2	3	2	3	**2.4**
CO5	3	3	2	3	2	3	2	2	3	2	**2.5**
										Mean Overall Score	**2.5**
										Correlation	**High**

Mean Overall Score	Correlation
< 1.5	**Low**
≥ 1.5 and < 2.5	**Medium**
≥ 2.5	**High**

Course Coordinator: Dr. R. SHALINI

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
VI	23UBT6CC15P	CORE - XV	6	6	20	80	100

Course Title	ANIMAL BIOTECHNOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY – PRACTICAL

SYLLABUS		
Exp.No.	**Contents**	**Hours**
	ANIMAL BIOTECHNOLOGY	
1.	DNA extraction from animal cells – Isolation of DNA from cheek cells/ Blood	**50**
2.	Separation and visualization of DNA fragments by gel electrophoresis.	
3.	Preparation of animal cell culture medium.	
4.	Preparation of single cell suspension from animal tissue.	
5.	Preparation of animal cell monolayer.	
6.	Sub culturing of cell lines.	
7.	Cell counting- quantitation of cells in culture.	
8.	Cell viability assay.	
	ENVIRONMENTAL BIOTECHNOLOGY	
9.	Microbial Analysis of Water Quality	**40**
10.	Estimation of total solids in industrial wastes	
11.	Analysis of TDS in industrial wastes	
12.	Estimation of suspended solids in effluent water	
13.	Determination of COD and BOD in sewage water	
14.	Analysis of Microbial contamination in air by open plate method	
15.	Composting organic waste - Investigate the composting process and its effectiveness in waste reduction	
16.	Vermicomposting of Organic Waste - Study the process and efficiency of vermicomposting	
17.	Examine the effectiveness of microbial enzymes in degrading environmental pollutants.	

Text Book(s):

1. The book **"Environmental Biotechnology: Theory and Lab Practices"** by Debajit Borah has been updated with a second edition in 2019.
2. **Environmental Biotechnology"** by Gareth M. Evans and Judith C. Furlong (2nd Edition)2023

Reference Book(s):

1. Amanda Capes Davis, R.Ian Freshney, Freshney's Culture of Animal Cells - A Manual of Basic Technique and Specialized Applications, Wiley Publication, 2021
2. Jayanta Kumar Patra, A Practical Guide to Environmental Biotechnology, Springer, 2022

Web Resource(s):

1. https://bcrti.co.in/digitallibrary/includeFolder/noticeFolder/211112032116125.pdf
2. https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC203J-lab-manual.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Demonstrate the ability to isolate DNA from animal cells using saliva or blood samples.	K3
CO2	Interpret and separate DNA fragments using gel electrophoresis.	K4
CO3	Assess the health of cultured cells by conducting cell viability assays.	K5
CO4	Examine total dissolved solids (TDS) in industrial wastes to assess environmental impact.	K5
CO5	Judge the effectiveness of the composting process in reducing organic waste.	K6

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	3	3	3	2	3	2	2.6
CO2	3	3	2	3	2	2	2	2	2	2	2.3
CO3	3	3	2	3	2	2	2	3	3	3	2.6
CO4	3	3	1	3	2	3	3	2	3	3	2.6
CO5	3	3	3	3	2	2	2	2	2	1	2.3
									Mean Overall Score		**2.4**
									Correlation		**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

COURSE COORDINATOR: Ms. A. MEHER NISHA

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
VI	23UBT6DE2A	DSE-II	5	4	25	75	100
Course Title	BIOANALYTICAL TOOLS						

SYLLABUS		
UNIT	**CONTENT**	**HOURS**
I	**General approaches to biochemical investigations:** Cell disruption methods and subcellular fractionation. Centrifugation techniques: Basic principles of sedimentation, Svedberg's constant and RCF. Types of rotors, Principle, technique and applications of preparative centrifugation-differential and density gradient centrifugation. *Analytical ultracentrifugation*	**15**
II	Spectroscopy: Laws of absorption and absorption spectrum.CD, ORD, Principle, instrumentation and applications of UV-visible spectrophotometry, ESR, NMR, IR and spectrofluorimetric. Basic principles of turbidimetry and nephelometry. Atomic spectroscopy – principle and applications of atomic flame and flameless spectrophotometry. Use of lasers for spectroscopy. *MALDI-TOF*	**15**
III	**Types of Microscopes:** Light Microscopes – simple, compound and stereo microscope Electron Microscopes: Transmission Electron Microscope (TEM) - Scanning Electron Microscope (SEM), Fluorescence Microscopes, Confocal Microscopes, *Phase Contrast Microscope*, Dark Field Microscope, Atomic Force Microscope (AFM).	**15**
IV	**Electrophoretic techniques:** Gel Electrophoresis -Agarose Gel Electrophoresis - Polyacrylamide Gel Electrophoresis (PAGE), Capillary Electrophoresis (CE), Isoelectric Focusing (IEF), Two-Dimensional Gel Electrophoresis (2D-GE), SDS-PAGE (Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis), *Pulsed Field Gel Electrophoresis (PFGE)*.	**15**
V	Chromatographic techniques: Principles of chromatography, technique and applications of Paper chromatography, Thin Layer chromatography (TLC), *Colum Chromatography*, Size exclusion chromatography, Ion exchange and Affinity chromatography GCMS, LCMS, HPLC, HPTLC and NMR.	**15**
VI	**Current Trends for CIA:** Radio isotopy: Radioactive isotopes and half-life of isotopes; Autoradiography applications of radioisotopes in biological systems.	

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Text Book(s):

1. G. Sabari and A. Anupama Sharma, Fundamentals of Bio Analytical Techniques and Instrumentation, PHI Learning Pvt. Ltd. India, 2024.
2. A. Sibel Ozkan., Recent Advance in analytical techniques, Bentham books, 2023.
3. K. Wilson and J. Walker. Principles and Techniques of Biochemistry and Molecular Biology. 7th Edition. Cambridge University Press. 2010.

Reference Book(s):

1.A. Upadhyay, K. Upadhyay and N. Nath., Biophysical Chemistry: Princiles and Techniques 4th Edition, Himalaya Publishing House, India, 2016.
2. R.P. Braun., Introduction to Instrumental Analysis, Tata McGraw Hill, India, 1987.
3. J.M. Hollas, Modern Spectroscopy. 4th Edition. Wiley India Pvt Ltd. 2010.

Web Resource(s):

1.https://nptel.ac.in/courses/102/103/102103044/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	**Apply** cell disruption, subcellular fractionation, and centrifugation techniques, including analytical ultracentrifugation, to investigate biochemical systems.	K3
CO2	**Analyze** spectroscopy techniques like UV-visible spectrophotometry, ESR, NMR, IR, and atomic spectroscopy for bioanalytical applications.	K4
CO3	**Analyze** microscopy techniques, including light, electron, and fluorescence microscopy, to study the structural features of biological specimens.	K4
CO4	**Evaluate** electrophoretic techniques such as SDS-PAGE, 2D gel electrophoresis, and isoelectric focusing for biomolecule separation and analysis.	K5
CO5	**Create** experimental workflows using advanced chromatographic techniques (TLC, HPLC, GC) for purifying and separating biochemical compounds in complex mixtures.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (Pos)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	3	3	2	3	3	3	**2.8**
CO2	3	2	3	2	2	2	2	2	3	2	**2.3**
CO3	2	3	2	3	3	2	2	3	3	2	**2.5**
CO4	2	3	2	3	2	2	2	3	2	3	**2.4**
CO5	3	3	2	3	2	3	2	2	3	2	**2.5**
Mean Overall Score											**2.5**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	**Low**
≥ 1.5 and < 2.5	**Medium**
≥ 2.5	**High**

Course Coordinator: Dr. R. SHALINI

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
VI	23UBT6DE2B	DSE-II	5	4	25	75	100

Course Title	PLANT AND ANIMAL PHYSIOLOGY

SYLLABUS		
UNIT	**CONTENT**	**HOURS**
I	**Plant - Water relationship**: Structure, properties and significance of water - osmotic and non-osmotic uptake of water. Ascent of sap - Nutrient Uptake, Role of hormones in plant, flowering, senescence and abscission- Photoperiodism, *Vernalization and seed dormancy, and Physiological parameter*.	**15**
II	Photosynthesis: Absorption spectrum, Action spectrum, Role of pigments, enhancement effect, Photosystems I & II, Photophosphorylation, Carbon Assimilation: Calvin cycle, Hatch & Slack pathway, CAM pathway. Photorespiration. *Stress Responses: Types of Stress: Abiotic Stress and Biotic Stress*	**15**
III	**Circulatory and Respiratory system:** Human Circulatory system - Structure and functions, Circulatory organs, circulation, Hemoglobin, Components and functions of blood. Respiratory system- Structure, types and functions; Respiratory organs, Mechanism of Respiration, CO2 and O2 transport, *Regulation of respiration*.	**15**
IV	**Digestive and Excretory system:** Human Digestive system - Organization, Digestive glands and enzymes, Absorption of Nutrients. Excretory system - Excretory organs and products, Mechanism of Urine and Urea formation, *Kidney stones*. Endrocrine system-Happy hormones.	**15**
V	Nervous and Reproductive system: Human Nervous Coordination: Central and peripheral nervous systems, structure and functions of neurons and brain, Conduction of Nerve impulse. Reproduction - Male and Female Reproductive systems, Fertilization, Estrus and Menstrual cycles, *Pregnancy and Parturition*	**15**
VI	Current Trends for CIA: Plant signaling mechanisms, Zinc sensing in nodules, Pollen banking.	

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Text Book(s):

1. F.B. Salisbury and C.W. Ross, Plant Physiology. CBS Publishers and Printers, New Delhi, 2014.
2. E. Roger and D. Randall., Animal Physiology, CBS Publishers and Distributors Pvt Ltd, India, 2021.
3. A. Mariakuttikan and N. Arumugam., Animal Physiology, Saras Publication, Nagercoil, India. 2021.

Reference Book(s):

1. V.K. Jain, Fundamentals of Plant Physiology. S. Chand & Co., New Delhi, 2019.
2. S.N. Pandey, Plant Physiology. Vikas Publishing House (P) Ltd., New Delhi, 2021.
3. S.C. Rastogi, Essentials of Animal Physiology. New Age International Publishers., 2022.

Web Resource(s):

1. https://nptel.ac.in/content/storage2/courses/102103044/Physiology/lec1/1.html
2. https://nptel.ac.in/content/storage2/courses/102103047/PDF/mod1.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Outline and classify the metabolic functions of plants.	K4
CO2	Exemplify the role of enzymes in various metabolic activities of plants.	K4
CO3	Explain the structure, function and significance of cardiovascular and respiratory systems.	K3
CO4	Explain the structure, function and significance of human digestive and excretory systems.	K3
CO5	Exemplify the role of human male and female reproductive systems and cycles and their influence on hormonal regulation.	K4

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	1	3	3	2	3	2	2	3	2.5
CO2	3	3	1	3	2	3	3	2	3	3	2.6
CO3	3	2	1	3	2	3	3	3	3	2	2.5
CO4	3	3	2	3	2	3	3	3	3	3	2.8
CO5	3	3	1	3	2	3	3	2	3	2	2.5
Mean Overall Score											**2.5**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. S. GEET ANDREA

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
VI	23UBT6DE3A	DSE-III	4	4	25	75	100

Course Title	IPR, BIOSAFETY AND BIOETHICS

SYLLABUS

Unit	Contents	Hours
I	**IPR and its types:** TRIPS, WTO, IP. IPR: Concepts, Designs, Trademarks (TM), Trade secrets, Geographical indications, and Copyright. History of the Indian patent system. International Conventions and Treaties on IPR. Comparative analysis of patent laws in other countries. *Research on landmark patent cases globally*.	12
II	**Classification of Patents:** Classification of patents in India, WIPO, Categories of patents, special patents, provisional patents, patenting biological product. Grant of patent and patenting authorities: Invention, eligible criteria, patentable and non-patentable inventions in India and abroad, patent office and patent authorities.	12
III	**Biological Safety:** Biosafety Levels; Biosafety Levels of Specific Microorganisms, Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC for GMO applications in food and agriculture; Biopiracy; Environmental release of GMOs; *Risk Analysis; Risk Assessment; Risk management and communication*.	12
IV	**Bioethics and its scope:** different approaches to ethics, their social and ethical implications, public and private sector organizations for biosafety and bioethics, Web-based information of biosafety on GMO – Introduction, biosafety database, importance of good laboratory practices. Myriad's case on gene patenting – Bt brinjal, Bt cotton and golden rice, *Biosafety Committee and its significance*.	12
V	**Ethical Considerations in Biotechnology and Life Sciences:** Bioethics in biodiversity, ethics of resource management, ethics issue of the human genome project, ethical issues in MTP, ethical issues leading to legal issues, ethics involved in stem cell research, ethics in animal cloning, ethics in human cloning, ethics in xenotransplantation, *NBA approval in biological products*	12
VI	**Current Trends * (For CIA only):** Data Privacy and Ethics in Genomic Research; Ethics of Vaccine Distribution and Mandates.	

***.....* self study**

Text Book(s):

1. Intellectual Property Rights: A Review" by J. R. O. L. L. H. and P. B. (2022)
2. Intellectual Property Law in the New Technological Age" by Richard Stim (2022)
3. Timothy Rice. "Biosafety and Bioethics in Biotechnology",1st edition, May 2022.

Reference book (s):

1. M.K. Sateesh. "BIOETHICS AND BIOSAFETY", 1st edition, December 2013.
2. Goel and Parashar. "IPR BIOSAFETY AND BIOETHICS". 1st edition, January 2013.
3. Sibi. G. "Intellectual Property Rights, Bioethics, Biosafety and Entrepreneurship in Biotechnology". 1st edition, August 2020.

Web Resource(s):

1. https://www.slideshare.net/slideshow/1-ipr-biosafety-and-bioethics-deepa-goel-shomini-parasharpdf/252916166.
2. https://nptel.ac.in/courses/109106092.
3. https://www.scribd.com/document/686050510/IPR-Biosafety-and-Bioethics.

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Describe the Intellectual Property Rights.	K2
CO2	Establishing the Knowledge of Patent Classification and Granting Process.	K3
CO3	Illustrate the Biosafety Regulations and Practices.	K4
CO4	Evaluate the Insight into Bioethics and Ethical Considerations.	K5
CO5	Generalize the Knowledge in Real-World Scenarios.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	2	2	2	2	2	2.0
CO2	2	2	2	2	2	2	2	2	2	2	2.0
CO3	2	2	2	2	2	2	2	2	2	2	2.0
CO4	2	2	2	3	3	2	2	2	2	2	2.2
CO5	3	2	2	3	3	3	3	3	3	3	2.8
										Mean Overall Score	2.2
										Correlation	**Medium**

MEAN OVERALL SCORE	CORRELATION
< 1.5	Low
≥1.5 and <2.5	Medium
≥2.5	High

COURSE COORDINATOR: Dr. S. DEBORAH

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
VI	23UBT6DE3B	DSE - III	4	4	25	75	100
Course Title	CANCER AND STEM CELL BIOLOGY						

SYLLABUS		
Unit	**Contents**	**Hours**
I	Cancer: Definition, Description, Basic facts, cancer is clonal in origin, Hallmarks, general classification of human cancers, microscopic and macroscopic features of neoplasm's, Grade and stage of neoplasm – Histologic grade of malignancy and tumor staging. Cell cycle and cancer – Dysregulation of cell cycle control, *Epithelial to Mesenchymal Transition (EMT) and Metastasis*.	**12**
II	Causes of Cancer: Theory of HITS, Chemical carcinogenesis – metabolic activation of chemical carcinogens (donors of simple alkyl group, cytochrome P-450 mediated activation), Mechanism of tumor initiation, promotion and progression. Irradiation carcinogenesis and viral carcinogenesis (Epstein Barr virus and Hepatitis virus). *Cancer Epidemiology - Global cancer statistics, risk factors (genetic, environmental, lifestyle)*	**12**
III	**Molecular Genetics of Cancer:** Oncogenes, Oncogene families, cell transforming ability of onc gene, functional classes of oncogenes, Characteristics of individual oncogene (ras and erbA). Tumor suppressor genes – suppressor genes (rb and p53). Cancer diagnosis – categories of tumor markers (nucleic acid based markers and gene expression microarray). *Epigenetics in cancer*, Cancer prevention and therapy.	**12**
IV	**Introduction to stem cells:** Definition, types (embryonic stem cells, adult stem cells, induced pluripotent stem cells), and their unique properties (self-renewal, differentiation). Stem Cell Niches - Microenvironment regulating stem cell behavior (hematopoietic, neural, and mesenchymal stem cell niches) Stem cell potency, Embryonic stem cells (ES) – Origins of mouse embryonic stem cells, derivation of embryonic stem cells, factors influencing ES cell derivation and *uses of embryonic stem cells*.	**12**
V	**Stem cell therapy:** Role of stem cells (spinal cord injury, myocardial infarction and heart failure), Comparison of different sources of stem cells, Role of stem cells in basic research, Regulations of stem cell therapy – current regulatory system in India and permissive regulations in other countries, Stem cell ethics – *religious and other ethical issues*.	**12**
VI	**Current Trends * (For CIA only):** AYUSH system in India, which encompasses Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homoeopathy, offers a cancer healing.	

***.....* self study**

Text Book(s):

1. The Biology of Cancer" by Robert Weinberg (3rd Edition, 2021).
2. "Cancer Stem Cells: Methods and Protocols" by Mehboob K. Bhatti and J. N. O. V. (2023**)**
3. "Principles of Cancer Biology" by Lewis J. Kleinsmith (2021)
4. Robert Lanz, John Gearhart, Brigid Hogan et al, Essential of stem cell Biology, Elsevier Academic Press, 2006.
5. Christine L. Mummery,Hans Clevers,Anja Van de Stolpe,Bernard Roelen,Stem Cells:Scientific Facts and Fiction,Academic press, 2021.

Reference Book(s):

1. Paul Knoepfler, Stem Cells: An Insider's Guide. World Scientific. 2013.
2. C.Potten, Stem cells,.Elsevier Publication.1996 3. AmitaSarkar, Embryonic stem cells. Discovery Publishing House Pvt. Ltd. 2009

Web Resource(s):

1.http://jprsolutions.info/newfiles/journal-file-56c675c7d3f8c9.27227172.pdf
2.https://dbtindia.gov.in/sites/default/files/National_Guidelines_StemCellResearch-2017.pdf
3. https://stemcellres.biomedcentral.com/articles/10.1186/s13287-019-1165-5

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Understand the key characteristics of cancer, its hallmarks, and how neoplasms are classified, graded, and staged.	K2
CO2	Illustrate how chemical, radiation, and viral factors cause cancer, and understand the global impact of cancer through epidemiology.	K2
CO3	Makeuseof in detail the roles of oncogenes, tumor suppressor genes, and epigenetics in cancer, and how they are used for diagnosis and prevention.	K3
CO4	Analyze the various types of stem cells, their unique properties, the environments that regulate their function, and how embryonic stem cells are derived.	K4
CO5	Justify how stem cells are used in therapies, compare different sources of stem cells, and understand the regulations and ethical issues surrounding their use.	K5

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	1	1	3	2	2	2	3	2.2
CO2	3	2	3	1	3	3	2	2	2	2	2.3
CO3	3	3	2	1	1	3	3	2	1	2	2.1
CO4	2	3	3	1	2	3	3	2	1	2	2.2
CO5	3	3	1	3	2	2	3	2	2	2	2.3
										Mean Overall Score	2.2

MEAN OVERALL SCORE	CORRELATION
< 1.5	Low
≥1.5 and <2.5	Medium
≥2.5	High

COURSE COORDINATOR: Ms. A. MEHER NISHA