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UNION CHRISTIAN COLLEGE (AUTONOMOUS) ALUVA

Affiliated to Mahatma Gandhi University, Kottayam, India
NAAC Accredited with A++ Grade in Vth cycle
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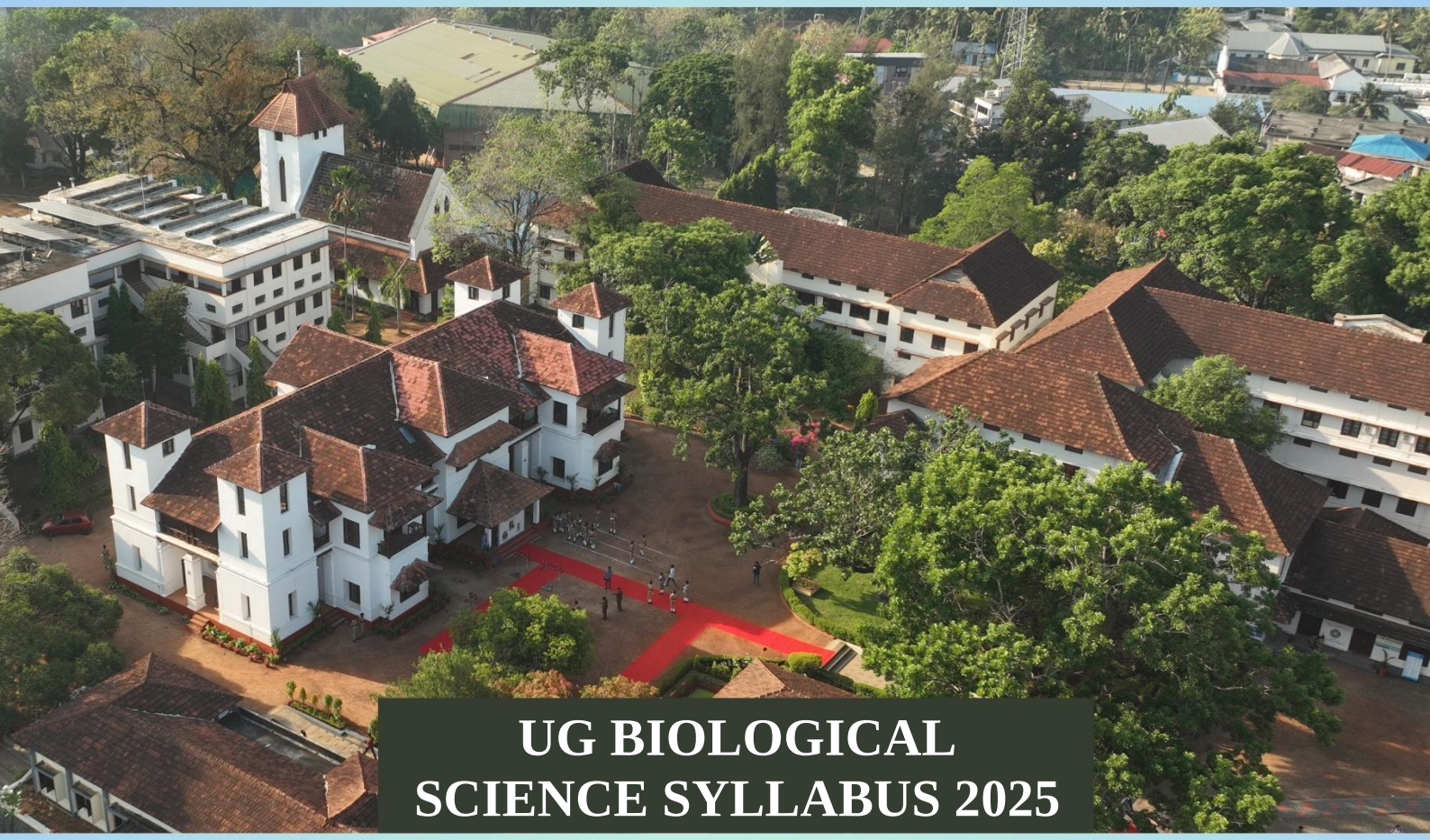
DEPARTMENT OF BIOSCIENCES



UG BIOLOGICAL SCIENCE SYLLABUS 2025

UNDERGRADUATE (HONOURS) PROGRAMMES {UCC UGP (HONOURS)}

Adopted from THE MAHATMA GANDHI UNIVERSITY
UNDER GRADUATE PROGRAMMES
(HONOURS) SYLLABUS
MGU-UGP (Honours)
(2024 Admission Onwards)

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THE TRUTH SHALL MAKE YOU FREE

UNION CHRISTIAN COLLEGE, ALUVA (Autonomous)

UNDERGRADUATE PROGRAMMES (HONOURS) SYLLABUS UCU-UGP (Honours) (2025 Admission Onwards)

Faculty: Biosciences

BoS: Biological Sciences

Subject: Bachelor of Science (Honours) Biological Sciences

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Title

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38. From Lab to Life
39. Practical Bioinformatics

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PREFACE

With great enthusiasm and deep sense of responsibility, we, the Board of Studies in Biological Sciences, Union Christian College (Autonomous), Aluva present this preface to the meticulously designed curriculum and syllabus, adopted from the Board of Studies in Zoology, Mahatma Gandhi University, for the Four-Year Undergraduate Program (FYUGP) in Biological Sciences at our institution. We extend our sincere gratitude to the Board of Studies in Zoology, Mahatma Gandhi University, for their exceptional work in developing this comprehensive and forward-thinking syllabus.

University Grants Commission has put forward the concept of Four Year Under Graduate Program which envisions a paradigm shift from a teacher-centric to student-centric higher education system in India. The same has been recommended for implementation by Kerala Higher Education Council. As per the Regulations of Mahatma Gandhi University, Board of Studies of Zoology has designed a curriculum which gives importance to skill - based education where the graduate attributes are first set to design the programs, courses and supplementary activities.

The Four Year undergraduate program in Biological Sciences is designed to equip students with a strong foundation in various fields of Biology while addressing the emerging trends and challenges in areas such as Molecular Biology, Biotechnology, and Environmental Sustainability. The Bachelor of Science (Honours) in Biological Sciences is a dynamic and interdisciplinary program designed to provide students with a solid foundation in the principles, practices, and frontiers of modern biology. This course explores the diversity of life, from the molecular and cellular levels to the complexity of ecosystems and evolutionary processes. As the world faces growing challenges in health, environment, and sustainable development, the role of biological sciences has never been more critical. This syllabus aims to equip students not only with theoretical knowledge but also with practical skills in research, critical thinking, and scientific communication.

The curriculum integrates core biological concepts with opportunities for specialization and hands-on laboratory experience. It is structured to foster curiosity, innovation, and a lifelong appreciation for the living world. In an era where biological research is at the forefront of addressing global challenges such as disease outbreaks, climate change, food security, and biodiversity loss, this course offers students both relevance and opportunity. Graduates of this program are well-prepared for diverse career paths. They may pursue opportunities in research institutions, healthcare and diagnostics, pharmaceuticals, environmental agencies, biotechnology companies, and agricultural industries. Additionally, the course lays a strong groundwork for those seeking to advance their studies through postgraduate education in specialized fields such as Molecular Biology, Bioinformatics, Biomedical Sciences, or Environmental Biology.

The curriculum framework provides an exit option at the end of third year, with BSc Degree in Biological Sciences. Continuing into the fourth year a student can either opt for BSc Honours in Biological Sciences, or BSc Honours with Research in Biological Sciences. The learning outcomes-based curriculum framework is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at

various stages. A student of BSc Biological Sciences (Honours) with Research have to undertake a **research project** of 12 credits. It offers several significant benefits, promoting inquiry-based learning, where students take an active role in driving their own learning process and develop a strong foundation for future academic or professional endeavours in the field of their interest and spark further inquiry. The **Internship** during the summer vacation of second year provides students with the opportunity to gain real-world experience in their chosen field of study. It offers the chance to develop and enhance a wide range of skills, including communication, teamwork, problem-solving, time management, adaptability and professional growth. The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society.

By fostering scientific curiosity, innovation, and ethical responsibility, this program aspires to cultivate not only skilled professionals but also conscientious citizens capable of making meaningful contributions to both science and society. In conclusion, we eagerly anticipate guiding students through this enriching journey across the diverse landscapes of Biological Sciences. We hope this syllabus serves as a gateway to a transformative academic experience one that lays a solid foundation for lifelong learning and impactful contributions.

Dr.Sareen Sarah John
Chairperson
UG Board of Studies in Biological Sciences

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22	**Dr. Aneymol V S**, Assistant Professor, Department of Zoology,St. Xavier's College (Autonomous), Aluva.	**Members**

.Syllabus Index

Name of the Major: Biological Sciences

Semester: I

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution/ week			
					L	T	P	O
UC1DSCBTS100	New biology for the new century	DSC A	4	5	3	0	2	
UC1DSCZGY100	Introduction To Zoology	DSC A	4	5	3	0	2	
UC1DSCBCH100	Biochemistry-The Science of Life	DSC A	4	5	3	0	2	
UC1MDCBTS100	Food, Nutrition and Medicine	MDC	3	4	2	0	2	

L — Lecture, T — Tutorial, P — Practical/Practicum, O — Others

Semester: II

Course Code	Title of the Course	Type of the Course DSC, MDC,SEC etc.	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC2DSCBTS100	Preparation of Biological Specimens	DSC A	4	5	3	0	2	
UC2DSCZGY100	Environmental Biology	DSC A	4	5	3	0	2	
UC2DSCBCH100	Essentials of Biochemistry: Vitamins, Hormones, Enzymes and Neurotransmitters	DSC A	4	5	3	0	2	
UC2MDCBTS100	Biological Foundations for Health and Wellness	MDC	3	4	2	0	2	

Semester: III

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC3DSCBTS200	Essentials of Biological Techniques	DSC A	4	5	3	0	2	
UC3DSCBTS201	General Microbiology	DSC A	4	5	3	0	2	
UC3DSEBTS200	Clinical Biochemistry and Clinical Microbiology	DSE **(Any 1)**	4	4	4	0	0	
UC3DSEBTS201	Aquarium Management		4	4	4	0	0	
UC3DSCBTS202	Diverse Animal Life	DSC B	4	5	3	0	2	
UC3DSCBCH202	Techniques in Biochemistry and Forensic Science	DSC B	4	5	3	0	2	
UC3MDCBTS200	Science of Organic Farming	MDC	3	3	3	0	0	
UC3VACBTS200	Public Health, Hygiene and Sanitation: An awareness	VAC	3	3	3	0	0	

Semester: IV

Course Code	Title of the Course	Type of the Course DSC, MDC,SEC etc.	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC4DSCBTS200	Genetic Engineering and Plant Tissue Culture	DSC A	4	5	3	0	2	
UC4DSCBTS201	Cell Biology	DSC A	4	5	3	0	2	
UC4DSEBTS200	Enzymology	DSE **(Any 1)**	4	4	4	0	0	
UC4DSEBTS201	Research Methodology and Biostatistics		4	4	4	0	0	
UC4DSCBTS202	The Molecules of Life	DSC B	4	5	3	0	2	
UC4VACBTS200	Human rights and Gender Equality	VAC	3	3	3	0	0	
UC4SECBTS200	Basic Molecular Techniques	SEC	3	3	3	0	0	
UC4INTBTS200	Internship	INT	2					

Semester: V

Course Code	Title of the Course	Type of the Course DSC, MDC,SEC etc.	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC5DSCBTS300	Developmental Biology	DSC A	4	5	3	0	2	
UC5DSCBTS301	Molecular Biology	DSC A	4	5	3	0	2	
UC5DSCBTS302	Genetics	DSC A	4	4	4	0	0	
UC5DSEBTS300	Immunology	DSE	4	4	4	0	0	
UC5DSEBTS301	Introduction to Forensic Biology	DSE **(Any 1)**	4	4	4	0	0	
UC5DSEBTS302	Evolution and Ethology		4	4	4	0	0	
UC5DSEBTS303	Neurobiochemistry		4	4	4	0	0	
UC5SECBTS300	Entrepreneurship in Biochemistry	SEC	3	3	3	0	0	

Semester: VI

Course Code	Title of the Course	Type of the Course DSC, MDC,SEC etc.	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC6DSCBTS300	Food and Industrial Microbiology	DSC A	4	5	3	0	2	
UC6DSCBTS301	Human Physiology	DSC A	4	5	3	0	2	
UC6DSEBTS300	Biotechnology for Human Welfare	DSE	4	5	3	0	2	
UC6DSEBTS301	Introduction to Bioinformatics	DSE **(Any 1)**	4	4	4	0	0	
UC6DSEBTS302	Animal Cell Culture and Stem Cell Biology		4	4	4	0	0	
UC6VACBTS300	From Lab to Life	VAC	3	3	3	0	0	
UC6SECBTS300	Practical Bioinformatics	SEC	3	3	3	0	0	

Semester: VII

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC7DCCBTS400	Microbial Food Safety	DCC	4	5	3	0	2	
UC7DCCBTS401	Biotechnology in Clinical Diagnosis	DCC	4	4	4	0	0	
UC7DCCBTS402	Biosafety, Bioethics and IPR	DCC	4	4	4	0	0	
UC7DCEBTS400	Plant Physiology and Phytochemical Techniques	DCE **(Any 3)**	4	4	4	0	0	
UC7DCEBTS401	Cancer Biology		4	4	4	0	0	
UC7DCEBTS402	Clinical Research and Pharmacovigilance		4	4	4	0	0	
UC7DCEBTS403	Stress Physiology		4	4	4	0	0	
UC7DCEBTS404	Toxicology Studies and Techniques		4	4	4	0	0	

Semester: VIII

Course Code	Title of the Course	Type of the Course DSC, MDC,SEC etc.	Credit	Hours/ week	Hour Distribution/week			
					L	T	P	O
UC8DCCBTS400	Omics approaches in Biotechnology	DCC	4	5	3	0	2	
UC8DSCBTS401	Microbial Biotechnology	DCC	4	5	3	0	2	
UC8DSEBTS400	Plant Biotechnology	DCE (Any 3)	4	5	3	0	2	
UC8DCEBTS401	Biotechnology and Forensic Science		4	5	3	0	2	
UC8DCEBTS402	Plant Microbe Interaction		4	5	3	0	2	
UC8DCEBTS403	Molecular Phylogeny		4	5	3	0	2	
UC8DCEBTS404	Genomics, Proteomics and Nanotechnology		4	5	3	0	2	
UC8PRJBTS400	Project	PRJ	12					

SEMESTER-I

Programme	**BSc (Honours) Biological Sciences**					
Course Name	NEW BIOLOGY FOR THE NEW CENTURY					
Type of Course	DSC A					
Course Code	UC1DSCBTS100					
Course Level	**100**					
Course Summary	Introductory level course for understanding the general outlook of the world of diverse life forms, their emergence, organization and diversity. The molecular machinery of organisms, selected techniques used to learn them and their impact on world welfare and research are studied keeping the future in mind.					
Semester	**I**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	Case Studies Group work Seminars Presentations	75
Pre-requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No
1	Understand the fundamental principles and concepts that govern the living world enabling the organisms to exist through various levels of biological organization.	U	2,3,10
2	Categorize and identify group organisms based on their cellular structures and biological classification	K	2,3,10
3	Identify and classify different types of biomolecules based on their function	K	2,3,10
4	Understand the basic principles of molecular genetics and gene expression	U	2,3,10
5	Analyze the relationships of biomolecules and how it contributes to the overall function of cell and organism	An	2,3,10
6	Understand the basic principles behind evolution of life forms and environmental biology	U	2,3,10
7	Explore the milestones and techniques used for the advancements and emerging trends in the field of modern day applied biology	E	2,3,10

8	Develop thinking abilities through the analysis of case studies and articles related to biological studies	An	2,3,10
9	Understand the evolving global challenges and its impact on the various aspects of the world	U	2,3,10
10	Understand some of the modern day concerns of the world and think how they can be addressed using the technologies in Biology	U, An	2,3,7,10
Remember(K), Understand(U), Apply(A), Analyse(An), Evaluate(E), Create(C), Skill(S), Interest(I) and Appreciation(Ap)			

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1	1.1	The living world , the five kingdom classification by Whittaker	5	1,2
	1.2	Prokaryotic and eukaryotic cell structures; The structural composition and the biomolecular dissection of the cell.	5	1,2,3
	1.3	Organisms as molecular machines driving the genetic flow of information. The era of the genetic code	5	1,3,4,5
2	2.1	Cell cycle and cell division. Genes defining the organizational fabric of life. The principles of inheritance and variation.	5	1,4,5
	2.2	Emergence; Key aspects of evolution, misconceptions and evidences. Origins of life (Darwin),Mechanism and concept of Mutation	5	1,6
	2.3	Organism and its environment. Concepts of population and ecosystem. Biodiversity	3	1,6
3	3.1	Introduction to emerging branches which are poised to accelerate discovery and predictability in design and support of research, medicine, agriculture and manufacturing. Biotechnology Bioinformatics The 'Omics' approaches Nanotechnology	5	7
	3.2	Important biological techniques for visualization and understanding chemistry of cells Microscopy, histochemical and biochemical techniques.	4	7

	3.3	Important biological techniques for structural, cellular and molecular studies; NMR ,X-ray crystallography, Flow cytometry and radioisotope techniques	4	7
	3.4	Important molecular techniques; Cloning, Monoclonal Antibody technology, Sequencing technology. Bioinformatics	4	7
4		**PRACTICAL**	**30**	
	4.1	Case studies and identification of the important milestones which have improved human welfare and the role played by biological techniques in • prevention and treatment of infectious diseases • enhanced agricultural productivity and food security • health care diagnosis • drug development and therapy • research (Group work)	10	8,9,10
	4.2	Case studies on global issues which can be addressed using technologies in life sciences (a) Climate Change (b) Food Security (c) Disease prevention and management (d) Environmental conservation & water management (e) Aging population (Group work)	10	8,9,10
	4.3	Scientific breakthroughs in Biology Antibiotics Hela Cell line Double Stranded structure of DNA PCR Gene Therapy Fluorescent Protein HGP RNAi Crispr-Cas9 (Student Presentations on working knowledge of the technologies listed above)	10	7, 8,9,10
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, group interactions, group seminar, power point, case studies Teaching aids used- Audio Visual Presentation, Photographs, Internet Resources

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 25 marks** Test Papers/Assignments/Seminars **Practical Total= 15 marks** Case Study presentations Chart/Visual presentations Case Study Reports
	B. End Semester Examination **Theory Total = 50 marks (Duration 1.5 hrs)** Multiple Choice Questions (10 X 1) = 10 marks Short Questions (10 out of 12) X 2= 20 marks Short essays (5 out of 7) X 4= 20 marks **Practical Total =35 marks (Duration 2hrs)** Record= 10 marks Viva= 5 marks Case Study Report=5 marks Examination=15 marks

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1. Agarwal, S. R., & Agarwal, S. K. (2019). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. New Delhi, India: S. Chand Publishing.
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SUGGESTED READINGS

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2. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
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5. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

Programme	**BSc (Honours) ZOOLOGY**					
Course Name	INTRODUCTION TO ZOOLOGY					
Type of Course	**DSC A**					
Course Code	**UC1DSCZGY100**					
Course Level	**100**					
Course Summary	The course includes several marvelous facts about the animal world which can foster sense of interest¸ connection, empathy and caring towards the animals. They feel responsible and enthusiastic to learn more about the animal world.					
Semester	I	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	---	1	---	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Identify the wonders of the animal world and the facts behind the phenomena.	U	2,3
2	Explain Coloration, Mimicry & Parental care.	U	2,3
3	Discover the research avenues & career opportunities in Zoology	U	2,3
4	Predict the Entrepreneurial Possibilities in the field of Zoology	E	1,2,3
5.	Prepare detailed report of field visits to environmentally important places¸ research institutions and career orientation centers	A	2,3

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Wonders of Animal world**	**15**	
	1.1	**Incredible Animal Architects** Introduction to Animal Societies	7	1
	1.2	Honeybees – Skilled Engineers of Nature Comb building in Honey bees		
	1.3	Architectural secret of Termite hills		
	1.4	Weaver Bird-Wonderful Architect		
	1.5	**Glowing Wonders** Bioluminescence – Mechanism Noctiluca – Sparkle of the sea Firefly- Stars on earth Octopus – Wild Glowing Wonder Angler fish – the glowing monster	8	1
	1.6	Story of Pearl , Types of Pearl, Pearl Formation, Process of Picking best Pearl		
2		**Coloration , Mimicry & parental care**	15	
	2.1	**Coloration & Mimicry** Fakers of Nature- Secret behind Coloration & Mimicry Beautiful Butterflies, Colorful Earthworms, Painted Starfish Blue beauty Frog , Lovely Chameleon , Handsome Peacock Magnificent Owl Butterfly Leaf insect – The Walking leaves	7	2
	2.2	**Parental care** Animal Parenting – Facts & examples Who will take care? Father or Mother. Mother – Velvet Spider - Epitome of sacrifice Father – Water bug - Model father Pregnant Father – Sea Horse Father Brooder – Male Darwin frog. Sophisticated parents – Python parenting Supermom – Humming Bird Aggressive Mother – Otter	8	
3		**Major Research Areas & Careers in Zoology**	15	
	3.1	**Exciting avenues for research** Bioinformatics, Molecular biology, Biostatistics, Wildlife Biology, Toxicology & Pharmacology, Forensic biology, Physiology, Genetics,	5	3

		Microbiology, Immunology, Developmental Biology, Ethology, Biotechnology, Environmental Biology, Animal Systematics, Marine biology, Fisheries, Cell biology, Entomology, Biochemistry, Parasitology, **brief description only**		
	3.2	**Attractive career opportunities** **General**- All general UPSC jobs especially IFS (Indian Forest Service), Kerala PSC (all general degree based jobs), jobs in Kerala Forest and wildlife department (Range Forest Officer and Beat Forest officer),Scientists, Research assistants, Lab technicians, Animal house keepers in reputed research centers like ZSI, CSIR, ICAR, RGCB, KFRI, NCBS, TIFR, SACON, BARC, ICZN etc. Jobs in NGOs like WWF, ATREE, Wildlife SOS, Wildlife Trust of India, Center for Wildlife Studies, Nature Conservation Foundations etc. **Specific**- Entomologist in Vector control board and in research institutes like KFRI; Teaching; Biologist and Curator in Museum and Zoological Parks; Fisheries officer in Fisheries department, Junior scientific assistant in pollution control board, District Malaria Officer, forensic assistant in police department and health department; ecologist, conservation biologist and nature education officers in various wildlife sanctuaries and protected areas; jobs in Pharmaceutical companies. Embryologist, Cytological specimen preparation, Cytogeneticist in diagnostic labs and hospitals. Medical coding	5	3
	3.3	**Lucrative Entrepreneurial Possibilities** Products, byproducts & value added products of: Apiculture, Sericulture, Dairy Farming, Poultry Farming, Pets and their management, Aqua culture (Edible and ornamental) and Vermiculture	5	3,4
4		**Practical**	**30**	
	4.1	Identification of any 10 specimens coming under the following categories 1. Animal architects, 2. Glowing animals, 3. Animal mimicry, 4 Animal coloration, 5. Parental care.	8	5

	4.2	Search wonders of animal world and make short videos/reports/photos: 1. Animal architects, 2. Glowing animals, 3. Animal mimicry, 4 Animal coloration, 5. Parental care.	5	
	4.3	1. Field visit - Nature camp, butterfly garden, museum, pearl culture farm.(any 2) 2. Visit to any 2 research institutes 3. Visit and interact with any two entrepreneurs from different fields and submit the report 4. Career Orientation class by experts	17	
5.		**Teacher Specific Module**		

EVALUATION AND ASSESSMENT

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture¸ group interaction¸ seminar¸ presentations **Note:** Only a brief description of the focal topic is required. Teaching aids like photographs¸ models¸ videos¸ short films¸ documentaries related to the topic may be used
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory** **Total = 25 marks** Quiz, Test Papers, seminar **Practical Total = 15 marks** Lab performance, record, field report, entrepreneur interaction report
	B. End Semester Examination **Theory Total = 50 marks, Duration 1.5 hrs** Short Essays - 5 out of 7 x4 =20 marks Short questions - 10 out of 12 x2 =20 marks Fill in the blanks -10x1=10 marks **Practicals Total = 35 marks; Duration- 2 hrs Record 10 marks,** **Examination 25 marks:** spotter identification - 16 marks Viva - 4 marks, research institute visit report- 5 marks

REFERENCES

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Programme	**BSc (Honours) Biochemistry**					
Course Name	BIOCHEMISTRY-THE SCIENCE OF LIFE					
Type of Course	**DSC A**					
Course Code	**UC1DSCBCH100**					
Course Level	**100-199**					
Course Summary	The primary objective of this course is to establish a strong foundation in biochemistry for students, with a focus on essential molecular components. Additionally, the course covers fundamental procedures within a biochemistry laboratory and the qualitative analysis of biomolecules.					
Semester	I	Credits			4	
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	Total Hours
		3	0	1	0	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Acquire an understanding of the nature of cells, water, buffers and the scope of Biochemistry	K, U, I	2, 3, 4, 6, 10
2.	Demonstrate the structure and functions of carbohydrates	K, U, E	1, 2, 3, 4
3.	Describe the general structure of amino acids and structural organisation of proteins	K,U, E	1,2,3,4
4.	Evaluate the chemical nature of lipids and nucleic acids.	U, E, An	1, 2, 3, 4
5.	Demonstrate laboratory safety practices and preparation of solutions.	An, E, Ap	2, 5, 8,10
6.	Employ appropriate biochemical tests to identify unknown biomolecules	U, A, C, S	2, 8,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill(S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	1.1	History of Biochemistry.	2	1
	1.2	Cells - the basis of living organisms- prokaryotic and eukaryotic cells.	2	1

1. Introduction to Biochemistry	1.3	Importance of water in biological systems - interactions in aqueous systems.	3	1
	1.4	Dissociation of water, ionic product of water, concepts of pH and pOH, acids and bases, pH scale, Buffers.	3	1
	1.5	Buffers, biological buffers- bicarbonate buffer, phosphate buffer, hemoglobin buffer.	2	1
	1.6	Different types of biomolecules and their functional groups.	2	1
	1.7	Scope of Biochemistry.	1	1
2. Carbohydrates and Proteins	2.1	Classification of carbohydrates	1	2
	2.2	Monosaccharides and their importance (glucose, galactose, mannose and fructose with structures), Isomerism of carbohydrates - D and L forms, epimers, anomers. Disaccharides - sucrose, maltose, lactose	3	2
	2.3	Haworth perspective formula and functions of disaccharides - sucrose, maltose, lactose.	2	2
	2.4	Structure and important properties of the homopolysaccharides — starch, cellulose and glycogen. (without structure) heteropolysaccharide - hyaluronate (without structure)	3	2
	2.5	Name (with one letter and three letter code) of the 20 standard amino acids, general structure of amino acid. Zwitter ions.	3	3
	2.6	Elementary study of primary, secondary, tertiary and quaternary structural levels in proteins.	3	3
3. Lipids and Nucleic Acids	3.1	Classification and functions of lipids, Fatty acids - structures of stearic acid, oleic acid and linoleic acid.	2	4
	3.2	Structure and significance of triacylglycerol phosphatidic acid, lecithin and cholesterol.	3	4
	3.3	Chemical nature of nucleic acids- purines and pyrimidines, deoxyribose, ribose, nucleosides, nucleotides. Phosphodiester linkage.	4	4
	3.4	Watson-Crick model of DNA, Chargaff rule, Different forms of DNA-A, B and Z DNA. Introduction to types of RNA (mRNA, rRNA and tRNA). Central Dogma	6	4
4. Practical	4.1	Laboratory Safety Practices, Preparation of normal, molar, percentage solution and dilution of stock solutions. Determination of pH using a pH meter.	6	5
	4.2	Systematic analysis of carbohydrates and aminoacids in the given unknown samples.	10	6
	4.3	Qualitative analysis of lipids and nucleic acids	9	6

	4.4	Industry/ Laboratory visit	5	6
5. Teacher specific content/ Teacher facilitated activities				

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through Lectures, E-learning, Seminars, presentations, Group activity, Interactive sessions and Laboratory sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Theory 25 marks 1. Poster making/model building (2 marks) 2. Seminar presentation/Quiz (5 marks) 3. Involvement in group discussion (3 marks) 4. Multiple Choice questions (10 marks) 5. Assignment (2 marks) 6. Open book test (3 marks) Practical 15 marks* 1. Viva (5 marks) 2. Record (5 marks) 3. Laboratory involvement (5 marks) *This mark to be converted to 7.5 marks
	B. End Semester Examination (ESE) **Theory Total = 50 marks, Duration 1.5 hrs** A Multiple Choice Questions 5 out of 5 (1 mark each) 5 x 1= 5 B Fill in the Blanks 5 out of 5 (2 marks each) 5 x 2 = 10 C Short Answer 5 out of 7 (3 marks each) 5 x 3 = 15 D Short Essay 4 out of 6 (5 marks each) 4 x 5 = 20 **Practical examination (35 marks)*** *This mark to be converted to 17.5 marks

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Co Ltd.
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3. West E.S., Todd W.R., Mason H.S., Van Bruggen J.T., (2017) Text Book of Biochemistry (4th ed.)
4. Voet D., Voet J., Pratt C.W., (2018) Voet's Principles of Biochemistry (5th ed.)
5. Rastogi V. B., Aneja K.R.,(2020) Zubay's Principles of Biochemistry (5th ed.)

Suggested Readings

1. Das D., (2015) Biochemistry (14th ed.) Academic publishers

Programme						
Course Name	FOOD, NUTRITION AND MEDICINE					
Type of Course	MDC					
Course Code	UC1MDCBTS100					
Course Level	**100**					
Course Summary	Foundations of Nutritional Biochemistry- Basics of importance and the role of food for health					
Semester	**I**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	0	1	0	60
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To understand the importance of health for quality living and health hazards	U	2,3,10
2	To acquire knowledge about the role of food for sound health.	A	2,3,10
3	To learn the impact of different nutraceuticals and functional foods on health	An	2,3,10
4	To understand phytochemical components and its management on health and diseases	U	2,3,10
5	To apply basic nutrition knowledge in making foods choices and obtaining an adequate diet.	A,K	2,3,10
6	To gain competence in connecting the role of various nutrients in maintaining health and learn to enhance traditional recipes	A,An,C,I	2,3,9,10
7	To gain knowledge about principles of diet therapy and different therapeutic diets.	E,S	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 30	CO No.
1		**Food and health**		
	1.1	Health – Definition, meaning of health and factors affecting health. Health hazards – environment, population explosion, explosives, adulteration, dampness and measures to prevent health hazard.	2	1
	1.2	Food for health promotion-Definition of food, Nutrition, Nutrients and Nutritional status. Functions of food – Physiological, psychological and socio - cultural functions, constituents of food and their functions	3	1,2
	1.3	Principles of nutrition Introduction to Nutrition - General introduction, history of Nutrition. Energy - Definition of Kilocalories, Joule, energy value of foods. Basal metabolic rate definition, Factors affecting BMR. Energy requirements and recommended dietary allowance (RDA) for infants, children and pregnant women. Carbohydrates, Proteins, Fats and Lipids- Functions, sources, utilization, requirement and important functions	8	1,2
	1.4	Vitamins – Fat soluble vitamins –A, D, E and K- functions, source, requirements, deficiency disorders. Water soluble vitamins –The B-complex vitamins – Thiamine, Riboflavin, Niacin, Folic acid, Biotin, Pantothenic acid, B12 and Vitamin C - functions, source, requirements and deficiency disorders	8	2,3
	1.5	Minerals - General functions in the body, classification- macro and micro minerals. Micro minerals – Iron, Fluorine, Zinc, copper, Iodine -functions, absorption, utilization, requirements, deficiency and toxicity. Macro minerals – Calcium & phosphorus - functions, absorption &utilization of iron, deficiency and toxicity. Water Balance – Functions of water, water distribution, maintenance of water and regulation of acid-base balance in the body.	5	2.3
2	2.1	**Functional food and nutraceuticals** Definition and source- Functional foods and	2	2.3,4

		Nutraceuticals. Development of functional foods, challenges and safety considerations, Future trends of functional foods. Types of functional foods: whole foods, enriched foods, enhanced foods, fortified foods, modified foods. Dietary supplements and fortified foods- its need, health benefits and adverse effects.		
2	2.2	Functional foods of animal origin: Diary products, sea foods, egg. Functional foods of plant origin: fruits, vegetables, nuts, spices, cereals. Probiotics, prebiotics and synbiotics as functional foods, current trend and effects of probiotics on health	1	3,4
	2.3	Nutraceutical and herbal nutraceuticals. Phytochemicals, phytosterols and other bioactive compounds, peptides and proteins, carbohydrates, lipids, vitamins and minerals- their sources and role in promoting human health. Current and future trends.	1	4
3		**PRACTICALS**	**30**	
	3.1	Case Studies on Objectives of diet therapy - Role of a dietitian. Principles of diet preparation and counselling. Normal diet in the hospitals –, liquid, semi liquid, light, soft diet, bland diet and regular diet, Different types of Feeding. Therapeutic diets for the following disorders: a) Obesity - definition, etiology, treatment. b) Diseases of the gastro intestinal tract- ulcer, constipation & diarrhoea c) Diseases of the liver and gall bladder (risk factors and diet therapy) d) Diseases of the cardio vascular system (risk factors and diet therapy) e) Diabetes mellitus – Types, causes, symptoms, bio-chemical changes, insulin, hypo-glycemic drugs, dietary management. f) Diseases of the kidney and urinary tract.	8	5,6,7
	3.2	Case studies on 1. The impact of processed foods on the health of individuals, comparing the nutritional content of processed versus whole foods and analyzing the potential long-term health effects. 2. The prevalence of food allergies in children and how diet modifications can help prevent allergic reactions and improve overall health.	8	5,6,7

	3.3	3. How access to nutritious foods can improve health outcomes and reduce the risk of malnutrition. 4. Relationship between gut health and mental health, exploring the role of probiotics, prebiotics, and dietary fiber in supporting a healthy microbiome and improving mood and cognitive function.	8	5,6,7
	3.4	Nutritional status assessment of the critically ill patients, complications, nutritional support systems for the critically ill, commercial feeding formulas and special diets for critically ill.	6	5,6,7
4		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, group interactions, group seminar¸ power point presentations, case studies Teaching aids used- Audio Visual Presentation, Photographs, Internet Resource
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 15 marks** Test Papers/Assignments/Seminars **Practical Total= 15 marks** Timely submission of Records Chart/Visual presentations Diet assessment study
	B. End Semester examination **Theory Total = 35 marks (Duration 1hr)** Multiple Choice Questions (5X1) = 5 marks Short Questions (5 out of 7) X 2 = 10 marks Short essays (5 out of 7) X 4= 20 marks **Practical Total =35 marks (Duration 2hrs)** Record = 10 marks Viva= 5 marks Case Study Report=5 marks Practical case study= 15 marks

References

1. Antia, F.P. (1987). Clinical Dietetics and Nutrition. Oxford University Press.
2. Bamji, M.S., Krishnaswamy, K., & Brahmam, G.N.V. (2009). Textbook of Human Nutrition (3rd ed.). Oxford and IBH Publishing Co. Pvt. Ltd.
3. Dash, B. N. (2003). Health & Physical Education (1st ed.). Neelkamal Publications.
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SEMESTER-II

Programme	**BSc (Honours) Biological Sciences**					
Course Name	PREPARATION OF BIOLOGICAL SPECIMENS					
Type of Course	DSC A					
Course Code	UC2DSCBTS100					
Course Level	**100**					
Course Summary	The student will acquire basic knowledge on the classification and life cycles of plants and animals. They get skills on collection, preparation and preservation of biological specimens.					
Semester	**II**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basic knowledge about collection and preservation of biological specimens	U	2
2	Understand the basic knowledge about animal classification and its life cycle.	U	2,3
3	Acquire skill of different methods of animal specimen preparation techniques.	U, S	2,3,10
4	Understand the basic knowledge about plants classification and anatomy.	U	2,3,9,10
5	Acquire skill of different methods of plant specimen preparation techniques.	U, S	2,3,9,10

Remember(K), Understand(U), Apply(A), Analyse(An), Evaluate(E), Create(C), Skill(S), Interest(I) and Appreciation(Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1.	1.1	General Concepts of specimen preservation, Types, collection techniques-(Baerman funnel, Berlese funnel, Dreger, orange peel bucket, dippers, sampling method, plankton net and night lighting. Transect and Quadrat method.	2	1
	1.2	Preservatives and their usage, field note, labeling, and transportation and storage, Precaution measure for preservation.	2	1
	1.3	Rules and laws for collecting specimen.	1	1
2	2.1	Brief classification, Collection and preservation of Invertebrates-(Protista, porifera, coelenterate, ctenophore, Platyhelminthes, Nematoda, Annelida, Arthropoda, Mollusca and Echinodermata). Collection and preservation technique (any two method)	12	1,2
	2.2	Brief classification, Collection and preservation of Vertebrates-(Pisces, aves, amphibians, reptiles and mammals). Collection and preservation technique (any two method)	8	1,2
3	3.1	Brief classification of plants, Basics of plant anatomy: simple tissue, complex tissues	4	4
	3.2	Where and how to collect plants? Methods of preparation and storage of herbarium sheets and museum specimens.	3	5
	3.3	Preparation of life cycles of specimens (any 5), Alizarin staining, Articulated skeleton preparation, Dermestid technique, Resin embedded specimen, preparation of sections involving microtome and cryostat, Taxidermy.	7	3
	3.4	Staining: Simple stains, double stains, special stains, HE staining. Temporary and permanent slide preparation.	3	4
	3.5	Collection of plants, preservation of plants: dry (display box, Ricker box, herbarium and wet preservation (special preservatives) and storage.	3	5
4		**PRACTICAL**	**30**	
		1. Whole mount preparation of small animals, parts of animals and plants 2. Alizarin preparation of small invertebrates 3. Preparation of articulated skeletons 4. Preparation of resin embedded specimens**(plant or animal)** 5. Demonstration of Taxidermy 6. Preparation of herbarium sheets 7. Preparation of specimens by each student from a given phylum		3,5

		8. Preparation of display boxes of dry plant and plant product mounts		
		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture¸ Group activities, group interaction¸ seminar¸ presentations, Field studies Note: Only a brief description of the focal topic is required. Teaching aids like photographs¸ models¸ videos related to the topic may be used.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory** **Total=25 marks** Quiz/ Test Papers/ seminars **Practical Total 15 marks** Lab performance/ record/ field report, individual specimen preparation, herbarium sheets
	B. End Semester Examination **Theory Total 50 marks, Duration 1.5 hrs** Multiple Choice Questions -12x1 =12 marks Short questions- 6 out of 8 x 3 = 18 marks Short Essays 4 out of 6 x 5 = 20 marks **Practicals Total 35 marks Duration- 2 hrs Record 10 marks,** **Examination 25 marks:** Preparation of Specimens 15 marks Viva-2 marks, Herbarium sheets- 8 marks

References

1. Bean, A.R., ed. (2006). Collecting and preserving plant specimens: a manual. Queensland Herbarium, Environmental Protection Agency Biodiversity Sciences unit, Brisbane, Australia. [ii], 28 p. Call No.: QK 61 .C64 2006
2. Bhaskaran, K.K. (1986). Micro technique and Histochemistry. Evershine Press, Vellangalloor.
3. Clute, W.N. (1903). The making of an herbarium. Charles D. Pendell, Publisher, Binghamton, NY. 23 p. Call No.: QK 61 .C58 1903
4. DeWolf, G.P., Jr. (1968). Notes on making an herbarium. Arnoldia, 28(8/9), 69-111. Call No.: QK 61 .D48 1968
5. Junqueira, L.C., & Carneiro, J. (2005). Basic Histology (11th ed.). Mc GrawHill.

Programme	**BSc (Honours) ZOOLOGY**					
Course Name	ENVIRONMENTAL BIOLOGY					
Type of Course	**DSC A**					
Course Code	**UC2DSCZGY100**					
Course Level	**100**					
Course Summary	This comprehensive course covers the fundamental principles of ecosystems, populations, and communities, emphasizing biodiversity & its threats. It explores biogeochemical cycles, renewable and non-renewable resources, and ecological interactions. The module on biodiversity delves into its types, significance, and threats, including climate change & habitat destruction. Conservation efforts, both international & national, are detailed, along with key environmental laws. It concludes with a focus on managing environmental issues, addressing solid waste, watershed management, carbon-related concepts, and eco-friendly initiatives.					
Semester	**II**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	--	1	--	75
Pre- requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Explain the dynamics of Ecosystem	U	1,2, 7
2.	Describe the attributes of Population, community and animal interaction.	U	1,2, 7
3.	Distinguish concepts of biodiversity¸ threats to biodiversity and measures to conserve Biodiversity.	A	1,2,6,7
4.	Employ strategies to manage environmental issues.	An	1,2,6,7
5.	Administer experiments in Environmental Biology.	An	2¸6¸10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Dynamics of Ecosystem**	**10**	
	1.1	Introduction to Environmental Biology; Scope and History.	1	1
	1.2	**Basic concept and structure of ecosystem**: Definition; Abiotic (Sunlight, temperature, soil, water, atmosphere) and Biotic components (Producers, consumers, decomposers)	2	1
	1.3	**Functions of ecosystem**: Productivity-Food chain- Food web- Energy flow-Laws of Thermodynamics	2	1
	1.4	**Types of Ecosystem**: **Terrestria**l (Forest-Grassland- Desert) and **Aquatic**-(Marine, Fresh water, Wetland); Biome; Ecological pyramids (number, biomass, energy)	3	1
	1.5	**Biogeochemical cycles:** Concept, gaseous (Carbon cycle, Nitrogen cycle) and sedimentary cycles (phosphorous cycle).	2	1
2		**Population and Community**	**8**	
	2.1	**Concept of population**: Population attributes- Population growth forms, Basic concepts of growth rates, density, natality, mortality, growth curves.	1	2
	2.2	**Animal interactions**: **Positive**- Commensalism-Mutualism-Proto-cooperation, **Negative**-Predation-Parasitism-Competition-Antibiosis.	3	2
	2.3	**Characteristics of a community**: Species diversity-richness, evenness, stratification, dominance, ecological indicators, Ecotone and Edge effect, Keystone species, Flagship species¸Umbrella species. Concepts of Ecological Niche and Guild, Ecological succession, community evolution- climax.	4	2
3		**Biodiversity Conservation and Disaster Management**	**27**	
	3.1	**Introduction to Biodiversity:** Types of biodiversity- Alpha, Beta and Gamma diversity.	7	3

		Concept and importance of Biodiversity: Levels of Biodiversity- Species diversity, Genetic diversity, Microbial, Ecosystem diversity (in brief); Biodiversity indices (Shanon-Weiner index, Simpson's index); Basic sampling techniques (Quadrat and Transect methods). **Significance of Biodiversity** - Ecosystem productivity (Ecosystem services, Biological resources, Social benefits), Ecosystem stability; India as a mega-diversity nation, Biodiversity hotspots. **Threats to Biodiversity:** 1. Climate change and global warming (details of greenhouse effect and Ozone depletion to be included here), 2. Habitat destruction, 3.Pollution (air, water, noise and plastic pollution) - causes, effects and control measures in brief, Invasive species, Over-exploitation of natural resources.		
	3.2	**Conservation of Biodiversity** **Protected area concept:** Wildlife Sanctuary, National Park, Biosphere Reserve, Conservation Reserve, Community Reserve	1	3
	3.3	**International Efforts in Biodiversity Conservation**: WWF, Convention on Biological Diversity (CBD), International Union for the Conservation of Nature and Natural Resources (IUCN), United Nations Environment Program-World Conservation Monitoring Centre (UNEP-WCMC), Red Data Book, Green Data Book, Blue Data Book; IUCN's Post 2020 Global Biodiversity Framework (GBF) Strategy Initiative, UN's Sustainable Developmental Goal 15 of 2030 Agenda. Overview of G20 Summit 2023 in terms of Biodiversity Conservation and Sustainable development .	3	3
	3.4	**National level initiatives** National Biodiversity Strategy and Action Plan; People's Biodiversity Register. **Regional level initiatives**: The Chipko movement, Narmada Bachao Andolan, The Silent Valley Episode.	4	3
	3.5	**Environmental disasters:** Natural disasters (Earthquakes, Cyclones, Floods, Tsunamis and Landslides) and Man-made disasters-case studies (Global level- Chernobyl nuclear power plant explosion, National level - Bhopal gas tragedy and Regional level- Endosulfan issue). PRRP for disaster management.	5	4
	3.6	**Management of Environmental Issues**	7	4

		Solid Waste Management; Watershed Management; Rainwater Harvesting; **International agreements:** Montreal Protocol, Kyoto Protocol, Inter-government Panel on Climate Change (IPCC), Overview of UN Climate Change Conferences (COP 2023 to be included); Ramsar Convention. Carbon Credit; Carbon Trading (Emission trading); Carbon Sequestration; Carbon Footprint; Ecological Footprint **Environmental Laws (Brief accounts only):** The Wildlife Protection Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air (Prevention and Control of Pollution) Act,1981; Indian Forest Act (Revised) 1982; The Environment Protection Act, 1986; The Biodiversity Act, 2002; National Green Tribunal Act, 2010; Environment (Protection) Amendment Rule, 2022.		
4		**Practicals**	**30**	
	1.	Estimation of Dissolved Oxygen (Demonstration).	2	5
	2.	Estimation of Carbon-dioxide	2	
	3.	Plankton identification using permanent slides & comment on adaptations.	4	
	4.	Identify the Animal Interactions using appropriate pictures/diagrams	4	
	5	Spotters:Plankton counting chamber, Secchi disc & Plankton net	2	
	6.	Visit to any polluted site and preparation of a detailed report (it should include observation and remedial measures). (Group Report)	10	
	7.	Identify five influential personalities (from India) who have contributed towards the conservation of the environment and comment on their contributions (eg. Vandana Shiva,Sundarlal Bahuguna, ,Daya Bhai, Sugathakumari, M.K.Prasad, Prof.Sitaraman, Sankaranarayana, Kallen Pokkudan)	6	
5		**Teacher Specific Module**		

EVALUATION AND ASSESSMENT

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, Field Visit to Ecologically significant areas
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA):** **Theory Total = 25 Marks** Quiz, Test Papers, Seminar **Practical Total = 15 Marks** Lab performance, record , field report
	B. End Semester Examination: **Theory: Total =50 Marks, Duration 1.5 hrs** Multiple Choice Questions – 12 x 1 =12 Marks Short questions-6 out of 8 x 3 =18 Marks Short Essays 4 out of 6 x 5 = 20 Marks **Practical Total =35 Marks; Duration - 2 hrs** **Record - 10 Marks** **Examination - 25 Marks** : Estimation of CO2 8 marks./O2 Estimation- Principle & Procedure only- 4 marks + any 2 planktons (4 marks), Spotter identification - 6 marks, Identify & comment on the Animal Interactions using photographs – 5 marks ,Viva - 2 marks , Polluted site visit report- 4 marks.

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Programme	**BSc (Honours) Biochemistry**					
Course Name	ESSENTIALS OF BIOCHEMISTRY: VITAMINS, HORMONES, ENZYMES AND NEUROTRANSMITTERS					
Type of Course	**DSC A**					
Course Code	**UC2DSCBCH100**					
Course Level	**100-199**					
Course Summary	This comprehensive course delves into the fundamental biochemical aspects of vitamins, hormones, enzymes, and neurotransmitters, exploring their roles in maintaining physiological balance and supporting essential cellular functions.					
Semester	II	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Discuss the fundamentals of vitamins	K,U	1,2,3,4
2	Describe the general features of hormones and their receptors.	U, E	2,3,4
3	Describe the classification, functions, mechanism of action and deficiency disorders of hormones	U, E, A	1,2,3,4
4	Evaluate neurotransmitter and its mechanism of action	A, E	1,2,3,4
5	Analyse the mechanism of enzyme catalysis, kinetics and specificity	U, An, E	1,2,3,4
6	Demonstrate proficiency in enzyme and vitamin extraction and quantification from various sources	U, A, S, Ap	1,2,3,4 ,10
7	Demonstrate the mechanism of action of hormones/neurotransmitters through presentations	A,S,C, I	2,3,4,6 ,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C),Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1. Vitamins	1.1	Vitamins- General introduction	3	1
	1.2	Classification and nomenclature of vitamins	4	1
	1.3	Fat soluble vitamins (types, biochemical and physiological functions, deficiency diseases) Vitamins as Coenzymes	3	1
	1.4	Water soluble vitamins (types, biochemical and physiological functions, deficiency diseases)	5	1
2. Hormones & Neurotransmitters	2.1	History of endocrinology	1	2
	2.2	Concept on target gland, negative and positive feedback, characteristics and transport of hormones	3	2
	2.3	Hormone receptors and its classification	3	2
	2.4	Outline study of hypothalamic, pituitary, thyroid, parathyroid, adrenal, pancreatic and gastro intestinal hormones (types of hormones, physiological and biochemical role, deficiency diseases)	3	3
	2.5	Mechanism of action of peptide and steroid hormones	3	3
	2.6	Neurotransmitters-definition, classification, types of receptors, role in synaptic transmission	3	4
	2.7	Molecular mechanisms of action - Acetylcholine, biogenic amines, catecholamines, serotonin, amino acids. Neuroactive peptides as transmitters.	4	4
3. Enzymes	3.1	Classification of enzymes- six major classes of enzymes with one example each.	2	5
	3.2	Cofactors and coenzymes	1	5
	3.3	Elementary study of the factors affecting velocity of enzyme catalysed reactions- effect of substrate concentration, enzyme concentration, temperature and pH	2	5
	3.4	Michaelis- Menten equation (without derivation). Km and its significance, Lineweaver Burk plot.	2	5
	3.5	Enzyme specificity- an example each for group specificity, optical specificity, geometrical specificity and cofactor specificity of enzymes.	3	5
4. Practical	4.1	Extraction and assay of enzymes - Acid phosphatase from Fresh Potato (*Solanum tuberosum*)	5	6

	4.2	Extraction and assay of enzymes - β- amylase from sweet potato (*Ipomoea batatas*)	5	6
	4.3	Extraction and assay of enzymes -Catalase from bovine /porcine liver	5	6
	4.4	Extraction and assay of enzymes -Urease from Jackbean (*Canavalia ensiformis*)	5	6
	4.5	Estimation of ascorbic acid from lemon guice	5	6
	4.6	Demonstration of the mechanism of action of hormones/neurotransmitters through posters, models, and digital presentations	5	7

5.Teacher specific content/ Teacher facilitated activities

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The course content will be transacted through seminars, power point presentations, Group activity, Interactive sessions and Laboratory sessions.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Theory 25marks 1. Poster making/model building (2 marks) 2. Seminar presentation/Quiz (5 marks) 3. Involvement in group discussion (3 marks) 4. Multiple Choice questions (10 marks) 5. Assignment (2 marks) 6. Open book test (3 marks) Practical 15 marks* 1. Viva (5 marks) 2. Record (5 marks) 3. Laboratory involvement (5 marks) *This mark to be converted to 7.5 marks
	B. End Semester Examination (ESE) Written examination for one and a half hours (50 marks) Practical examination (35 marks)* *This mark to be converted to 17.5 marks

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7. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi
8. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi
9. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana

Suggested Readings

1. Banerjee P.K. (2020) Introduction to Biophysics (Revised Edition) AB Book.
2. Das D. (2015) Biochemistry (14th ed.) Academic publishers

Programme						
Course Name	BIOLOGICAL FOUNDATIONS FOR HEALTH AND WELLNESS					
Type of Course	MDC					
Course Code	UC2MDCBTS100					
Course Level	**100**					
Course Summary	Introductory level course for understanding the basic multi-faceted concepts in biology and its relevance in promoting human health and the overall wellbeing and quality of life.					
Semester	**II**	Credits			**3**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	0	1	Case Studies Group work	60
Pre-requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Understand the fundamental principles of biology and how they relate to human health and wellness.	U, K	2,3,10
2	Learning the structure and function of the human body systems and their role in maintaining human health and wellness.	K	2,3,10
3	Explore the role of genetics, molecular expression and advancements in the field of biology in determining individual health outcomes including genetic testing, personalized medicine.	U,E	2,3,10
4	Analyse the molecules of life, nutrition and lifestyle choices and its relation with preventable diseases.	U, An	2,3,10
5	Explore the relationship between biology and mental health, including the role of neurotransmitters and hormones in health and well-being.	U, An	2,3,10

Remember(K), Understand(U), Apply(A), Analyse(An), Evaluate(E), Create(C), Skill(S), Interest(I)and Appreciation(Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 30	CONo.
1	1.1	Biomolecules in the cell and their functions. Hierarchical organization in living systems.	5	1
	1.2	Role of Biology in health and wellness. Exploring wellness and its dimensions. Relationship between biology and wellness	3	1
	1.3	Role of nutrition in maintaining wellness. Relationship between diet and chronic diseases	3	1,4
	1.4	Genetics and wellness. Basic concepts of reproduction. Genes as the basis of heredity. Central dogma of molecular biology and genetic code	5	1,3
2	2.1	Understanding the basic level structure and function of major body systems Circulatory system, respiratory system, digestive System	4	2
	2.2	Muscular and skeletal system, excretory system and reproductive system	4	2
	2.3	Nervous system, immune system and endocrine system. Understanding the different regions and structures of the brain as a part of nervous system. Neuro endocrine signaling mechanisms. Biological basis of mental health disorders	6	2,5
3		**PRACTICALS**	**30**	
	3.1	1. Systematic analysis of biomolecules using qualitative assays. 2. Estimation of protein using Biuret method. 3. Separation of components of a given mixture of amino acids using paper chromatography	15	1,2
	3.2	4. Study of different stages of mitosis in onion root tip (temporary preparation)	5	1,3
	3.3	5. Case study on lifestyle disorders; importance of early detection and regular screening of common diseases 6. Analysing popular diet patterns in Kerala	5	1, 3,4
	3.4	Practical Classes on Relaxation Techniques . Yoga . Cardio training & exercise 3. Meditation 4. Mindfulness (Hands on Training and Teaching Sessions)	5	2,5
4		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, group interactions, group seminar, power point presentations, case studies Teaching aids used- Audio Visual Presentation, Photographs, Internet Resources
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 15 marks** Test Papers/Assignments/Seminars **Practical Total= 15 marks** Timely submission of Records Chart/Visual presentations Diet assessment study
	B. End Semester examination **Theory Total = 35 marks (Duration 1hr)** Multiple Choice Questions (5 X 1) = 5 marks Short Questions (5 out of 7) X 2= 10 marks Short essays (5 out of 7) X 4= 20 marks **Practical Total =35 marks (Duration 2hrs)** Record = 10 marks Viva= 5 marks Case Study Report=5 marks Practical case study= 15 marks

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13. Tortora, G. J., &Derrickson, B. H. (2017). Principles of Anatomy and Physiology (15th ed.). Hoboken, NJ: Wiley.
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2. Brown, K. L., & Davis, R. M. (2021). The impact of nutrition on immune function: A comprehensive review. Nutrition Reviews, 79(2), 144-165.
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SEMESTER-III

Programme	**BSc (Honours) Biological Sciences**					
Course Name	ESSENTIALS IN BIOLOGICAL TECHNIQUES					
Type of Course	DSC A					
Course Code	UC3DSCBTS200					
Course Level	**200**					
Course Summary	Essentials in Biological Techniques is a comprehensive and interdisciplinary course that covers a broad range of bioanalytical techniques applicable to various scientific disciplines. It begins with a review of basic bio analytical technique and an introduction to general terminologies. This course contains widely employed techniques along with their theory, working principle, its possible applications.					
Semester	**III**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1		75
Pre-requisites, if any	Student with basic knowledge of biology.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Students are able to deal with different tools and techniques used in biological research.	K	2,3,9,10
2	Applications of various bioanalytical instruments in biological research	U,A,An	2,3,9,10
3	Helps to understand the principles and working mechanisms of different instruments.	U,A	2,3,9,10
4	Understand the basic concepts of microbiological techniques including staining and sterilization	U, A,An,S	2,3,9,10
5	Learn the working of various instruments used in microbiology.	U,A,S	2,3,9,10
6	Highlighting the diverse roles that radioisotopes play in medical diagnosis and treatment.	U,I	2,3,9,10

Remember(K), Understand(U), Apply(A), Analyse (An), Evaluate(E), Create(C), Skill(S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1		**Introduction to Basic Bioanalytical Techniques. Analytical techniques: Colorimetry, pH meter, Spectrophotometry**	**15**	
	1.1	Definition and scope of bioanalysis	2	1
	1.2	Importance and applications of bioanalytical techniques in various fields of biological science. (biological research, medical diagnostics, and therapeutic interventions)	3	1
	1.3	General principles and applications of Colorimeter, Beer-Lamberts Law, Derivation, Parts & working of a Single Cell Colorimeter, & Double Cell Colorimeter.	3	2
	1.4	Principles, working and applications of pH meter Measurement of pH: Indicators, pH meter, Different Types of Electrodes, advantages and disadvantages of different Electrodes, Factors affecting pH determination	4	2
	1.5	Principle involved in Spectrophotometer. Applications of UV-Visible spectroscopy in bioanalysis Merits and Demerits of: Colorimeter and Spectrophotometer	3	2
2		**Separation techniques: Centrifuge, chromatography, electrophoresis**	**12**	
	2.1	Centrifugation: Principles, types of centrifuges, application	3	2, 3
	2.2	Principle and technique of chromatographic separations, brief over view about the types of chromatographic techniques (Thin layer, Ion-exchange, Size exclusion chromatography)	5	2,3
	2.3	Principles of electrophoresis, Gel electrophoresis (SDS- PAGE, agarose gel electrophoresis).	4	2,3
3		**Radiolabeling techniques**	**18**	
	3.1	Methods of detection and measurement of different types of radioisotopes used in biology, incorporation of radioisotopes in biological tissues and cells. Autoradiography, Liquid Scintillation Counting, Geiger-Muller Counting.	8	6
	3.2	Radioisotopes and their biological applications. Medical Imaging: Technetium-99m (Tc-99m): Radiation Therapy: Iodine-131 (I-131). Tracer Studies in Biology: Carbon-14 (C-14): Carbon	10	6

		dating. DNA and Protein Labeling: Phosphorus-32 (P-32) and Sulfur-35 (S-35). Blood Flow Studies: Technetium-99m (Tc-99m). Radioimmunoassays (RIA): Iodine-125 (I-125) and Iodine-131 (I-131). Bone Imaging: Technetium-99m (Tc-99m) and Strontium-85 (Sr-85).		
		Practical	**30**	**CO**
	4.1	Perform paper chromatography of amino acids.	4	5
	4.2	Colorimetric estimation of Ascorbic acid	4	5
	4.3	Spectrophotometric Quantification of DNA.	8	5
	4.4	SDS-PAGE, agarose gel electrophoresis.	8	5
4	4.5	Problems in radiology [on half cycle, quantity, disposal]	6	6
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, group interaction, seminar, presentations Note: Only a brief description of the focal topic is required. Teaching aids like photographs, models, videos related to the topic may be used
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory** **Total=25 marks** Quiz/ Test Papers/ seminars/ Assignments **Practical Total 15 marks** Lab performance/ record
	B. Semester End examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks -10 x 1 =10 marks Short questions-(10 out of 12) x 2 = 20 marks Short Essays (5 out of 7) x 4 = 20 marks **Practicals Total 35 marks Duration- 2 hrs** Record 10 marks, Examination 25 marks: Performance of various experiments 12marks , Problems in radiology- 8 marks, Viva-5 marks

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Programme	**BSc (Honours) Biological Sciences**					
Course Name	GENERAL MICROBIOLOGY					
Type of Course	DSC A					
Course Code	UC3DSCBTS201					
Course Level	**200**					
Course Summary	The course provides an overview of the fundamental concepts and principles of Microbiology. It covers various aspects of microorganisms, including their structure, function, genetics, classification, and diversity. The course also delves into the study of microbial growth and metabolism and the ways to control their growth by physical and chemical means. Additionally, it develops a good understanding of the importance and scale of the antimicrobial resistance crisis.					
Semester	**III**	Credits			4	
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	Total Hours
		3	0	1	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Develop a good understanding of the microbial world	U	2,3,10
2	Exposure in bacterial cultivation and identification	S	2,3,10
3	Understand the microbial growth and the ways to control their growth	U	2,3,10
4	Understand the role Antibiotics and Antimicrobial resistance	U,A	2,3,10
5	Create basic knowledge about microbial metabolism, microbial genetics and gene transfer.	U,A,S	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1		**The world of microbes**	**15**	
	1.1	History and scope of Microbiology	2	1
	1.2	Microbial taxonomy & Identification	2	1,2
	1.3	Microscopy & staining techniques	3	1,2
	1.4	Ultrastructure of bacteria	3	1
	1.5	Ultrastructure of yeast and economic importance of Fungi	3	1
	1.6	Viruses : General properties, Phages and its significance	2	1
2	2.	**Microbial growth and metabolism**	**12**	
	2.1	Bacterial growth curve, continuous culture	3	2,3
	2.2	Factors affecting microbial growth-environmental and nutritional factors	2	3
	2.3	Bacterial nutrition, nutritional types of bacteria	2	3
	2.4	Culture media and cultivation techniques	2	2,3
	2.5	Transport and storage of microbes	1	3
	2.6	Microbial metabolism	2	3,5
3	3	**Antimicrobial agents and Microbial Genetics**	**18**	
	3.1	Sterilization and disinfection : Conditions influencing the effectiveness of antimicrobial agent activity	2	3,4
	3.2	Physical agents of sterilization	2	3,4
	3.3	Chemical agents of sterilization	2	3,4
	3.4	Testing of disinfectants	1	3,4
	3.5	Antibiotics –mode of action	2	3,4
	3.6	Drug resistance in bacteria	2	3,4
	3.7	Methods of testing antimicrobial susceptibility	1	3,4
	3.8	Genetic materials in bacteria. Bacterial chromosome. Extrachromosomal genetic elements: Plasmid, Transposons.	4	5

	3.9	Mechanism of gene transfer & transformation, transduction and conjugation.	2	5
4		**PRACTICALS**	**30**	
	4.1	**Microscopy and Instruments** WHO Safety guidelines and laboratory protocols Study of simple and compound light microscopes Instruments –Autoclave, Hot air oven, Bacteriological incubator , Laminar air flow chamber	4	2
	4.2	**Preparation of solid and liquid media for microbial cultures** **Solid media** (1) Nutrient agar (2) Mac Conkey's agar **Liquid Media** (1) Nutrient broth (2) Peptone water	8	2
	4.3	**Culture methods** Streak plate technique and isolation of pure colonies. Lawn culture and Liquid culture Pour plate and spread plate techniques.	6	2
	4.4	**Staining techniques** Simple staining, Grams staining Staining of Yeast cell Negative staining Fungal staining- Lactophenol cotton blue staining	6	2
	4.5	**Examination of microbes in living condition** Hanging drop method for demonstrating motility of bacteria	4	2
	4.6	**Antibiotic sensitivity test** Disc Diffusion method	2	2
5		**Teacher specific Module**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ➢ Classroom lectures ➢ Video presentations ➢ Article and general reviews ➢ Seminars & group discussions ➢ Group assignments & presentations ➢ Hands on training

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=25 marks** Quiz/ Test Papers/ seminars/viva **Practical Total 15 marks** Lab performance/ record/viva
	B. End Semester Examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks or one word questions -10 x 1=10 marks Short questions-(10 out of 12) x2 = 20 marks Short Essays (5 out of 7) x 4 = 20 marks **Practicals Total 35 marks Duration- 2 hrs** **Record 10 marks,** **Examination 25 marks:** Performance of any 3 lab experiments-15 marks , spotter identification - 5 marks Viva-5marks

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Programme	**BSc (Honours) Biological Sciences**					
Course Name	CLINICAL BIOCHEMISTRY AND CLINICAL MICROBIOLOGY					
Type of Course	DSE					
Course Code	UC3DSEBTS200					
Course Level	**200**					
Course Summary	Clinical Biochemistry and Clinical Microbiology is a comprehensive and interdisciplinary course that inspire the students in learning the frontier areas of biological sciences The topics on biochemical analysis, clinical diagnosis and treatment of diseases creates an awareness among students and helps in developing the technical and critical thinking skills to evaluate clinical specimens.					
Semester	**III**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Helps to inspire students in learning the frontier areas of biological sciences.	K	2
2	Students will be exposed to fundamentals in Clinical Chemistry and Clinical Microbiology.	U, A, An	2,3,9,10
3	Students will be able to learn the functions and clinical assessment of various organs of human body	U,A	2,3,10
4	Helps to make them aware of the pathogens, health related problems, their origin and treatment.	U	2,3,9,10
5	Students will be able to understand the symptoms, causative agents, clinical features, laboratory diagnosis of important Medically important microorganisms	U,A	2,3,9,10

Remember(K), Understand(U), Apply(A), Analyse (An),Evaluate(E),Create(C),Skill(S), Interest(I) and Appreciation(Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
1		**Lifestyle diseases**	**15**	
	1.1	An overview of AIDS, Diabetes Mellitus, Obesity, Cancer, Cardiovascular diseases, kidney disorders, liver disorders.	15	1
2		**Functions of various organs and their clinical assessment**	**20**	
	2.1	Brief treatment only but emphasizing the biochemical aspect): e.g., liver, kidney, heart, pancreas endocrine glands, lung, brain.	12	2,3
	2.2	Biochemical changes in the organs under pathological conditions	8	2,3
3		**Biochemical Tests**	**10**	
	3.1	Routine biochemical tests of blood sugar, cholesterol and NPN	10	
4		**Microorganisms of medical importance**	**15**	
	4.1	Symptoms, causative agents, clinical features, laboratory diagnosis and treatment of important **Bacterial diseases**- Diphtheria, Pneumonia, Cholera, Tuberculosis, Salmonellosis, Typhoid	4	6
	4.2	Symptoms, causative agents, clinical features, laboratory diagnosis and treatment of important **Viral diseases** - Common cold, Respiratory Syncytial virus infections, Corona virus (SARS).	4	
	4.3	Symptoms, causative agents, clinical features, laboratory diagnosis and treatment of important **Fungal diseases** - Oral thrush, Aspergillosis	3	4
	4.4	Symptoms, causative agents, clinical features, laboratory diagnosis and treatment of important **Parasitic diseases**- Symptoms, causative agents, clinical features, laboratory diagnosis and treatment of Malaria, Filariasis, Amoebiasis,	4	4,5
5		Teacher Specific Module		

Teaching & Learning Approach	**Classroom Procedure (Mode of transaction)** ICT Enabled Learning, Experiential learning, Tutorial, Lecturing,
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=30marks** Quiz/ Test Papers/ Seminar/ Activity Report

	B. End Semester examination **Theory Total 70 marks, Duration 2 hrs** Fill in the blanks -10 x 1 = 10 Marks Short questions-(10 out of 12) x 3 = 30 Marks, Short Essays (6 out of 8) x 5 = 30 Marks

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1. Ananthanaryanan R. and C.K.J. Panicker (2009) Text book of Microbiology, 9th edition, University Press (India) Pvt. Ltd. Publisher
2. Elmer W. Koneman (2006) Color Atlas & Textbook of Diagnostic Microbiology 5th edition, Lippincott Publication
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2. Boyer, R. F. (2012). Biochemistry laboratory: modern theory and techniques (2nd ed.). Prentice Hall.
3. Harvey, D. (2000). Modern analytical chemistry. McGraw-Hill.
4. Katoch, R. (2011). Analytical techniques in biochemistry and molecular biology. Springer.
5. Switzer, R. L. (1999). Experimental biochemistry (3rd ed.). W. H. Freeman and Co

Programme	**BSc (Honours) Biological Sciences**					
Course Name	AQUARIUM MANAGEMENT					
Type of Course	DSE					
Course Code	UC3DSEBTS201					
Course Level	**200**					
Course Summary	Course provides knowledge on diversity of ornamental fish and plants, history and development of aquarium keeping and ornamental fish culture, principles of setting up and management of aquaria, breeding biology of various ornamental fishes, commercial farming techniques, seed production, packing and transportation of ornamental fishes, feeding and nutrition of ornamental fishes, prophylaxis and quarantine and disease management.					
Semester	**III**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Introduce the nature and scope of aquarium management and ornamental fish culture	U	2,3,10
2	Impart practical skills to students on aquarium management and ornamental fish culture	S	2,3,10
3	Impart knowledge on self-employment opportunities in ornamental fish culture and Aquarium management.	R	2,3,7,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs. 45	CO No.
	1.1	Diversity of ornamental fish. Contribution of marine and freshwater fishes. Major ornamental fish species of India. Ornamental plants. Ornamental invertebrates.	5	1

1	1.2	History of aquarium fish keeping. Etiology of aquarium. Biotope aquarium. Vivarium, Insectarium, terrarium, paludarium, oceanarium, dolphinarium. Reef aquarium. Nano Aquariums. Role of public aquaria. Aquarium keeping as a hobby.	5	1,2
2	2.1	Principles of setting up and maintenance of aquaria: Construction of aquarium. Aquarium Accessories- aerators, filters, skimmers, chillers, lighting, decorates, etc. Latest trends in Aquarium tanks.	10	3
	2.2	Reproductive biology. Sex determination in ornamental fish. Breeding and seed production of Common ornamental fishes: Construction of breeding tanks. Larval rearing.	10	3
3	3.1	Commercial farming technologies. Indigenous ornamental fishes and their culture, propagation and trade. Ornamental aquatic plants: Propagation methods, nutrient and environmental requirement, cropping methods, packing and transport	10	3
	3.2	Feeding and nutrition of ornamental fishes. Nutritional requirements of aquarium fish. Larval Feeding. Live feed culture. Artemia culture, infusoria, brachionus culture, Formulated feeds. Preparation of aquarium fish food.Common diseases and parasites of freshwater and marine ornamental fish. Health management of aquarium fishes	10	2,3
	3.3	Field Trips and Workshops Visits to public aquariums, fish farms, and aquatic research centers. Hands-on workshops in advanced aquascaping and breeding techniques. Guest lectures from industry professionals and researchers.	10	2,3
4		Teacher specific module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom lectures, Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory Total=30 marks** Quiz/ Test Papers/ seminars
	B. End Semester Examination Theory Total 70 marks, Duration 2 hrs Multiple choice questions-10 x 1 = 10 Marks Short questions-(10 out of 12) x 3 = 30 Marks, Short Essays (6 out of 8) x 5 = 30 Marks,

REFERENCES

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2. Atz, W. (1971). Aquarium Fishes. Pelham Books Ltd., London.
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Programme						
Course Name	DIVERSE ANIMAL LIFE					
Type of Course	DSC B					
Course Code	UC3DSCBTS202					
Course Level	**200**					
Course Summary	This course offers a comprehensive overview of the diversity of animal life on Earth, exploring the evolutionary relationships, functional adaptations, and ecological roles of different animal groups. It covers the major phyla, classes, and representative species, emphasizing their morphology, physiology, behavior, and interactions with their environments					
Semester	**III**	Credits			**4**	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre- requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No
1	Understand the evolutionary relationships among major animal groups.	U	2,3,10
2	Recognize the morphological and physiological adaptations of diverse animals.	K	2,3,10
3	Explore the ecological roles and behaviors of different animal species.	S	2,3,10
4	Analyze the impact of environmental changes on animal diversity.	AN	2,3,10
5	Develop an appreciation for the complexity and interdependence of life forms.	AP	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs. 45	CO No.
1	1.1	Introduction to Animal Diversity: Principles of taxonomy and systematics. Overview of the tree of life and major animal phyla.	5	2
	1.2	**Porifera and Cnidaria** Characteristics of sponges (Porifera) and their ecological roles. Cnidarians: jellyfish, corals, and sea anemones.(BRIEF ACCOUNT) Life cycles and symbiotic relationships in Cnidaria (OBELIA). **Platyhelminthes and Nematoda** Flatworms (Platyhelminthes): free-living and parasitic forms. Eg: Schistosoma, Taenia solium Roundworms (Nematoda): Diversity and Ecological significance. Eg: *Wuchereria bancrofti*, *Ascaris lubricoides* Parasitic adaptations and life cycles.	10	2,3,4
2	2.1	**Mollusca**: overview of molluscan diversity: bivalves, gastropods, cephalopods. Eg: Sepia,sycon and pinctada (Morphological and physiological adaptations). Ecological roles and economic importance of molluscs. **Annelida and Arthropod:** overview of Annelida and arthropod. Segmented worms (Annelida): earthworms, leeches, and polychaetes. Arthropods: diversity and success of insects, arachnids, crustaceans. Exoskeleton and molting process in arthropods.	10	1,2,4
	2.2	**Echinodermata-Echinodermata** Characteristics and diversity of echinoderms (Phylum Echinodermata). Overview of major classes: Asteroidea, Ophiuroidea, Echinoidea, Holothuroidea. Echinoderm structure, function, and regeneration.(star fish)	5	2,4
	3.1	C**hordate:** Overview and Non-vertebrate Chordates Characteristics of the phylum Chordate. Non-vertebrate chordates: tunicates and lancelets. Evolutionary significance of chordate features.	5	3,2

3	3.2	**Amphibians** Evolution and diversity of amphibians: frogs, salamanders, caecilians. Life cycle and metamorphosis(frog) Amphibians as ecological indicators.	5	2,4
	3.3	**Reptiles** Characteristics and classification of reptiles: turtles, lizards, snakes, crocodilians. Adaptations for terrestrial life. Reptilian reproduction and thermoregulation. **Birds** Evolution and characteristics of birds.(eg: archaeopteryx) Adaptations for flight: feathers, skeletal modifications, respiratory system. Behavioral ecology and migration patterns.(brief account)	10	1,2,4
	3.4	**Mammals** Overview of mammalian diversity: monotremes, marsupials, placentals. Characteristics: hair, mammary glands, endothermy. Mammalian reproductive strategies and parental care. Aquatic mammals and its examples **Conservation of Animal Diversity** Threats to animal diversity: habitat loss, climate change, pollution. **Conservation strategies:** protected areas, captive breeding, restoration ecology	10	1,3
4		**PRACTICALS** 1. Introduction to laboratory equipment and safety procedures. 2. Microscopy basics: using light and dissecting microscopes. 3. simple identification (5 invertebrate/5 vertebrate organism) 4. Microscopic examination of sponge cells, spicules, honey bee sting 5. Feeding activity of paramecium 6. Identification of protozoans in pond water sample. 7. Field study/museum visit /zoo visit –report	30	5
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom lectures Direct Instruction:, Explicit Teaching, E-learning, Interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, photography Presentation by individual student/ Group representative
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=25 marks** Quiz/ Test Papers/ seminars / entrepreneur interaction **Practical Total 15 marks** Lab performance/Lab report/ Viva Voice/Field study report
	B. End Semester Examination **Theory Total 50 marks, Duration 1.5 hrs.** Multiple Choice Questions -12 x 1 = 12 marks Short questions-(6 out of 8) x 3 = 18 marks Short Essays (5 out of 7) x 4 = 20 marks **Practicals: Total 35 marks Duration- 2 hrs.** Record 10 marks, Examination 25 marks: spotter identification-5 marks, viva -5 marks, Experiments- 10 marks. Field study/museum visit /zoo visit –report-5 marks.

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13. Winston, J.E. (2000). Describing species: Practical Taxonomic Procedures for Biologists. Columbia University.

Programme						
Course Name	**Techniques in Biochemistry and Forensic Science**					
Type of Course	**DSC B**					
Course Code	**UC3DSCBCH202**					
Course Level	**200-299**					
Course Summary	This course provides a comprehensive understanding of advanced techniques widely used in biochemistry, molecular biology and forensic science with a focus on practical applications in research and diagnostics. Students will gain both theoretical knowledge and hands- on experience, preparing them for careers in various scientific fields.					
Semester	**3**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1		75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Develop a comprehensive understanding of various biochemical and forensic techniques used in analysing biological samples.	K, U, An	1,2,3,4
2	Evaluate diverse aspects of chromatographic techniques	U, E, A	1,2,3,9, 10
3	Explore electrophoresis and blotting methods	E, An, A	1,2,3,9
4	Explain the fundamental principles of spectroscopy, colorimetry, centrifugation and microscopy	U, An, S	1,2,3,4
5	Demonstrate the crime scene sample collection and Processing	U, E, C	1,2,3,9
6	Describe the role of DNA fingerprinting role in clinical settings, such as paternity/maternity testing	U, E, A	1,2,4,6, 8
7	Apply techniques in biochemistry, molecular biology, forensic science, and biotechnology	U, S, Ap	1,2,3,9, 10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1. Separation Techniques	1.1	Introduction to Biochemical Techniques	1	1
	1.2	Chromatography- Terminology, classification based on principle and type of chromatographic bed used, and the physical state of mobile phase.	3	2
	1.3	Planar chromatography-Principle, procedure & applications of paper chromatography and	3	2
	1.4	Column chromatography- Principle, procedure & applications of Affinity Chromatography, Gel Exclusion Chromatography	3	2
	1.5	Electrophoretic techniques-Introduction, principle, procedure and applications of AGE and PAGE	3	3
	1.6	Blotting techniques- Southern, Northern and Western	2	3
2. Spectroscopy, Colorimetery, Centrifugation and	2.1	Spectroscopy- Types of spectroscopy (an outline study)	2	4
	2.2	Colorimetry-Beer Lambert's law	2	4
	2.3	Instrumentation and applications of colorimeter and UV-Visible Spectrophotometer.	4	4
	2.4	Centrifugation-Principle and types	6	4
	2.5	Introduction to Microscopy (Overview)	1	4
3. Crime site sample collection and	3.1	Source of DNA in Forensic cases, PCR	5	5
	3.2	ELISA, RIA	5	5
	3.3	DNA Finger Printing- Paternity and maternity Testing	5	6
4. Practical	4.1	Beer Lambert's law verification	4	7
	4.2	Paper Chromatography/Thin layer Chromatography	8	7
	4.3	Electrophoresis (Demonstration)	8	7
	4.4	DNA Isolation (from onion/Green peas)	5	7
	4.5	Estimation of isolated DNA	5	7
5. Teacher specific content/ Teacher facilitated activities				

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Direct Instruction: Lecture, tutorials, e- resources, animated videos, virtual lab Indirect session: Group discussion, seminar presentation Practical: Hands on learning, real world application, problem solving

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Theory 25 marks 1. Poster making/model building (2 marks) 2. Seminar presentation/Quiz (5 marks) 3. Involvement in group discussion (3 marks) 4. Multiple Choice questions (10 marks) 5. Assignment (2 marks) 6. Open book test (3 marks) Practical 15 marks* 1. Viva (5 marks) 2. Record (5 marks) 3. Laboratory involvement (5 marks) *This mark to be converted to 7.5 marks
	B. End Semester Examination Written examination for one and a half hours (50 marks) Practical examination (35 marks)* *This mark to be converted to 17.5 marks

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2. Pound, J. (2008). Immunochemical Protocols. Springer Science & Business Media

Programme						
Course Name	**SCIENCE OF ORGANIC FARMING**					
Type of Course	MDC					
Course Code	UC3MDCBTS200					
Course Level	**200**					
Course Summary	This course helps students to gain knowledge and skills necessary to practice organic farming and the production of healthy food					
Semester	**III**	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To introduce the principles and benefits of organic farming	U	2,3,10
2	To equip students with the knowledge and skills necessary to practice organic farming and the production of healthy food	A	2,3,10
3	To introduce the concept of organic ecosystem and the basics of plant physiology and nutrition	U	2,3,10
4	To know the importance of soil health in organic farming	E	2,3,10
5	To inculcate the importance of doing organic farming as the responsibility of every human being to ensure food safety and food security.	C	2,3,7,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No
1		**Concept of Organic Farming**	**10**	
	1.1	Principles of Organic farming		1
	1.2	Benefits of Organic farming		1
	1.3	Organic Ecosystem and their concept		3
	1.4	Eco friendly farming-Natural farming, Organic farming and Zero budget farming		1
2		**Soil and Plant Nutrition**	**15**	
	2.1	Types of soil, Composition of soil, Soil profile, Soil texture and Soil pH		4
	2.2	Role of soil in Organic Farming, Soil health		4
	2.3	Soil factors affecting plant growth: light, heat, water, humidity, pH and nutrition C: N ratio of good fertile soil		4
	2.4	Structural organization & function of different Plant organs		3
	2.5	Plant nutrients- Micro and Macro, Importance & Deficiency symptoms		3
	2.6	Organic manures, Green manure, Methods of composting, Importance of mulching		3
	2.7	Soil microorganism: Mycorrhiza, Rhizosphere-Significance, Role of biofertilizers in crop production		4
3		**Organic farm management and crop management**	**15**	
	3.1	Land preparation - Tools and Technique		2
	3.2	Preparation of seed bed, manuring, sowing, watering and raising of seedling		2
	3.1	Pest control: Biological and Organic methods		2
	3.2	Integrated Pest Management		2
	3.3	Crop rotation: Need and benefits		2
	3.4	Harvesting and Post Harvesting Management		2
		Certification and Marketing	**5**	
	3.5	Inspection, Certification & Labelling procedure		5

	3.6	Marketing & Export		5
4		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Videos, Seminars, Power point presentations, Organic farm visit and Field study.
Assessment types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment** **Theory Total 25 Marks** Quiz/Test Papers/Seminar/ Field Study
	B. End Semester Examination **Theory: Total - 50 Marks, Duration 1.5 hrs** Fill in the blanks -10 x 1 = 10 Marks Short questions- (10 out of 12) x 2 = 20 Marks Short Essays (5 out of 7) x 4 =20 Marks

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3. Mukund Joshi, & Prabhakarasetty, T.K. (2006). Sustainability through organic farming. Kalyani publishers, New Delhi.
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Programme						
Course Name	**PUBLIC HEALTH, HYGIENE AND SANITATION: AN AWARENESS**					
Type of Course	VAC					
Course Code	UC3VACBTS200					
Course Level	**200**					
Course Summary	This course provides a comprehensive insight into the significance of public health and sanitation in enhancing the overall well-being of communities.					
Semester	**III**	Credits			3	
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	Total Hours
		3	0	0	0	45
Pre- requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To inculcate a general awareness among the students regarding the real sense of health.	K,U	2,3,10
2	To understand the role of balanced diet in maintaining health.	K,U	2,3,10
3	To motivate them to practice yoga and meditation in daily life.	U, An, E	2,3,6,10
4	To aware them transmission of food and water borne diseases	An, E	2,3,6,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate I, Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction

Module	Units	Course description	Hrs 45	CO No.
1		**Dimensions of Health**	**12**	
	1.1	Definition and meaning of health:	2	1
	1.2	Dimensions of health, physical activity and health benefits, Effects of exercise on body systems	10	1
2		**Nutrition and Constituents of healthy life style**	**25**	

	2.1	Constituents of balanced diet	3	2
	2.2	Malnutrition and Deficiency diseases.	3	2
	2.3	Life skill education	2	3
	2.4	Emotional adjustment and well being	6	3
	2.5	Yoga, meditation and relaxation. Psychoneuroimmunology	5	3
	2.6	Life style and hypokinetic diseases.	4	3
	2.7	Health and safety in daily life and at work. Dangers of alcoholic abuse	2	3
3		**Introduction to food and water borne diseases**	**8**	
	3.6	Briefly mention botulism, salmonellosis, typhoid, cholera and hepatitis A	4	4
	3.7	Potable water, Determination of quality of drinking water	2	4
	3.8	Water purification techniques.	2	4
4		Teacher specific module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, presentations, videos, group interaction.
Assessment types	**MODE OF ASSESSMENT** **B. Continuous Comprehensive Assessment** **Theory Total 25 Marks** Quiz/Test Papers/Seminar/Case study and report writing
	B. End Semester Examination **Theory: Total – 50 Marks, Duration 1.5 hrs** Fill in the blanks -10 x 1 = 10 Marks Short questions- (10 out of 12) x 2 = 20 Marks Short Essays (5 out of 7) x 4 = 20 Marks

References

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SEMESTER-IV

Programme	**BSc (Honours) Biological Sciences**					
Course Name	GENETIC ENGINEERING AND PLANT TISSUE CULTURE					
Type of Course	DSC A					
Course Code	UC4DSCB TS200					
Course Level	**300**					
Course Summary	This course aims to provide students with an in-depth understanding of genetic engineering tools, techniques and their applications in biotechnology. Students will develop practical skills in genetic manipulation, gene cloning, and genetic modification of organisms. This course also provides a comprehensive overview of the principles and techniques involved in plant tissue culture					
Semester	**IV**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	Invited lectures	75
Pre- requisites, if any	NO					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Understand the fundamental principles and techniques of genetic engineering.	U	2,3,10
2	Develop practical skills in genetic engineering techniques and laboratory procedures.	A, S	2,3,9, 10
3	Gain knowledge of gene expression regulation and genetic modification methods.	K, U	2,3,9, 10
4	Critically assess and interpret scientific literature on genetic engineering.	S, U	2,3,9, 10
5	Understanding the principles theories and application behind plant cell culture techniques	U, A, An	2,3,9, 10
6	Develop proficiency in sterile technique and aseptic handling of cell cultures	U,A,	2,3,9, 10
7	Acquiring knowledge of plant cell culture media and their formulation	K,U	2,3,9, 10
8	Gaining hands on experience in plant cell culture	U,S	2,3,9, 10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
		Genetic Engineering	**25**	
1		**Fundamentals of Genetic Engineering**	**6**	
	1.1	Definition, scope, and historical overview of genetic engineering	2	1
	1.2	Techniques for DNA, RNA and plasmid isolation and purification. Methods for quantification and characterization of DNA and RNA samples.	4	2
2		**Recombinant DNA technology- tools and techniques**	**19**	
	2.1	Enzymes- Restriction endonucleases, Polymerases, Ligase, kinases, and phosphatases. Linkers, Adapters and homopolymer tailing.	4	1
	2.2	Cloning vectors- Plasmids, phage, cosmid, BAC, and YAC. Expression vectors	3	1
	2.3	Construction of genomic library and cDNA library, PCR technique, Hybridization techniques, Southern, Northern, western. DNA sequencing	5	2
	2.4	Methods of gene delivery. Physical, chemical, and biological methods.	3	3
	2.5	Applications of Genetic Engineering: Gene therapy, Metabolite engineering, antisense therapy, Gene Knockout, CRISPR-Cas9 technology	4	4
3		**Introduction to plant tissue culture**	**20**	
	3.1	Composition and preparation of plant tissue culture media, Cellular totipotency, clonal propagation	6	5
	3.2	Callus culture, meristem culture types of haploid culture, Embryo culture and embryo rescue; single cell clones, Endosperm culture, Somatic embryogenesis	6	7
	3.3	Isolation and fusion of protoplast, Somatic hybridization, Germplasm conservation and cryopreservation	4	8
	3.4	Application of plant tissue culture**:** Application of plant transformation for enhanced quality: Herbicide resistance, insect resistance, abiotic stresses, Plantibodies	4	4

4		**PRACTICALS**	**30**	
	4.1	**Introduction to Laboratory Techniques**	4	6
		Safety guidelines and laboratory protocols, Aseptic techniques and proper handling of materials.		
	4.2	**GENETIC ENGINEERING**	15	
		Nucleic Acid Extraction ,Quantification and amplification		
		DNA extraction from different sources (e.g., bacteria, plant, animal),Quality assessment and quantification of nucleic acids (spectrophotometry, gel electrophoresis), Polymerase Chain Reaction (PCR) and Agarose gel electrophoresis for PCR product analysis		2
	4.3	**PLANT TISSUE CULTURE**	11	
		Media formulation for plant tissue culture and surface sterilization, callus induction and auxiliary bud culture, Isolation of protoplast		8
5		**Teacher specific module**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, presentations, videos, group interaction.
Assessment types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment(CCA)** **Theory Total 25 Marks** Quiz/Test Papers/Seminar/Case study and report writing
	B. End Semester Examination **Theory: Total - 50 Marks, Duration 1.5 hrs** Fill in the blanks -10 x 1 = 10 Marks Short questions-(10 out of 12) x 2 = 20 Marks Short Essays (5 out of 7) x 4 =20 Marks **Practicals Total 35 marks Duration- 2 hrs** **Record 10 marks** **Examination 25 marks:** Performance of Experiments 16 marks Viva-4 marks, research institute visit report- 5 marks

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3. Brown, T.A. (2019). Gene Cloning and DNA Analysis: An Introduction (7th ed.). Wiley Blackwell. ISBN: 978-1119072560.
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2. Fowler, M.R. (2019). Genetic Engineering: Principles and Methods (3rd ed.). CABI. ISBN: 978-1789240605.
3. Gibson, G., & Muse, S.V. (2019). Genomics: The Science and Technology Behind the Human Genome Project (2nd ed.). Oxford University Press. ISBN: 978-0198786207.
4. Ginsburg, G.S., & Willard, H.F. (2014). Genomic Medicine: Principles and Practice (2nd ed.). Oxford University Press. ISBN: 978-0199334468.
5. Ginsburg, G.S., & Willard, H.F. (2016). Essentials of Genomic and Personalized Medicine (2nd ed.). Academic Press. ISBN: 978-0124078652.
6. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., & Doebley, J. (2020). Introduction to Genetic Analysis (12th ed.). W.H. Freeman. ISBN: 978-1319149609.
7. Katz, L.A., & Bhattacharya, D. (2019). Genomics and Evolution of Microbial Eukaryotes (1st ed.). Oxford University Press. ISBN: 978-0198830202.
8. Krebs, J.E., & Goldstein, E.S. (2020). Molecular Genetics and Genomics (1st ed.). Jones & Bartlett Learning. ISBN: 978-1284154544.
9. Pevsner, J. (2015). Bioinformatics and Functional Genomics (3rd ed.). Wiley-Blackwell. ISBN: 978-1118581780.
10. Wichard, J., & Maertens, A. (2019). Genomic Approaches for Cross-Species Extrapolation in Toxicology (1st ed.). CRC Press. ISBN: 978-0815348023.
11. Wonkam, A., Puck, J.M., & Marshall, C.R. (2019). Genomic Medicine in Resource-limited Countries: Genomics for Every Nation (1st ed.). Academic Press. ISBN: 978-0128133003

Programme	**BSc (Honours) Biological Sciences**					
Course Name	CELL BIOLOGY					
Type of Course	DSC A					
Course Code	UC4DSCBTS201					
Course Level	**200**					
Course Summary	This course provides a comprehensive understanding of the basic principles and complex processes that govern the biology of cells.					
Semester	**IV**	Credits			4	
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	Total Hours
		3	0	1	Invited lectures	75
Pre- requisites, if any	NO					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Deep understanding of the structure and function of cells and the processes that govern their behaviour	U, K	2,3,9,10
2	Demonstrate knowledge of cellular processes, including cell division, protein synthesis, and signal transduction	U, K, A	2,3,9,10
3	Develop critical thinking, skill and research aptitudes in basic and applied biology	A, S	2,3,9,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module			Hrs 45	CO No.
1		**CYTOLOGY AND CYTOSKELETON**	21	
	1.1	Overview of cells: cell theory, Prokaryotic and eukaryotic cell, General organization of eukaryotic and prokaryotic cell Evolution of eukaryotic cell. Plant cell and animal cell.	5	1
	1.2	Structure and functions of cell organelle; nucleus, mitochondria, chloroplast, ribosomes, peroxisomes, Golgi bodies, Lysosomes, Vacuoles and endoplasmic reticulum.	8	1,2

	1.3	Chromosomes – structure of a typical metaphase chromosome - centromere, telomere, chromomere, satellite DNA, nucleosome organization -histones, linker DNA. Polytene chromosomes-Balbiani rings, Lamp brush chromosomes.	5	1,2
	1.4	Cytoskeletal elements: Structure & functions of Microtubule, Microfilaments and intermediate filaments.	3	1,2
2		**PLASMA MEMBRANE AND MEMBRANE TRANSPORT**	8	
	2.1	Plasma membrane: Structure, functions, and various models of plasma membrane. Membrane transport - active, passive, facilitated - symport, antiport	2	1,2
	2.2	Cell junctions: Tight junctions, Gap junctions, Desmosomes, Hemi desmosome	3	1,2
	2.3	Cell-cell interaction - selectins, integrins, cadherins,	3	1,2
3		**CELL CYCLE AND CELL SIGNALLING:**	16	
	3.1	Cell cycle studies; mitosis and meiosis. Regulation of Cell Cycle-Role of cyclins and cyclin-dependent kinases, Cell cycle checkpoints	8	2,3
	3.2	Cell Birth, lineage and death, Cellular senescence and ageing, Apoptosis and Necrosis	3	2,3
	3.3	Signalling molecules and cell surface, receptors; intracellular signal transduction; G protein coupled receptors; plant growth factors and hormones,	5	2,3
		endocrine signalling, quorum sensing and intercellular signalling, Signal peptides, biofilm formation		
4		**PRACTICALS**	**30**	
	4.1	Examination of different kinds of cells - Prokaryotic and eukaryotic cell	4	3
	4.2	Identification of cell organelles	4	3
	4.3	Micrometry: a) Calibration using ocular micrometer b) Finding out average cell size	4	3
	4.4	Mounting of polytene chromosome (Drosophila/ Chironomous)	6	3
	4.5	Study of Barr body in human buccal epithelium	4	3
	4.6	Demonstration Squash preparation of onion root tip for mitotic stages	4	3
	4.7	Study of various stages of meiosis	4	3
5		Teacher specific module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture¸ group interaction¸ seminar¸ presentations Teaching aids like photographs¸ models¸ videos related to the topic can be used
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=25 marks** Quiz/ Test Papers/ seminars **Practical Total 15 marks** Lab performance/ record

	B. End Semester Examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks –10 x 1 = 10 marks Short questions-(10 out of 12) x 2 = 20 marks Short Essays (5 out of 7) x 4 = 20 marks **Practicals Total 35 marks Duration- 2 hrs** Record 10 marks, Examination 25 marks: Performance of experiment 20 marks, Viva-5marks,

References

1. B D Singh. (2011). Fundamentals of Genetics. Kalyani Publishers.
2. Gardner, A. G. (2020). Principles of Genetics. John Wiley and Sons.
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8. Pollard, T. D., & Earnshaw, W. C. (2016). Cell Biology. Saunder's Publishers.
9. Becker, W. M., Reece, J. B., & Poenie, M. (2019). World of the Cell. The Benjamin/Cumming's Pub.

Programme	**BSc (Honours) Biological Sciences**					
Course Name	**ENZYMOLOGY**					
Type of Course	DSE					
Course Code	UC4DSEBTS200					
Course Level	**200**					
Course Summary	The course on enzymology provides an in-depth understanding of the principles and mechanisms of enzyme action, enzyme kinetics, enzyme regulation, and enzyme technology. The applications of enzymes in various industries such as food, pharmaceuticals, and biotechnology are covered along with topics such as enzyme immobilization, enzyme purification and enzyme characterization techniques.					
Semester	**IV**	Credits			4	
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	Total Hours
		4	0	0	0	60
Pre-requisites, if any	**NO**					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To understand the basic principles of enzymes and their role in biological processes.	U,K	2,3,10
2	To learn the mechanism of action of enzymes and understand the kinetics of enzyme action.	U,K	2,3,10
3	To gain knowledge of various techniques used in enzyme purification and characterization.	U,A	2,3,10
4	To evaluate the broad spectrum applications of enzymes	U,A	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Introduction to enzymes Historical account, general properties and nature of enzymes Classification and nomenclature of enzymes. Cofactors and coenzymes. Apoenzymes and holoenzymes	4	1
	1.2	Specificity of enzymes, active site and features, Active site mapping Fischer and Koshland hypothesis. Proenzymes and multi enzyme complexes	5	1
	1.3	Enzymes involved in digestion. Enzymes in metabolic pathways with suitable examples.	5	1,2
2	2.1	Mechanism of Enzyme action Activation energy, transition state. Mechanism of catalysis with suitable examples on role of metal ions and coenzymes. Acid base catalysis and covalent catalysis	5	1,2
	2.2	Enzyme kinetics, Terms used in enzyme kinetics. ES Complex and Michaelis-Menten Equation and Hill Equation	6	2
	2.3	Enzyme Inhibition Reversible and Irreversible Inhibitors Competitive, Non competitive and uncompetitive inhibitions. Enzyme regulation; Allosteric, Feed back and covalently regulated enzymes	8	1,2
3	3.1	Methods employed in extraction and purification of enzymes. Precautions to be adopted in enzyme purification	5	3
	3.2	Subcellular fractionation and centrifugation,salting out, techniques in electrophoresis and chromatography	5	3
	3.3	Methods of protein estimation. ELISA and Western blotting.	5	3
4	4.1	Enzymes in Clinical biochemistry Enzymes used in clinical diagnosis and clinically useful inhibitors with suitable examples, Isoenzymes, Enzyme immobilization Therapeutic enzymes	6	4
	4.2	Enzyme Technology Industrial application of enzymes Enzymes used in food and dairy industry	6	4
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom Procedure Lectures¸ group interactions¸ group seminar¸ power point presentations Teaching aids used- ICT enabled Audio Visual Presentations, Internet Resources
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 30 marks** Test Papers/Assignments/Seminars
	B. End Semester examination **Theory Total = 70 marks (Duration 2 hrs)** Multiple Choice Questions (1X 10) = 10 marks Short Questions (10 out of 12) X 2 = 30 marks Short essays (6 out of 8) X 5 = 30 marks

References

1. Bender, D., Botham, K. M., Kennelly, P. J., Rodwell, V. W., & Weil, P. A. (2018). Harper's Illustrated Biochemistry. New York, NY: McGraw-Hill Education.
2. Jain, J. L., Jain, S., & Jain, N. (2016). Fundamentals of Biochemistry. New Delhi, India: Jaypee Brothers Medical Publishers.
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SUGGESTED READINGS

1. Aehle,W. (2007). Enzymes in Industry: Production and Applications. Weinheim, Germany: John Wiley & Sons Inc.
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Programme	**BSc (Honours) Biological Sciences**					
Course Name	RESEARCH METHODOLOGY AND BIOSTATISTICS					
Type of Course	DSE					
Course Code	UC4DSEBTS201					
Course Level	**200**					
Course Summary	This course aims to provide a comprehensive understanding on the research methodologies used in biosciences. The development of critical thinking skills and the techniques and tools required to design and conduct scientific research are learned. The statistical methods for analyzing and evaluating data, developing critical thinking skills and the ability to evaluate and interpret scientific literature are emphasized along with methods to communicate and present research findings.					
Semester	**IV**	Credits			4	
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	Total Hours
		4	0	0	0	60
Pre-requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To understand the fundamental principles and concepts of research methodology and design.	U,K	1,2,3,10
2	To gain skills in designing and conducting experiments, including hypothesis formulation, sample collection, and experimental design.	U,E	1,2,3,10
3	To learn methods of data collection, analysis, and interpretation using appropriate statistical methods.	U,A	1,2,3,10
4	To evaluate and observe research articles and scientific literature for enhancing scientific writing skills, including the preparation of research proposals, reports, and manuscripts.	U	1,2,3,10
5	To communicate research findings effectively through written reports and presentations.	A,S	1,2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
1	1.1	Introduction to Research- Definition, Objectives and characteristics of research.	5	1
	1.2	Types of Research- Basic, Applied and Action research, Exploratory and Descriptive, Ex-post facto research.	5	1
	1.3	Identification of Research Problem Sources of research problem, Criteria for the selection of research problem. Research design, Rationale, Statement of problem, Setting objectives. Definition of concepts, operational definition, variables independent and dependent, control and intervening variables, limitations and delimitation. Hypothesis - Meaning and importance, types of hypotheses.	5	1,2
2	2.1	Methods of Collecting Primary Data- Questionnaire, preparation of schedules, interview method, case study method, experimentation method and sources of secondary data. Editing and Coding the Data	5	2,3
	2.2	Organization of Data - Classification - meaning and objectives, types of classification. Representation of Data - Diagrammatic and graphical representation - significance of diagrams and graphs - general rules for constructing diagrams - types of diagrams, graphs of time series, graphs of frequency distribution. Interpretation and Report Writing-Meaning of interpretation, precautions and essentials for good report, footnotes and bibliographical citations	5	2,3
	2.3	Methods - Survey, observation, interview, experimental, clinical methods. Tools Questionnaire, Schedule (for interview and observation) Rating Scales, Attitude Scales. Reliability and validity.	5	3
3	3.1	Introduction to Biostatistics: Variable and attribute; Population vs. sample; Census vs sample survey;;	5	3
	3.2	Arrangement of data; Frequency distribution. Graphical presentation of data: Line diagram; Bar diagram, Pie chart; Histogram,	5	3
	3.3	Level of significance, Probability, Normal distribution, Error of inference, Student's t-test, Paired t-test, Fisher's t-test, Chi-square test and ANOVA. Introduction to SPSS	5	3
	4.1	Structure and Components of Research Reports Types of Reports Layout structure and language of typical reports	5	4

4	4.2	Preparation of Project Proposal Title, Abstract, Introduction-Rationale, Objectives, Methodology- Time frame and work plan, Budget and justification, References	5	5

	4.3	Preparing research paper for journals, seminars and conferences. Impact factor of a journal, citation index, ISBN & ISSN	5	5
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures¸ group interactions¸ group seminar¸ power point presentations. Solving problems in biostatistics Teaching aids used- ICT enabled Audio Visual Presentations, Internet Resources
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 30 marks** Test Papers/Assignments/Seminars
	B. End Semester examination **Theory Total = 70 marks (Duration 2 hrs)** Multiple Choice Questions (10 X 1) = 10 marks Short Questions (14 out of 16) X 2= 28 marks Short essays (8 out of 10) X 4= 32 marks

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2. Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches.Sage publications.
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4. Rosner, B. (2015). Fundamentals of biostatistics. Cengage Learning.
5. Sullivan, L. M. (2018). Essentials of biostatistics in public health. Jones & Bartlett Learning research: Planning and design. Pearson.

Programme						
Course Name	THE MOLECULES OF LIFE					
Type of Course	DSC-B					
Course Code	UC4DSCBTS202					
Course Level	**200**					
Course Summary	The course is designed to get a clear idea on the basic biomolecules and their importance in the various biochemical processes in life so that the course builds a base for the students to comprehend and articulate the advanced concepts in life sciences. The basic laboratory practices and study of biochemical analysis are also incorporated.					
Semester	**IV**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To identify the different types of biomolecules such as lipids, carbohydrates, proteins and nucleic acids	U	2,3,10
2	To differentiate the structural and functional characters of different biomolecules	A	2,3,10
3	To understand the coordinated functions of different biomolecules in a complex living system	A/An	2,3,10
4	To compare the structure and functions of biomolecules	A	2,3,10
5	To describe the structure and functions of vitamins and hormones	U	2,3,10
6	To gain experience in basic laboratory practices in biochemistry and qualitative analysis of carbohydrates and proteins	A	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1	1.1	**Carbohydrates:** Classification of Carbohydrates with examples- monosaccharides, disaccharides and oligosaccharides; their structure and functions;	5	1,2,3,4
	1.2	Polysaccharides - occurrence, structure, isolation, properties and functions of homoglycans- starch, glycogen, cellulose, dextrin. Occurrence, structure, properties, and functions of heteroglycans – bacterial cell wall polysaccharides, glycoaminoglycans, agar, blood group substances and sialic acids. Glycolipids and Glycoproteins and their biological applications.	5	1,2,3,4
	1.3	**Lipids:** Classification of lipids with examples; their structure and functions.	5	1,2,3,4
	1.4	Complex lipids- phospholipids -classification, structure and functions. Amphipathic lipids -membranes, micelles, emulsions and liposomes Ceramides and sphingomyelins. Eicosanoids, structure and functions of prostaglandins, thromboxanes, leukotrienes Types and functions of plasma lipoproteins	3	1,2,3,4
	1.5	Steroids -cholesterol structure and biological role -bile acids, bile salts. Sterols in Plant system: Phytohormones: Brassinosterroids (functions); Sterols in microbial system: mycosterols.	2	1,2,3,4
2	2.1	**Proteins:** Amino acids- Structure and properties**,** Classification of proteins on the basis of solubility and shape, structure, and biological functions Denaturation and renaturation of proteins.	3	1,2,3,4
	2.2	Primary structure -determination of amino acid sequence of proteins. Ramachandran plot, Secondary, tertiary and quaternary structures of proteins. Study with appropriate examples and functions	3	1,2,3,4
	2.3	**Nucleic Acids**: Components of nucleic acids, Nucleotide structures, Watson -Crick model of DNA structure. A, B and Z DNA	3	1,2,3,4
	2.4	RNA Structure: Types of RNA; structure of mRNA, tRNA and rRNA,Si RNA, micro RNA with emphasis on importance of structure to its function	3	1,2,3,4
3	3.1	**Vitamins:** Vitamins -water soluble -thiamine, riboflavin, niacin, pyridoxine, folic acid, ascorbic acid-source, structure, biochemical functions, deficiency diseases, daily Requirements	5	5

	3.2	Fat soluble -vitamin A, vitamin D2, vitamin E and vitamin K -sources, structure, biochemical functions, deficiency diseases, daily requirements.	3	5
	3.3	Hormones: different types, structures, their biological functions and disorders.	3	5
	3.4	Mechanism of action of peptide and steroid hormones	2	5
4		**Techniques in Biochemistry Laboratory- Practicals**	**30**	
	4.1	Laboratory Safety Practices, Preparation of normal, molar, percentage solution and dilution of stock solutions	5	6
	4.2	Determination of pH by using pH meter. Preparation of reagents involved in qualitative analysis	10	6
	4.3	Systematic analysis of carbohydrates and proteins in the given unknown samples. Quantitative Analysis of Protein by Biuret Method	15	6
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures¸ group interactions¸ group seminar¸ power point presentations Teaching aids used- ICT enabled Audio Visual Presentations, Internet Resources
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 25 marks** Test Papers/Assignments/Seminars Practical 15 marks
	B. Semester End examination **Theory Total = 50 marks (Duration 2 hrs)** Multiple Choice Questions (1X 12) = 12 marks Short Questions (6 out of 8) X 3 = 18 marks Short essays (5 out of 7) X 4= 20 marks Practical 35 marks, record-10 ,examination 25 marks

References

1. Nelson, D. L., & Cox, M. M. (2004). Lehninger Principles of Biochemistry (4th ed.). W. H. Freeman.
2. Voet, D., &Voet, J. G. (2004). Biochemistry [with Cdrom]. John Wiley & Sons Inc.
3. Zubay, G. L., Parson, W. W., & Vance, D. E. (1995). Principles Of Biochemistry. Mcgraw-Hill Book Company–Koga.
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6. West, E. S., Todd, W. R., Mason, H. S., & van Bruggen, J. T. (1974). A Text Book of Biochemistry. Oxford and IBH Publishing Co.

SUGGESTED READINGS

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (5th ed.). Garland Science. ISBN-10: 0815341059, ISBN-13: 978-0815341055
2. Baker, T. A., Bell, S. P., & Watson, J. D. (2008). Molecular Biology Of The Gene 5/e (s). Dorling Kindersley (India) Pvt Ltd. ISBN: 8177581813, ISBN-13: 9788177581812, 978-8177581812
3. Lewin, B. (2008). Genes IX. J&b. ISBN: 0763752223, ISBN-13: 9780763752224, 978-0763752224

Programme						
Course Name	HUMAN RIGHTS AND GENDER EQUALITY					
Type of Course	VAC					
Course Code	UC4VACBTS200					
Course Level	**200**					
Course Summary	The course aims to provide students with a comprehensive understanding of human rights issues and equip them with the knowledge and skills to advocate for human rights in their personal and professional lives. The course aims to empower students to become informed and active global citizens committed to promoting and protecting human rights for all individuals.					
Semester	**IV**	Credits			3	
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	Total Hours
		3	0	0	0	45
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To develop the real sense of Human rights – its concepts & manifestations	U,K	1,2,3,10
2	Developing a comprehensive understanding of human rights principles, laws, and mechanisms	K,U,A	1,2,5,6,7,10
3	Critical analysis of human rights issues, advocate for social justice, and effectively communicate ideas and perspectives on human rights violations.	U, A, An	2,5,6,7,10
4.	Develop a critical understanding of the social construction of gender and its impact on individuals and society.	U, A, An, E	2,5,6,7,10
5.	Identify and critique systems of power and privilege that perpetuate gender inequality	A, An, E	2,5,6,7,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1	1.1	Historical development of human rights	2	1
	1.2	Main concepts associated with Human Rights	2	1,2
	1.2	International human rights laws and treaties	2	1,2
	1.3	Different categories of rights (civil, political, economic, social, and cultural)	3	1
2	2.1	Constitutional provisions related to Human rights	3	2
	2.2	Governments and non-governmental organizations in promoting and protecting human rights	3	2
	2.3	Mechanisms for checking violations of human rights	4	2
	2.4	National human right commission	1	2
3	3.1	Conceptualizing Gender: Sex and Gender, Types of Gender. Concepts in relation with Gender- Gender needs, Gender Roles, Gender Stereotyping, Gender Discrimination, Gender Identity.	3	4
	3.2	Gender in India: Gender Status and gender disparity in Education, Labour force participation Political participation, Health. Gender and Media- Role of Media in constructing ideologies, Gender sensitivity, Gender equality, Gender and Development	3	4
	3.3	Gender based violence- Sexual abuse, Domestic Violence, Female infanticide, dowry death, workplace harassment.	3	4,5
	3.4	Legal and Statutory Remediation, Remedies and Support	3	2
	3.5	Current human rights issues and challenges.	3	2,5
	3.6	Case studies and report writing	10	3,5
4		Teacher specific module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, presentations, videos, debate, group interaction
Assessment types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment** **Theory Total 25 Marks** Quiz/Test Papers/Seminar/Case studies and report writing

	B. End Semester Examination **Theory: Total - 50 Marks, Duration 1.5 hrs** Fill in the blanks -1x10=10 Marks Short questions-(10 out of 12) x 2 = 20 Marks Short Essays (5 out of 7) x 4 = 20 Marks

References

1. Agarwal, H.O. (2018). Human Rights. CLP.
2. Agarwal, H.O. (2019). International Law and Human Rights. CLP.
3. Bhasin, K. (2000). Understanding gender. Kali for women, N. Delhi.
4. Chitnis, V., et al (1997). Human Rights and the Law: National and Global Perspective: Ketan Thakkar for Snow White Publications Pvt. Limited,
5. Deshpande, B.A. (2017). Human rights- Law and Practice. CLP.
6. Dharmadhikari, D.M. (2016). Human Values and Human Rights. Lexis Nexis.
7. Gupta, K.R. (2009). Gender: Problems and policies. New Delhi: Atlantic Publishers.
8. Jain, R. (2016) Text book on Human Rights Law and Practice. Lexis Nexis.
9. Kumar Sinha, M (2013). Implementation of Basic Human Rights. Lexis Nexis.
10. Mukherjee, M. (1992). Human Rights and gender issues. New Delhi: Institute of Social Sciences.
11. Pal, M. (2009). Gender and Discrimination: Health, Nutritional status and role of women in India. London: Oxford University Press.

Programme						
Course Name	BASIC MOLECULAR TECHNIQUES					
Type of Course	SEC					
Course Code	UC4SECBTS200					
Course Level	**200**					
Course Summary	Participants will learn about DNA extraction, PCR, and gel electrophoresis. The course focuses on troubleshooting common issues and optimizing experimental protocols. By the end of the course, participants will have a solid understanding of these techniques and be able to apply them to their own research projects.					
Semester	**IV**	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	0	0	60
Pre- requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To develop basic laboratory skills such as safety protocols, proper handling of equipment and chemicals, accurate measurement techniques, data analysis, and interpretation of results	U, A, An, S	1,2,3,10
2.	To gain proficiency in various laboratory techniques such as DNA isolation, PCR, gel electrophoresis	U, A, An E,S	1,2,3,,9,10
3.	To develop a strong understanding of molecular biology concepts, experimental design, data analysis, and interpretation	U,A An ,S	
4	To equip students with the practical skills and knowledge needed to excel in research	A, An E,C,S	
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction

Module	Units	Course description	Hrs 60	CO No.
		General laboratory Practices	**15**	
	1.1	General laboratory rules and procedures in a Molecular biology laboratory.		1
	1.2	General Rules/Protocols for Lab Safety measures, Precaution and Safety in handling of chemicals, Laboratory tools, Glassware and instruments.		1

1.	1.3	Laboratory Standard Operating Procedures and Log book maintenance. Instruments and Apparatus: pH meter, Spectrophotometer, UV Transilluminator, water bath, weighing balance and micropipettes.		1
	1.4	Preparation of Standard Solution and Buffers used in molecular biology labs.		1
	1.5	Sterilization techniques: moist heat and dry heat sterilization.		1
	1.6	Storage facilities of chemicals and reagents.		1
2.		**Isolation of DNA**	**20**	
	2.1	Isolation of genomic DNA from bacteria.		2,3,4
	2.2	Isolation of genomic DNA from plant tissue.		2,3,4
	2.3	Isolation of plasmid DNA from bacterial cells.		2,3,4
3.		**Polymerase Chain Reaction and Agarose Gel Electrophoresis**	**25**	
	3.1	Polymerase chain reaction: Reagents of PCR, Preparation of master mix, PCR programming.		2,3,4
	3.2	Preparation of Agarose gel, role of Gel loading dye and Ethidium bromide, preparation of TAE buffer, Visualization and Interpretation of gel.		2,3,4
4.		Teacher specific module		

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Lectures, presentations, videos, Experiential learning, hands on training
Assessment types	**MODE OF ASSESSMENT** **B. Continuous Comprehensive Assessment Theory** **Total 25 Marks** Quiz/Test Papers/Seminar/Viva
	B. End Semester Examination **Theory: Total – 50 Marks, Duration 1.5 hrs** Fill in the blanks -1x10=10 Marks Short questions- (10 out of 12) x 2 = 20 Marks Short Essays 5 out of 7 x4 =20 Marks

References

1. Innis, M. A., Gelfand, D. H., & Sninsky, J. J. (1990). PCR Protocols: A Guide to Methods and Applications. San Diego, CA: Academic Press.
2. Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Thieman, W. J., & Palladino, M. A. (2011). Laboratory Techniques in Biotechnology.

SEMESTER-V

Programme	**BSc (Honours) Biological Sciences**					
Course Name	DEVELOPMENTAL BIOLOGY					
Type of Course	DSC A					
Course Code	UC5DSCBTS300					
Course Level	**300**					
Course Summary	The course is designed to equip students in perceiving, understanding, and Analyzing reproductive and embryological developmental processes.					
Semester	**V**	Credits			4	Total Hours
CourseDetails	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre- requisites, If any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Students will be able to understand the reproductive and developmental events	U/A	2,3,10
2	explain how developmental processes initiates and proceeds	E	2,3,10
3	To achieve a basic understanding of the experimental methods and designs that can be used for future studies and research	U	2,3,10
4	Discuss basic embryonic development	U	2,3,10
5	Explore the Molecular and Genetic Basis of Development:	E	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs. 45	CO No.
	1.1	**Introduction**: Definition, Scope of developmental biology, sub-divisions (descriptive, Comparative, experimental and chemical), historical perspectives, basic concepts and theories.	3	1

1	1.2	**Reproductive Physiology**: Gonads- anatomy of testis and ovary, spermatogenesis, oogenesis, gonadal hormones and their functions. Hormonal control of human reproduction - Female reproductive cycles (Estrous cycle, Menstrual cycle). Structure of mammalian sperm and egg, Pregnancy, parturition and lactation. **Egg types:** Classification of eggs based on the amount, distribution and position of yolk. Mosaic and regulative, cleidoic and noncleidoic eggs. Polarity and symmetry of egg.	12	2
2	2.1	**Fertilization**: Mechanism of fertilization- (Encounter of spermatozoa and Ova, Approach of the Spermatozoon to the Egg, Acrosome Reaction and Contact of Sperm and Ovum, Activation of Ovum, Migration of Pronuclei and Amphimixis,), Significance of fertilization, Polyspermy, **Parthenogenesis**- Different types and significance	5	2
	2.2	**Cleavage:** Types, planes and patterns of cleavage, Cell lineage of Planaria. Influence of yolk on cleavage. **Blastulation:** Morula, blastula formation, types of blastula with examples Fate maps: Concept of fate maps, construction of fate maps (artificial and natural), structure of a typical chordate fate map. Significance of fate map. **Gastrulation:** Major events in gastrulation. Morphogenetic cell movements. Influence of yolk on gastrulation. Exogastrulation. Concept of germ layers and derivatives.	10	2

3	3.1	**Cell differentiation and gene action**: Potency of embryonic cells (Totipotency, Pleuripotency, Unipotency of embryonic cells). Determination and differentiation in embryonic development, Gene action during development with reference to Drosophila (maternal effect genes), Zygotic genes.	5	5
	3.2	**Organogenesis –**vulva formation in Caenorhabditis elegans, eyelens induction,(BRIEF ACCOUNT) limb development and regeneration in vertebrates **Experimental embryology**: Spemann's constriction experiments, Organizers and embryonic Induction. Embryo transfer technology, cloning, stem cell research. Ethical issues.	10	4,5
	3.3	Prenatal diagnosis: Amniocentesis, Chorionic villi sampling, Ultra sound scanning, Foetoscopy, Maternal serum alpha-fetoprotein, Maternal serum beta-HCG.	5	3

	3.4	Embryology of Frog: Gametes, fertilization, cleavage, blastulation, , gastrulation, neurulation, notogenesis. Differentiation of Mesoderm and Endoderm, Development of eye. Metamorphosis of frog, Hormonal and environmental Control.	10	4
4		**PRACTICALS** 1. Study of permanent slides of Frog embryology: T.S. Blastula, T.S. Gastrula. 2. Embryo transfer, cloning, Amniocentesis 3. Candling method. 4. Vital staining- demonstration 5. Calculate the gonado-somatic index of given fish 6. Male and female reproductive organs in cockroach	**30**	1,3
5		Teachers specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom lectures Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory Total=25 marks** Quiz/ Test Papers/ seminars /Peer Review **Practical Total 15 marks** Lab performance/Lab report/ Viva Voice
	B. End Semester Examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks /MCQ-1x10=10 marks Short questions- (10 out of 12) x 2 = 20 marks Short Essays (5 out of 8) x 4 = 20 marks **Practicals Total 35 marks Duration- 2 hrs** Record 10 marks, Examination 25 marks: spotter identification- 5marks, viva -5 marks, Experiments/Dissection- 15 marks.

References

1. Agrawal, V., & Sharma, R. (2007). Developmental biology. S. Chand Publishing.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular biology of the cell (6th ed.). Garland Science.
3. Balinsky, B. I., & Fabian, B. C. (2012). An introduction to embryology (5th ed.). CBS Publishers & Distributors.
4. Bhatnagar, S. P., & Moitra, A. (1996). Developmental biology. Oxford University Press.
5. Datta, S. C. (2008). Developmental biology. New Age International Publishers.
6. Gilbert, S. F. (2010). Developmental biology (9th ed.). Sinauer Associates.
7. Gilbert, S. F., & Barresi, M. J. F. (2016). Developmental biology (11th ed.). Sinauer Associates.
8. Gupta, P. K. (2007). Elements of developmental biology. Rastogi Publications.
9. Hall, B. K. (1999). The neural crest in development and evolution. Springer.

Programme	**BSc (Honours) Biological Sciences**					
Course Name	MOLECULAR BIOLOGY					
Type of Course	DSC A					
Course Code	UC5DSCBTS301					
Course Level	**300**					
Course Summary	This course provides students with a comprehensive understanding of the principles and processes that govern the structure and function of biological molecules at the molecular level. They will also learn about the latest advancements in molecular biology research and how these findings can be applied in various fields such as medicine, agriculture, and biotechnology. By the end of the course, students will have gained a strong foundation in molecular biology that will prepare them for further studies or careers in the field.					
Semester	**V**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	NO					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	To understand the basic principles of molecular biology and its significance in the field of genetics and biotechnology.	U, K I	2,3,10
2	To acquire knowledge on various molecular mechanism involved in the regulation of gene expression in prokaryotes and eukaryotes.	K, A, S	2,3,10
3	To develop critical thinking skills to analyze and interpret experimental data in molecular biology research.	A, An, S	2,3,10
4	To acquire knowledge of current trends and advancements in molecular biology research	K, U	2,3,10
5	To apply knowledge of molecular biology to real-world problems and challenges in various fields, such as medicine, agriculture, and biotechnology	A,An, E	2,3,9,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs 45	CO No.
1		**Introduction to Molecular Biology-Genetic material**	**10**	
	1.1	Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase, bacteriophage experiment, Structure and types of DNA & RNA. Modern concept of gene (Cistron, muton, recon, viral genes), Split genes (introns and exons), Junk genes, Pseudogenes, Overlapping genes, Transposons.	2	1
	1.2	DNA Replication- Models of DNA Replication, Conservative, Semiconservative and discontinuous, Steps in DNA replication (prokaryotes and Eukaryotes), Enzymatic factors involved, Modes of replication- theta, rolling circle, d-loop replication,	4	1,2
	1.3	DNA Repair mechanisms- Photolyase, Excision Repair- BER, NER. Mismatch repair, SOS repair, Recombination repair systems	4	1,2
2		**Process of transcription**	**8**	
	2.1	Types of RNA (mRNA, tRNA, rRNA)	2	1
	2.2	Process of transcription (prokaryotes and eukaryotes) promoters, Enhancers, RNA polymerases,	3	1,2
	2.3	Post-transcriptional modifications- Polyadenylation, capping, splicing	3	1,2
3		**Process of Translation and gene regulation and Nucleic acid - based technologies**	**27**	
	3.1	Central Dogma of molecular biology and central dogma reverse, one gene- one enzyme hypothesis, One gene-one polypeptide hypothesis Characteristics of genetic code, Contributions of Har Gobind Khorana, Eukaryotic and prokaryotic ribosomes, tRNAs, aminoacyl t-RNA synthetases,	4	1
	3.2	Steps involved in translation (prokaryotes and eukaryotes), Post translational modification	5	4
	3.3	Gene regulations: Prokaryotic(inducible & repressible systems) Operon concept -Lac operon	6	4
		and Tryptophan operon, Brief account of Eukaryotic gene regulation.		
	3.4	RNA interference, Antisense RNA, SiRNA, MicroRNA,	4	3,4,5
	3.5	Riboswitches & their applications,	2	3,4,5

	3.6	Nucleic acid as therapeutic agent,	3	3,4,5
	3.7	Human genome project and its implications	3	3,4,5
4		**PRACTICAL**	**30**	
	4.1	Introduction to Laboratory Techniques	4	
		Safety guidelines and laboratory protocols and Aseptic techniques and proper handling of materials, Preparation of solutions for Molecular Biology experiments		
	4.2	Extraction and Separation Experiments	16	4
		Isolation of chromosomal DNA from bacterial cells, Isolation of RNA, Determination of Purity of DNA using UV-Visible spectrophotometer (A260/ A280measurement), Separation of DNA and RNA by agarose gel electrophoresis, Extraction of protein from tissues, Separation of protein by SDS- PAGE		
	4.3	Cloning and Plasmid Manipulation	10	4
		Isolation of Plasmid, Restriction enzyme digestion, Ligation reactions, Transformation of bacterial cells with recombinant plasmids Colony selection and screening		
5		Teacher specific module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture¸ group interaction¸ seminar¸ presentations, Experiential learning, Teaching aids like photographs¸ models¸ videos related to the topic can be used
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=25 marks** Quiz/ Test Papers/ seminars/Viva **Practical Total 15 marks** Lab performance/ record
	B. End Semester Examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks -1x10=10 marks Short questions-(10 out of 12) x 2 = 20 marks Short Essays (5 out of 7) x 4 = 20 marks **Practicals Total 35 marks Duration- 2 hrs Record 10 marks,** **Examination 25 marks** Performance of experiment 20 marks Viva-5 marks

References

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular biology of the cell (6th ed.). New York, NY: Garland Science.
2. Allison, A. C. (2015). Fundamental Molecular Biology. Wiley.
3. Calladine, C. R., Drew, H. R., Luisi, B. F., & Travers, A. (2004). Understanding DNA. Elsevier.
4. Cox, M. M., Nelson, D. L., & Lehninger, A. L. (2007). Molecular Biology: Principles and Practice. Freeman.
5. Freidfelder, D. (2006). Molecular Biology. Narosa.
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7. Hartwell, L. H., Hood, L., Goldberg, M. L., Reynolds, A. E., & Silver, L. M. (2011). Genetics: From Genes to Genome. McGraw-Hill.
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9. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., & Darnell, J. (2000). Molecular Cell Biology. Scientific American Books.
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11. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). Molecular cloning: A laboratory manual.
12. Tropp, B. E. (2011). Molecular Biology: Genes to Proteins. Jones and Bartlett.
13. Walker, J. M., & Gringold, E. B. (1994). Molecular Biology and Biotechnology. Panima.
14. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). Molecular Biology of the Gene. Benjamin/Cummings.
15. Weaver, R. F. (2011). Molecular biology (5th ed.). New York, NY: McGraw-Hill.

Programme	**BSc (Honours) Biological Sciences**					
Course Name	GENETICS					
Type of Course	DSC A					
Course Code	UC5DSCBTS302					
Course Level	**300**					
Course Summary	Introduce students to the concepts of Genetics and to develop deep understanding on genes and genetic variation for shaping population structure.					
Semester	**V**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Develop a deep understanding of the fundamental concepts and theories of Genetics	K,U	2,3,10
2	To develop critical thinking, skill and research aptitudes in Genetics	K,U	2,3,1o
3	To emphasize the central role of genes and their inheritance in the life of all organisms	U, An, E	
4	Analyze the role of genetics in shaping population structure and dynamics.	An, E	

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
1	1.1	**Mendelian Genetics:**	**16**	
		Mendel's experiment - Monohybrid Cross, Dihybrid Cross, Mendel's Laws of heredity, Test Cross, Back Cross and Reciprocal Cross. Chromosome Theory of Inheritance	4	1
	1.2	**Interaction of genes:**		
		Allelic interactions: Incomplete Dominance and Co- Dominance with examples Lethal gene: Dominant and recessive lethal gene with examples Non-Allelic interaction: Complementary, Supplementary gene interaction with examples Epistasis – dominant, and recessive with examples, Polygenes with an example Pleiotropism, Multiple alleles with examples	6	1
	1.3	**Linkage and Recombination:**		
		Linkage and recombination of genes based on Morgan's work in Drosophila, Linked genes, Linkage groups, chromosome theory of linkage, types of linkage, Recombination, cross over value, Chromosome mapping, Two factor cross and three factor cross in Drosophila.	6	1
2		**Mechanisms of sex determination:**	**9**	
	2.1	XX-XY mechanism of sex determination,, Species with heterogametic females, The Y-chromosome and sex determination in mammals, Sex determination in Drosophila(Genic balance theory),Intersex in Drosophila, Haplodiploidy, Hormonal and Environmental influence on sex determination, Barr body and Lyon's hypothesis.	5	3
	2.2	Characteristics of sex linked inheritance, X linked traits and Y linked traits in humans, Sex limited gene expression, Sex influenced dominance.	4	3
3		**Extra chromosomal Inheritance and Mutation**	**9**	
	3.1	Criteria for extra nuclear inheritance, cytoplasmic organelles containing DNA, Cytoplasmic male sterility in plants	3	1

	3.2	Types of mutation -Somatic and germinal, Chromosome structural changes-Deletion, Duplication, Inversion and Translocation, Chromosome Numerical changes, Molecular basis of gene mutation, Induced mutations and physical mutagens, significance of mutations	6	1,2
4		**Chromosomal disorders and Population Genetics and experiments**	**26**	
	4.1	Aneuploidy and Non-disjunction, Autosomal abnormalities -Down's syndrome, Cry du chat syndrome, Sex chromosomal abnormalities-Klinefelter's syndrome, Turner's syndrome, Autosomal gene disorder-Sickle cell anaemia, Inborn errors of metabolism-Phenylketonuria, Alkaptonuria, Albinism, Multifactorial disorders-Cleft lip and cleft palate	5	3
	4.2	Genetic variation, Allele frequencies, Hardy-Weinberg method, Inbreeding, Out breeding, Changes in allele frequencies, Genetic drift.	6	4
	4.3	**Experiential learning**		
		Experiments on monohybrid, dihybrid cross, test cross, and reciprocal cross, Experiments on epistatic interactions Determination of linkage and cross over analysis (two factor cross) Hardy Weinberg Law for calculation of gene frequency Sexing in Drosophila Pedigree Analysis Karyotype analysis	15	2
5		Teacher specific module		

Teaching & Learning Approach	**Classroom Procedure (Mode of transaction)** ICT Enabled Learning, Tutorial, Lecturing, Seminars
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=30marks** Quiz/ Test Papers/ Seminar/ Viva

	B. End Semester examination **Theory Total 70 marks, Duration 2 hrs** Multiple Choice Questions -10 x 1 = 10 Marks Short questions-(10 out of 12) x 3 = 30 Marks, Short Essay (6 out of 8) x 5 = 30 Marks,

References

1. Gardner, E.J., Simmons, M.J., & Snustad, D.P. (2009). Genetics: Principles and Analysis. Wiley.
2. Griffiths, A. J., Miller, J. H., Suzuki, D. T., Lewontin, R. C., & Gelbart, W. M. (2000). An Introduction to Genetic Analysis (7th ed.). New York, NY: W. H. Freeman.
3. Lewin, B. (2017). Genes XII. Jones and Bartlett Publishers.
4. Pierce, B. A. (2013). Genetics: A conceptual approach (5th ed.). New York, NY: W. H. Freeman.
5. Russell, P. J. (2011). iGenetics: A Mendelian approach. San Francisco, CA: Pearson Education.
6. Singh, B.D. (2019). Fundamentals of Genetics. Kalyani Publishers.
7. Snustad, D. P., & Simmons, M. J. (2012). Principles of genetics. Hoboken, NJ: John Wiley & Sons.

Programme	**BSc (Honours) Biological Sciences**					
Course Name	IMMUNOLOGY					
Type of Course	DSE					
Course Code	UC5DSEBTS300					
Course Level	**300**					
Course Summary	The course focuses on how the immune system functions to protect the body from infection and disease. It also highlights how the system is naturally or artificially perturbed in clinical conditions, such as immunodeficiency, autoimmunity and hypersensitivity conditions as well as latest advances in immunotherapy and vaccine development.					
Semester	**V**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand basic functioning of immune system	U	
2	Instill knowledge about organs and cells of immune system	U	
3	Provide knowledge on essential features of antigens and antibodies	K	
4	Apply knowledge in disease diagnosis through serological tests	A	
5	Acquire a broad understanding of immune system malfunctioning.	U	
6	Create basic knowledge about new approaches to vaccine production and cancer immunotherapies	U	

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C),Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
	1	**Immune system**	11	
	1.1	Introduction, historical background and scope of Immunology	2	1
	1.2	Primary lymphoid organs	2	1,2

	1.3	Secondary lymphoid organs	2	1,2
	1.4	Cells of immune system	3	1,2
1	1.5	B and T cell maturation	2	1,2
	2.	**Infection and Immunity**	14	
	2.1	Types and source of infection	2	1
	2.2	Immunity : Innate vs Adaptive	2	1
	2.3	Innate immunity: Innate immune mechanisms	3	1
	2.4	Acquired immunity : Active vs passive immunity	2	1
2	2.5	Immune responses : Humoral and cell mediated immune responses	2	1
	2.6	B cell activation	2	1
	2.7	T cell activation	2	1
	3	**Antigens & Antibody**	18	
	3.1	Antigens -types	2	3
	3.2	Essential features of antigenicity, B cell and Tcell epitopes	2	3
	3.3	MHC, Antigen processing and presentation	2	1
	3.4	Antibody- Basic structure and classes	3	3
3	3.5	Generation of Antibody diversity	3	3
	3.5	Monoclonal Antibodies: Hybridoma technology	2	3
	3.6	Antigen Antibody reactions-Serological tests	4	4

	4	**Clinical Immunology**	**17**	
	4.1	Hypersensitivity – Immediate and delayed reactions, Clinical types of hypersensitivity- Combs classification	3	5
	4.2	Auto immunity, Mechanisms of autoimmunization, Types of autoimmune disorders	3	5
	4.3	Immunodeficiency diseases.- Primary &Secondary immunodeficiency disorders	3	5
4	4.4	Tumor immunology, Tumor antigens ,Immune response in malignancy, Cancer Immunotherapies	3	5,6
	4.5	Immune hematology	2	5
	4.6	Vaccines: Types, new approaches in vaccine development	3	6
5		Teacher Specific Module		

Teaching & Learning Approach	**Classroom Procedure (Mode of transaction)** ➢ Classroom lectures ➢ Power point presentations ➢ Video presentations ➢ Article and general reviews ➢ Seminars & group discussions ➢ Assignments

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=30marks** Quiz/ Test Papers/ Seminar/ Assignment/Viva/Take home tests
	B. End Semester examination **Theory Total 70 marks, Duration 2 hrs** Multiple Choice Questions -(10 x 1) = 10 Marks Short questions-(10 out of 12) x 3 = 30 Marks, Short Essays (6 out of 8) x 5 = 30 Marks

References

1. Ananthanarayanan, R & Panicker, C(2007). Text book of Microbiology. Orient Longman.
2. Chappel,H & Haeney, M. Clinical Immunology. Wiley-Blackwell.
3. Flower,D.(2007). Immunoinformatics predicting Immunogenicity in Silico. Humana Press.
4. Janeway,C.& Travers,P.(2001) Immunobiology. Garland Science.
5. Kimball ,J.(2008). Introduction to immunology. Macmillan.
6. Kindt, T.& Kuby,J (2016).Immunology. W.H,Freeman.

Programme	**BSc (Honours) Biological Sciences**					
Course Name	INTRODUCTION OF FORENSIC BIOLOGY					
Type of Course	**DSE**					
Course Code	UC5DSEBTS301					
Course Level	**300**					
Course Summary	The program aims to provide students with a comprehensive understanding of the forensic science discipline, enabling them to apply scientific principles and techniques to solve crimes and contribute to the justice system.					
Semester	**V**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Solid understanding of forensic science principles	K, U	2,3,10
2	Proficiency in forensic laboratory techniques	U, A, S	2,3,10
3	Expertise in analyzing and interpreting evidence	An, E	2,3,10
4	Knowledge of legal and ethical considerations	U, K, A	2,3,7,10
5	Research and analytical skills	S, U, An	2,3,9,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
1		**Forensic Biology**		
	1.1	Overview of the field, its history, and its importance in criminal investigations.	3	1
	1.2	Forensic biology-Analysis of biological evidence such as DNA, blood, and other bodily fluids	4	1,2

	1.3	Biological techniques- DNA profiling, serology, and the interpretation of biological evidence in criminal investigations	5	2,3,5
2		**Forensic Chemistry**		
	2.1	Forensic Chemistry- analysis and identification of chemical substances found at crime scenes	3	2,3
	2.2	Analytical techniques, including spectroscopy, chromatography, and mass spectrometry, and how they are used to identify drugs, explosives, and other chemical compounds.	6	2,3,5
3		**Forensic Toxicology**		
	3.1	Analysis of drugs and toxins in biological samples and their impact on criminal investigations.	3	2,3
	3.2	techniques for drug identification and interpretation of toxicological findings	3	2,3,5
	3.3	The effects of drugs on the human body.	3	1,3
		Forensic Anthropology		
	3.4	Study of human skeletal remains and their significance in criminal investigations	3	1,2
	3.5	Techniques for estimating age, sex, and stature from skeletal remains	3	2,3,5
4		**Legal and Ethical Issues in Forensic Science:**		
	4.1	the legal and ethical considerations that are relevant to forensic science practice	4	1,4
	4.2	The admissibility of evidence in court, expert witness testimony, and the ethical responsibilities of forensic scientists.	5	4
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, group interactions, group seminar, power point presentations Teaching aids used- ICT enabled Audio Visual Presentations, Internet Resources
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 30 marks** Test Papers/Assignments/Seminars
	B. Semester End examination **Theory Total = 70 marks (Duration 2 hrs)** Multiple Choice Questions (10 X 1) = 10 marks Short Questions (10 out of 12) X 3 = 30 marks Short essays (6 out of 8) X 5 = 30 marks

References

1. Saferstein, R. (2018). Forensic Science: From the Crime Scene to the Crime Lab (4th ed.). Pearson.
2. Fisher, B. A. J., & Fisher, D. R. (2018). Techniques of Crime Scene Investigation (9th ed.). CRC Press.
3. Butler, J. M. (2019). Advanced Topics in Forensic DNA Typing: Methodology. Academic Press.
4. Levine, B. (2019). Principles of Forensic Toxicology (5th ed.). American Association for Clinical Chemistry.
5. Byers, S. N. (2018). Introduction to Forensic Anthropology (5th ed.). Routledge.
6. Turvey, B. E. (2017). Forensic Psychology (2nd ed.). Academic Press.
7. Houck, M. M., & Siegel, J. A. (Eds.). (2014). Fundamentals of Forensic Science (3rd ed.). Academic Press.
8. Saferstein, R. (2018). Criminalistics: An Introduction to Forensic Science (12th ed.). Pearson.
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11. Stimson, G. W. (2017). Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers (2nd ed.). CRC Press.
12. Ramsland, K. A. (2019). Forensic Investigation: Methods from Experts (2nd ed.). CRC Press.
13. Bell, S., & Fisher, B. A. J. (2017). Criminalistics: An introduction to forensic science. CRC Press.
14. Black, M. (2019). Forensic science: Modern methods of solving crimes. Amber Books.
15. Siegel, J. A., Saukko, P. J., & Knupfer, G. C. (2015). Encyclopedia of forensic sciences (2nd ed.). Academic Press.

SUGGESTED READINGS

1. Brown, M. K., & Williams, L. G. (2019). Advancements in Fingerprint Analysis Techniques: A Comparative Study. Forensic Science Review, 56(2), 87-101.
2. Baker, L. C., & Wilson, E. P. (2018). Forensic Odontology: Bite Mark Analysis and Its Reliability. Journal of Forensic Dentistry, 44(3), 143-157.
3. Butler, J.M. (2006). "Advances in Forensic DNA Analysis: Implications for Population Genetics"
4. Drummer, O.H. (2014). "Forensic Toxicology: Current Trends and Future Perspectives"
5. Garcia, R. S., & Martinez, C. D. (2020). The Use of Microscopic Hair Analysis in Forensic Investigations. Journal of Criminalistics, 38(4), 201-215.
6. Gonzalez, M. H., & Hernandez, J. R. (2019). Forensic Entomology: Current Trends and Future Directions. Journal of Forensic Entomology, 35(2), 98-112.
7. Kocsis, R.N. (2006). "Psychological Profiling in Forensic Investigations: An Overview"
8. Lewis, A. M., & Campbell, R. J. (2017). The Role of Forensic Psychology in Criminal Profiling. Journal of Forensic Psychology, 39(1), 12-27.

9. Patel, S. R., & Thomas, R. M. (2019). Forensic Anthropology: Techniques for Estimating Age and Sex from Skeletal Remains. Journal of Forensic Anthropology, 31(2), 75-89.
10. Roberts, E. L., & Collins, T. R. (2020). Forensic Toxicology: Advances in Drug Screening and Interpretation. Journal of Analytical Toxicology, 47(4), 230-245.
11. Smith, J. D., & Johnson, A. B. (2018). The Role of DNA Analysis in Solving Cold Cases. Journal of Forensic Science, 42(3), 123-136.
12. Thompson, P. H., & Davis, K. L. (2017). Digital Forensics: Challenges and Opportunities in the Cybercrime Era. Journal of Forensic Investigations, 25(1), 45-58.
13. Wilson, G. A., & Anderson, L. M. (2018). Ballistics Analysis: A Comprehensive Review of Methods and Tools. Forensic Science International, 145(3), 167-182.

Programme	**BSc (Honours) Biological Sciences**					
Course Name	EVOLUTION AND ETHOLOGY					
Type of Course	DSE					
Course Code	UC5DSEBTS302					
Course Level	**300**					
Course Summary	Introduce students to the basic concepts of Evolution and Genetics and to develop deep understanding on molecular mechanisms, driving genetic variation and adaptation for shaping population structure and dynamics leading to evolution					
Semester	**V**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Develop a deep understanding of the fundamental concepts and theories of evolution and Ethology	K,U	2,3,10
2	Explore the genetic basis of evolutionary processes, including natural selection, genetic drift, gene flow, and mutation.	K,U	2,3,10
3	Understand the principles and history of ethology.	U	2,3,10
4	Learn about various behaviors such as foraging, mating, communication, and social interactions.	An	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
1	1.1	Concepts in Evolution: Theories of evolution: theory of spontaneous generation (Abiogenesis or Autogenesis), Special creation, Biogenesis, Endosymbiosis, Evolution of Prokaryotes, origin of eukaryotic cells, origin of photosynthesis and aerobic metabolism.	5	3
	1.2	Chemical evolution - Haldane and Oparin theory, Miller-Urey experiment; Direct evidences of evolution – Recapitulation Theory of Haeckel, Lamarckism and Neo-Lamarckism, Darwinism and Neo-Darwinism, Theory of De Vries, Modern synthetic theory, Punctuated equilibrium, Molecular evolution in Darwinian finches	10	1
	1.3	Molecular Evolution - Neutral theory of molecular evolution; Phylogenetic relationships- Homology; Homologous sequences of proteins and DNA - orthologous and paralogous; parsimony analysis; nucleotide and protein sequence analysis	5	1,3
2	2.1	Population genetics: Gene pool, gene frequency, Hardy-Weinberg Law, rate of change in gene frequency through natural selection, migration and random genetic drift, Founder effect and Bottle check phenomenon	5	2
	2.2	Speciation: Types of speciation, phyletic speciation, True speciation, Instantaneous and gradual speciation, allopatric and sympatric speciation Isolation: Types of isolating mechanisms-Geographic isolation and Reproductive isolation. Role of isolating mechanisms in evolution, Co-evolution Continental drift theory, Types and means of animal distribution, Factors affecting animal distribution; insular fauna – oceanic islands and continental islands. Geological time scale, Mass extinction.	10	3,4
3	3.1	Ethology: Concept and classification: Patterns and Mechanisms in Animal Behaviour		
		Introduction and Patterns of behavior History (brief), scope of ethology. (a) Innate behaviour: Orientation-taxes/kinesis, simple reflexes, instincts, motivation.(b) Learned behaviour: Habituation, conditioned reflex, trial and error learning; latent learning, imprinting, insight learning, memory and learning.	5	3

	3.2	Neural mechanism in behavior Role of hypothalamus in thirst and feeding; role of cerebral cortex in emotional behavior; mammalian limbic system and control of behavior (brief account). Communication and Signaling Types of animal communication: visual, auditory, chemical, tactile. Evolution and function of signaling. Honest vs. deceptive signaling.	10	4
	3.3	Biological rhythm and Sociobiology: Biological clocks/rhythms Photoperiodism, circadian rhythm; migration, orientation, navigation and homing; diapause, hibernation and aestivation (brief account)	5	3
	3.4	Sociobiology Social groups in termites and elephants; Chemical communication: classification And significance of pheromones (mention human pheromones also).	5	3
4		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom lectures, Video presentations, Seminars Group discussions, Assignments
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 30 marks** Quiz/ Test Papers/ seminars
	B. End Semester examination **Theory Total 70 marks, Duration 2 hrs** Multiple choice questions-10 x 1 = 10 Marks, Short questions-(10 out of 12) x 3 = 30 Marks Short Essays (6 out of 8) x 5 = 30 Marks

References

1. Agarwal, V. K. (2009). Animal behaviour. S. Chand and Company Pvt. Ltd.
2. Arthur, W. (2011). Evolution: A developmental approach. Wiley-Blackwell.
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Programme	**BSc (Honours) Biological Sciences**					
Course Name	NEUROBIOCHEMISTRY					
Type of Course	DSE					
Course Code	UC5DSEBTS303					
Course Level	**300**					
CourseSummary	The course introduces fundamental biochemical molecules, concepts and processes involved in the control and coordination of the brain. The role of neurotransmitters in communication between neurons, learning and memory, regulating mood and behavior, the impact of stress, the importance of sleep for overall health and well-being.					
Semester	**VI**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, ifany	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	To gain an understanding of the biochemical processes underlying neural function and communication.	U,K	2,3,10
2	To understand the role of various neurotransmitters and receptors in the nervous system.	U	2,3,10
3	To analyse the impact of neurotransmitter imbalances on neurological disorders and diseases.	U,A	2,3,10
4	To acquire knowledge in neurobiochemistry and understanding its effect on physiology and homeostasis	U	2,3,10
5	To identify and learn biochemical concepts related to neurobiology affecting life and its overall well being	A,S	2,3,9,10

Remember(K),Understand(U),Apply(A), Analyse(An),Evaluate(E),Create(C),Skill(S), Interest(I)and Appreciation(Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
1	1.1	The nervous system; functions of the nervous system, Central, Peripheral and Autonomic Nervous System. Cells of the nervous system- neurons, structure, classification and properties of neurons; Synapses- types and properties. Mechanism of conduction of nerve impulses.	5	1
	1.2	Neurotransmitters- Role of neurotransmitters in the transmission of impulses, mechanism of action.	5	1
	1.3	Neurotransmitters Chemistry, Structure and Functions. ANS-Sympathetic and Parasympathetic neurotransmitters- Ach, Adrenaline, Noradrenaline. Neurotransmitters of CNS Serotonin, Histamine, Glutamine, Aspartate, GABA, Glycine, Nitric oxide, Substance P	5	1,2
2	2.1	EmotionsNeural centres of emotions; Hypothalamus and limbic system. Role of CNS in emotions	5	2,3
	2.2	Stress and health.Phases and types of stress. Hormonal, anatomical and physiological indicators of stress	5	2,3
	2.3	Regulation of stress HPA axis Fight o Flight response Understanding the biochemistry and managing stress.	5	3
3	3.1	Sleep and wakefulnessTypes of sleep and its significance. Brain areas involved in sleep. Factors affecting sleep. Sleep disorders, Circadian rhythm, EEG	5	3
	3.2	The concept of learning and memory. Role of hippocampus and its role in consolidation of memory. Neurotransmitters involved in learning and memory. Neurodegenerative disorders- Parkinson's, Alzhemer's disorders, ALS, Senile dementia etc	5	3
	3.3	Introduction to brain chemistry Brain barriers; blood brain barrier and its significance CSF; composition and functions. Brain chemistry, psychiatric drugs and mental illness	5	3
	4.1	An overview of the endocrine system. Hypothalamus and pituitary, thyroid, adrenal glands, endocrine control of growth, sex	5	4
4		hormones and pancreatic hormones, Feedback mechanism of hormone regulation with examples HPA axis and HPT axis		
	4.2	Impact of sex hormones and role of neurotransmitters in sexual behavior, fear, thirst and hunger	5	5

	4.3	Psychoneuroimmunology Connections between nervous system and immune functions. Influence of stress on immune function. Placebo effect Biofeedback, mind body technique and meditation	5	5
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures¸ group interactions¸ group seminar¸ power point presentations, chart making Teaching aids used- ICT enabled Audio Visual Presentations, Internet Resources
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 30 marks** Test Papers/Assignments/Seminars
	B. End Semester examination **Theory Total = 70 marks (Duration 2 hrs)** Multiple Choice Questions (1X 10) = 10 marks Short Questions (10 out of 12) X 3 = 30 marks Short essays (6 out of 8) X 5 = 30 marks

References

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Suggested Readings

1. Delcomyn, F. (1998). Foundations of Neurobiology. 1st edition. W. H. Freeman and Company.
2. Ganong, William F. (Year). Review of Medical Physiology.
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Programme	**BSc (Honours) Biological Sciences**					
Course Name	**ENTREPRENEURSHIP IN BIOCHEMISTRY**					
Type of Course	SEC					
Course Code	UC5SECBTS300					
Course Level	**300**					
Course Summary	The foundational concepts of biochemical entrepreneurship, exploring the transformative power of technological innovations.					
Semester		Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Acquire a comprehensive understanding of nutrition and herbal food supplements, emphasizing their benefits for daily nutrition and preventive care. Recognizing the global impact of dietary habits, participants will be equipped to apply this knowledge practically, selecting and utilizing herbal supplements for daily health benefits.	U	2, 3, 4, 6, 9, 10
2	Participants will gain a profound understanding of the nutraceutical business landscape, encompassing dietary supplements, functional foods, and phytochemicals. They will navigate the intricacies of product classifications, comprehend various nutraceutical ingredients, and discern unique selling points. Furthermore, participants will develop expertise in the regulatory aspects of nutraceuticals, including NPD activities, GMP requirements, and quality management systems. The module	U	1, 2, 3, 4

	will also empower participants with key marketing terminologies, focusing on FDA labelling, claims, expiration dates, and gluten-free labelling, enhancing their ability to make informed decisions in the nutraceutical industry.		
3	Participants will grasp the foundational concepts of biochemical entrepreneurship, exploring the transformative power of technological innovations. They will master the art of securing funds for biochemical ventures and navigate the complex regulatory landscape, ensuring ethical practices and safeguarding intellectual property. By the end, participants will be equipped with the knowledge and skills to initiate biochemically-driven entrepreneurial endeavors.	An, E, S, C	1, 2, 3, 4
4	Navigating Biochemical Ventures, participants will emerge equipped with the expertise to navigate the intricate path from laboratory discoveries to market realities. They will master the essentials of commercialization, encompassing the definition of commercialization in biochemistry and crucial stages in the process. Through in-depth market analysis, participants will develop a keen understanding of target audiences, market needs, and trends, fostering strategic product development. Furthermore, participants will gain valuable insights into scaling operations, expanding globally, and fostering social impact through biochemistry, establishing themselves as adept entrepreneurs in the biochemical landscape.	A. I, Ap	1, 5, 8
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1 **Foundations of holistic wellness: exploring nutrition, nutraceutical, and herbal health**	1.1	**Health and Nutrition** • Nutrition, Classification, Benefits and Uses • Herbal Food Supplements • Preventive Care, Health care products as daily supplements.	3	1
	1.2	**Role of Nutraceuticals supplements** • Nutritional deficiency and disorders • Preventive care and its role • Fruits / Food supplements and their nutritional values	3	1

supplements	1.3	**Lifestyle disorders** • Life Style Diseases • Imbalanced diet, Overeating • Under nourished diet Indian and global scenario, Problems and outcome	5	1
	1.4	**Herbal Supplements** • Preventive Health care through Rejuvenative Herbs and its formulation • Supplements for daily use from Common Herbs in Indian Medicine	4	1
2 **Navigating the nutraceutical landscape: business, regulations, and marketing essential**	2.1	**Nutraceutical business** • Dietary supplements, Functional foods, Phytochemicals, Multivitamins, Nutraceutical product classifications, • Understanding various nutraceutical ingredients, classifications, unique selling points Nutraceutical and disease management	4	2
	2.2	**Regulations and laws** • NPD and regulatory activities • GMP requirements for nutraceutical plants • Quality management system • Registration and regulation of food supplements	5	2
	2.3	**Key terminologies of marketing** • Nutraceutical labelling –FDA labelling, Label claim • Net quality of content statement • Expiration date • Gluten free labelling of food • Food shelf life stability testing	4	2
3 **Pioneering biochemical entrepreneurship**	3.1	**Biochemistry Unleashed: Understanding the Entrepreneurial Potential** • **Definition and Scope:** ◦ Defining Biochemical Entrepreneurship ◦ Scope in the Interdisciplinary Landscape • **Historical Perspective:** ◦ Tracing the Roots of Biochemical Entrepreneurship ◦ Key Milestones and Contributions • **Importance in Modern Industry:** ◦ Role in Technological Advancements ◦ Contributions to Biotechnology and Healthcare	5	3

	3.2	**Case Studies of Biochemical Entrepreneurship:**
		• **Success Stories:**
		  • Examining Notable Biochemical Ventures
		  • Factors Contributing to Success
		• **Learning from Failures:**
		  • Analyzing Unsuccessful Ventures
		  • Identifying Common Pitfalls
		• **Common Themes and Trends:**
			6	3,4

		• Patterns in Successful Ventures • Trends Shaping the Biochemical Entrepreneurship Landscape		

	3.3	**Emerging Trends:**
		• **Current Landscape:**
		  • Overview of the Present Biochemical Entrepreneurship Scenario
		  • Market Dynamics and Industry Players
		• **Future Projections:**
		  • Anticipated Developments in Biochemical Entrepreneurship
		  • Potential Areas of Growth and Innovation
		• **Industry Insights:**
		  • Perspectives from Experts and Industry Leaders
		  • Predictions and Recommendations for Aspiring Entrepreneurs
			6	3,4

4		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures¸ group interactions¸ group seminar¸ power point presentations Teaching aids used- ICT enabled Audio Visual Presentations, Internet Resources, hands on training of Bioinformatics tools and software.

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory** **Total = 25 marks** Test Papers/Assignments/Seminars
	B. End Semester examination **Theory Total = 50 marks (Duration 1.5hrs)** Multiple Choice Questions (1X 10) = 10 marks Short Questions (10 out of 12) X 2= 20 marks Short essays (5 out of 7) X 4= 20 marks

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SEMESTER-VI

Programme	**BSc (Honours) Biological Sciences**					
Course Name	FOOD AND INDUSTRIAL MICROBIOLOGY					
Type of Course	DSC A					
Course Code	UC6DSCBTS300					
Course Level	**300**					
Course Summary	The course will enable students to apply the learning of microbiology concepts toward the exploitation of microbial population for industrial and human benefits. The role of microbes in food spoilage, preservation and various food borne diseases will be discussed. The strategies for development of microbial strains, process optimization, large scale production and product recovery will be covered for industrially relevant microbial products.					
Semester	**VI**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Developing an understanding about the concept, importance and scope of Food microbiology and industrial microbiology.	U	2,3
2	Students learn techniques to isolate, maintain, and identify microorganisms from food samples.	U, A,S	2,3,9,10
3	Build awareness about microbial spoilage of food and gain acquaintance with food borne diseases and their significance.	U	2,3,9,10
4	Comprehend the functions of Microorganisms in food.	U,A	2,3,9,10
5	Discuss and apply methods for food preservation techniques-chemical preservation and irradiation.	U	2,3,9,10
6	Know about the techniques to isolate and screen the significant microorganisms capable to produce food products.	U,A	2,3,9,10
7	Understand the microbial roles in preparation of fermented foods.	U,A,I	2,3,9,10
8	Acquire knowledge about the benefits of fermented foods.	U,A,S	2,3,9,10

Remember(K), Understand (U),Apply(A), Analyse (An),Evaluate(E),Create(C),Skill(S), Interest(I) and Appreciation(Ap)

COURSE CONTENT

Content for Class room transaction (Units)

Module	Unit	Course description	Hrs 45	CO No.
1		**Overview of Food Microbiology**	**8**	
	1.1	Basic aspects, history and scope of food microbiology.	2	1
	1.2	Types of microorganisms associated with food - Bacteria, Molds	4	2,3
	1.3	Role and Significance of bacteria and molds in Foods.	2	2,3
2		**Microbial Food Spoilage and Preservation of Food**	**12**	
	2.1	Definition and major causes of food spoilage. Spoilage of specific food groups: Spoilage of canned foods, cereals, fruits, bread, eggs, meat and fish.	2	3
	2.2	A brief account on common food–borne infections and toxicoses - Salmonellosis, Botulism, Cholera, Mycotoxins -Aflatoxin in stored food and grains	2	3
	2.3	Principles of food preservation	1	4
	2.4	Preservation Methods: High and low temperatures drying, chemical preservation, irradiation.	1	
	2.5	(i) Preservation by use of High temperature- Pasteurization, Heating at 100°C, Canning.	1	4
	2.6	(ii) Preservation by use of low temperature - chilling or cold storage - Freezing or Frozen storage	1	4
	2.7	(iii) Preservation by Drying - Sun drying - Drying by Freeze drying - Smoking	1	4
	2.8	(iv) Preservation by food additives - Organic acids and their salts - Benzoates, Sorbates, Acetates, Nitrites and Nitrates.	1	5
	2.9	(v) Kinds of ionizing radiations used in food irradiation, uses of radiation processing in food industry, concept of cold sterilization	2	5
3		**Overview of Industrial Microbiology**	**10**	
	3.1	Historical account of microbes in industrial microbiology.	2	1
	3.2	Sources and characters of industrially important microbes; their isolation, purification and maintenance and storage.	3	5
	3.3	Screening of useful strains; primary screening and secondary screening.	2	5
	3.4	Strain improvement of industrially important microbes through random mutation and genetic engineering.	3	15
		Industrial production of f**ood products through f****ermentation**	**15**	6
	3.5	Introduction to microbial products and fermentation process.	2	6

		Definition of fermentation and fermenters.		
	3.6	Types of industrial fermentation processes: Batch, continuous, submerged, and solid state fermentation (SSF).	4	6
	3.7	Bread manufacturing, beer manufacturing.	2	6
	3.8	Fermented milk products- cheese production process, starter culture, types of cheese.	2	7
	3.9	Other fermented dairy products- butter milk, acidophilus milk, yoghurt, paneer.	2	7
	3.10	Microorganisms as food - Single Cell Protein (SCP) SCP production by algae and mycoprotein from fungi for use as food and feed. Industrially used SCP(Quoron, Pruteen); Advantage and disadvantages of SCP.	3	7
4		**PRACTICALS**	**30**	
		1. Preparation of sterilized media 2. Isolation of bacteria from food by Aerobic/Standard Plate Count using dilution plating technique 3. Isolation of spoilage microorganisms from bread 4. Isolation of spoilage microorganisms from spoiled vegetables/fruits 5. Methylene blue reduction test for milk. 6. Preservation of microbial cultures by making glycerol stocks 7. Microbial fermentations for the production and estimation (qualitative and quantitative) of amylase. 8. Food production by Microorganism: Fermented dairy products (Probiotic Curd, Yogurt)		2,8
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture¸ group interaction¸ individual assignments, seminar¸ presentations **A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.**
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=25 marks** Quiz/ Test Papers/ seminars **Practical Total 15 marks** Lab performance/ record/ Industry visit report

	B. End Semester Examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks -1x10=10 marks Short questions-10 out of 12x2=20 marks Short Essays 5 out of 7x4=20 marks **Practicals Total 35 marks Duration- 2 hrs** Record 10 marks , Examination 25 marks: Performance of Experiments 16 marks Viva-4 marks, research institute visit report- 5 marks

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Programme	**BSc (Honours) Biological Sciences**					
Course Name	HUMAN PHYSIOLOGY					
Type of Course	DSC A					
Course Code	UC6DSCBTS301					
Course Level	**300**					
Course Summary	This course is designed to provide an overview of human physiology. Course topics will include the various systems of the body, functions of each system, and interrelationships to maintain the internal environment					
Semester	**VI**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Understand Fundamental Concepts in Human Physiology:	U/A	2,3,10
2	Students should be able to explain interrelationships among molecular, cellular, tissue, and organ functions in each system	E	2,3,10
3	Able to gain the approaches used to study various functional systems of the human body and physiologic adaptation	I	2,3,10
4	understand the experimental methods and designs that can be used for further study and research.	U	2,3,10
5	Students should be able to identify causes and effects of homeostatic imbalances	E	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs. 45	CO No.
1	1.1	BLOOD &HAEMODYNAMICS: Formed elements of blood, function and life span; hematopoiesis: abnormalities, Hemostasis & Thrombosis, Blood flow, Blood pressure.	5	1
	1.2	CARDIOVASCULAR PHYSIOLOGY: Anatomy and general function of heart. structure of cardiac tissue, cardiac cycle, conduction system, ECG,(normal and abnormal)myocardial infraction, myocardial necrosis and myocarditis	10	1,2
2	2.1	RESPIRATORY PHYSIOLOGY: , Anatomy of Respiratory System, Physical principles of gas flow and resistance; lung volumes, Transport of respiratory gases - transport of oxygen, oxyhaemoglobin curve, factors affecting oxyhaemoglobin curve, transport of carbon dioxide,(chloride shift). Respiratory disturbances (Hypoxia, Hypercapnia, Asphyxia). Oxygen therapy and artificial respiration	10	1,3
	2.2	DIGESTIVE PHYSIOLOGY: Anatomy and histology of digestive glands (liver, pancreas, salivary, gastric and intestinal). Nervous and hormonal control of digestion. Gut-brain interaction: Gut-liver-brain axis, neuronal & endocrine regulations, role of micro biomes, role of phytochemicals including phytoestrogen, phyto insulin & phytopolyphenoles Pathophysiology of GI tract: Secretary diarrhea, ulceration, irritable bowel syndrome& Crohn's diseases	10	3
3	3.1	RENAL PHYSIOLOGY: Histology of Bowman's capsule and tubular part. Urine formation – glomerular filtration, tubular reabsorption, tubular secretion. Urine concentration – counter current mechanism. hormonal regulation of kidney function Renal disorders(kidney stone, acute and chronic renal failure, and dialysis	10	3
	3.2	NERVOUS PHYSIOLOGY: Ultra structure of neuron. Nerve impulse production (resting membrane potential, action potential), transmission of impulse along the nerve fiber, interneuron	5	3

		(synaptic) transmission, neuromuscular junction and transmission of Impulses. Neurotransmitters (acetyl choline, adrenalin, dopamine).EEG. Memory, Neural disorders (brief account on Dyslexia, Parkinson's disease, Alzheimer's disease, Epilepsy		
	3.3	SPORTS PHYSIOLOGY-: Structure of Skeletal Muscle, (Neuromuscular Junction, Muscular Contraction). Overview of the Sliding Filament Model, muscle metabolic system in exercise, Effect of athletic training on Muscle and Muscle performance	5	5
	3.4	ENDOCRINOLOGY: Endocrine physiology: Hormones – classification and mechanism of hormone action. Major endocrine glands(Histology is not included) their hormones, functions and disorders (hypothalamus, pituitary gland, pineal gland, thyroid gland, parathyroid gland, islets of Langerhans, adrenal gland),. Homeostasis and feedback mechanism.	5	3,5
4		**PRACTICALS**	**30**	
		1. Determination of hemoglobin content of blood 2).Total RBC count using Haemocytometer 3)Total WBC count using Haemocytometer 4). Estimation of microhaematocrit 5). Effect of hypertonic, hypotonic and isotonic solutions on the diameter of RBC 6) Demonstration of hemin crystals 7. ESR 8. Blood grouping (ABO, Rh). 9. Bleeding time and Clotting time 10. Instruments: Kymograph, Sphygmomanometer and Stethoscope (principle and use)		3,4
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom lectures Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion,
	Presentation by individual student/ Group representative
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=25 marks** Quiz/ Test Papers/ seminars **Practical Total 15 marks** Lab performance/Lab report/ Viva Voice

	B. End Semester examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks /MCQ- (10 x1) = 10 marks Short questions-(10 out of 12) x 2 = 20 marks Short Essays (5 out of 8) x 4 = 20 marks **Practical total 35 marks:** Record-10, Examination - 25

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Programme	**BSc (Honours) Biological Sciences**					
Course Name	BIOTECHNOLOGY FOR HUMAN WELFARE					
Type of Course	DSE					
Course Code	UC6DSEBTS300					
Course Level	**300**					
Course Summary	Course provides a comprehensive overview of the application of biotechnology in various aspects of human well being					
Semester	**VI**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre- requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To understand the historical background and application of biotechnology	K,U	2,3,10
2	To apply biotechnological methods to improve crop yield, quality and resistance to pests, diseases, and environmental stress	U,A,E	2,3,10
3	To gain a comprehensive understanding of the principles and techniques used in medical biotechnology	U, A, An	2,3,10
4	To equip the students with the knowledge and skills necessary to manipulate and optimize the production of desired metabolite	U, A. An, E	2,3,10
5	Students will develop the skills to assesses the suitability effectiveness of different biotechnological methods in solving specific environmental problems and also learn the biotechnological intervention for sustainable development	U, A, An, E ,S	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
		Introduction		
	1.1	History of Biotechnology	1	1

1	1.2	Role of biotechnology in human welfare	2	1
	1.3	Applications of biotechnology	2	1
		Agriculture Biotechnology		
	1.4	Plant disease and its Classification Disease free plants development: meristem culture, ovule culture	2	2
	1.5	Biofortification of crops using biotechnology : mineral bio fortification using transgenic plants, vitamin biofortified rice, golden banana	2	2
	1.6	Transgenic plants : Flavr - Savr tomato Pest and Drought resistant crops GM crops Biopharming	4	2
	1.7	Marker assisted selection of crops Molecular markers and its types, marker assisted selection, QTL mapping	2	2
2		**Medical Biotechnology**		
	2.1	Production of recombinant vaccines and therapeutic recombinant products(blood factors, hormones, growth factors, interferon's, interleukins)	3	3
	2.2	Gene therapy : Introduction, somatic and germ line gene therapy, gene replacement and gene addition, in vivo gene therapy, viral vectors, cancer gene therapy	5	3
	2.3	Diagnosis of various diseases using DNA Probe and monoclonal antibodies:	4	3
	2.4	Techniques used in the medical biotechnological field	3	3
	2.5	Current trends: Stem cell therapy, tissue engineering personalized medicine, regenerative medicine	3	3
		Industrial Biotechnology		
	3.1	Metabolite engineering: Introduction, ways for metabolite engineering, requirements and different approaches of	6	4
3		metabolite engineering, applications. Metabolic engineering in plants and microbes		
	3.2	Protein engineering: Introduction, objectives, techniques, applications	3	4
	3.3	Enzyme engineering: Role of enzymes in food and industry	3	4
		Environmental biotechnology		
	3.4	Introduction to Environmental Biotechnology: Providing an overview of the field and its importance in sustainable development, wastewater treatment	2	5
	3.5	Environmental Microbiology: Exploring the role of microorganisms in environmental processes, including biodegradation, bioaccumulation, and bioremediation. genetic engineering and bioremediation.	5	5

	3.6	Production of biofuel such as ethanol and biodiesel	1	5
	3.7	Bioplastics	1	5
	3.8	Environmental Monitoring and Analysis	1	5
4		**PRACTICALS**	**30**	
		1. Perform of ethanolic fermentation using Baker's yeast 2. Study of a plant part infected with a microbe 3. To perform quantitative estimation of residual chlorine in water samples 4. Isolation and analysis of DNA from minimal available biological samples 5. Case studies based on applications of biotechnology (any one topic from theory syllabus)		4,5
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture¸ group interaction¸ Video presentations individual assignments, seminar¸ presentations, Article and general reviews
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=25 marks** Quiz/ Test Papers/ seminars **Practical Total 15 marks:** Lab performance/ record/ Industry visit report
	B. Semester End examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks –(10 x 1) = 10 marks Short questions-(10 out of 12) x 2 = 20 marks Short Essays (5 out of 7) x 4 = 20 marks **Practicals Total 35 marks Duration- 2 hrs Record 10 marks** **Examination 25 marks:** Performance of Experiments 16 marks Viva-4 marks, Report writing- 5 marks

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Programme	**BSc (Honours) Biological Sciences**					
Course Name	INTRODUCTION TO BIOINFORMATICS					
Type of Course	DSE					
Course Code	UC6DSEBTS301					
Course Level	**300**					
Course Summary	Introduce students to biological databases and their resources for developing skills in molecular biology research. They will also gain an understanding in correlating chemical structures with their biological activities by using tools in bioinformatics and Cheminformatics having applications in biochemistry, molecular modeling and drug discovery.					
Semester	**VI**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre- requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No
1	Gain knowledge on the significant role of biological databases and learn to navigate and search various biological databases for retrieving biological data.	U,K	2,3,10
2	Analyze and interpret biological data and become proficient in the principles, methodologies, and tools in Bioinformatics	An,A	2,3,10
3	Acquire the skills to perform sequence database searches, identify homologous sequences, and evaluate sequence similarity and analysis.	S,A	2,3,10
4	Develop a foundation in the core principles and concepts of cheminformatics, including molecular representations, chemical databases, and structure-activity relationships.	U	2,3,10
5	Apply the software and tool used in cheminformatics for research and industry setting applications in biochemistry and drug discovery	A,S	2,3,10

Remember(K),Understand(U),Apply(A), Analyse(An),Evaluate(E),Create(C),Skill(S), Interest(I)and Appreciation(Ap)

COURSECONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
1	1.1	Bioinformatics. Definitions and brief history. Bioinformatics vs. Computational Biology; Scope/ Research Areas of Bioinformatics. Nature of biological data, introduction to biological databases. Pharmaceutical, R&D and Bioinformatics industries and Institutions in India & the World. Case study on job profiles of a bioinformatician.	5	1
	1.2	Introduction to Biological Databases: Nature and scope of biological data. Understanding the importance and role of biological databases in modern research and bioinformatics Types of Biological Databases: Overview of various types of databases. Sequence databases NCBI (GenBank, UniProt), structure databases (PDB), gene expression databases (GEO), and metabolic pathway databases (KEGG).	5	1
	1.3	Database Searching Techniques: Introduction to different search methods and algorithms used in biological databases, including keyword searches. Literature Searches using PubMed Effective search strategies and advanced query construction. Critical evaluation of scientific literature and accessing full-text articles.	5	1,2
2	2.1	Introduction to sequence alignment and its significance. Dynamic Programming algorithms- Needleman Wunsch& Smith Waterman Algorithms. Scoring matrices & substitution matrices	5	2,3
	2.2	Utilizing BLAST (Basic Local Alignment Search Tool) for sequence similarity searches. Interpreting BLAST results and assessing sequence alignments.	5	2,3
	2.3	Multiple Sequence Alignment and Phylogenetic Analysis Introduction to multiple sequence alignment algorithms. Hands-on practice with ClustalW for multiple sequence alignment. Constructing phylogenetic trees using aligned sequences in MEGA	5	2,3
3	3.1	Introduction to Cheminformatics: An overview of the field, combinatorial chemistry its applications, and its relevance in modern biochemistry and drug discovery	5	4
	3.2	Chemical Databases and Data Mining: Teach students how to retrieve, analyze, and interpret chemical data from various databases, such as PubChem or Chemical Abstracts Service (CAS).	5	4,5

	3.3	Molecular Modeling and Visualization: Molecular modeling techniques, molecular docking, molecular dynamics simulations, and visualization using tools PyMOL and Chimera. MolecularDescriptors and Chemical Similarity: Using molecular descriptors to assess similarity between different chemical compounds.	5	4,5
4	4.1	Cheminformatics Software and Tools: Introduce students to commonly used software and tools in the field, such as RDKit, ChemAxon, ChemSketch or Open Babel	5	4
	4.2	Structure-Activity Relationship (SAR) Analysis: Exploring the principles and methodologies behind SAR analysis, which involves correlating chemical structures with their biological activities. QSAR in drug discovery.	5	5
	4.3	Application of the tools in cheminformatics tasks. The role of cheminformatics in drug discovery, including virtual screening, lead optimization, and ADMET (absorption, distribution, metabolism, excretion, and toxicity) predictions.	5	4,5
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure(Mode of transaction)** Lectures, group interactions, group seminar, power point presentations, case studies Teaching aids used- Audio Visual Presentation, Photographs, Internet Resources
Assessment Types	**MODEOFASSESSMENT** **A. Continuous Comprehensive Assessment(CCA)** **Theory Total = 25 marks** Test Papers/Assignments/Seminars **Practical Total= 15 marks** Case Study presentations Chart/Visual presentations Case Study Reports
	B. End Semester examination **Theory Total = 50 marks (Duration 1.5 hrs)** Multiple Choice Questions (1X 10) = 10 marks Short Questions (10 out of 12) X 3 = 30 marks Short essays (6 out of 8) X 5 = 30 marks

References

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molecular similarity-based search engine. Journal of medicinal chemistry, 46(4), 499-511.

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Programme	**BSc (Honours) Biological Sciences**					
Course Name	ANIMAL CELL CULTURE AND STEM CELL BIOLOGY					
Type of Course	DSE					
Course Code	UC6DSEBTS302					
Course Level	**300**					
Course Summary	Course give an understanding and provide invaluable tool for studying and manipulating cell, enabling advancement in various fields of research and application					
Semester	**VI**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre- requisites, if any	No					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Understanding the principles theories and application behind animal cell culture and stem cell biology	U	2,3,10
2	Develop proficiency in sterile technique and aseptic handling of cell cultures	U,A,S	2,3,10
3	Acquiring knowledge of different types of cell culture media and their formulation	U,A,S	2,3,10
4	Familiarizing the usage of equipment's used in cell culture labs	U	2,3,10
5	Gaining knowledge on stem cell plasticity and propagation of embryonic stem cells, nuclear transfer technology, animal cloning and stem cell differentiation	U,A,S	2,3,10
6.	Learning stem cells and tissue engineering, human embryonic stem cells	U,A	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
Animal Cell culture				
1		**Introduction to Animal cell culture**	**20**	
	1.1	History of animal cell culture; Laboratory setup and equipment	3	1
	1.2	Types of cell culture media, media constituents, CO2 incubation & bicarbonate Buffering. Sterilization of cell culture media	4	3,4
	1.3	Isolation of tissue. Disaggregation of tissue – Mechanical and Enzymatic methods. Primary and secondary cell culture, monolayer culture and suspension culture, Passaging number	5	1
	1.4	Specialized cell culture technique: Histotypic cell culture, embryonic cell culture and adult stem cell culture, organ culture, fetal cell culture, three- dimensional cell culture	6	3
	1.5	Maintenance of cell lines- cryopreservation and germplasm storage.	2	2
2		**Application of animal cell culture technology**	**10**	
	2.1	Vectors for animal cells- adeno based vectors, SV 40, baculovirus. Measurement of viability & cytotoxicity; Cell cloning and selection; Cell synchronization	5	3
	2.2	Application of animal cell culture technology: Production of human and animal vaccines and pharmaceutical protein, Transgenesis, transgenic mice and cattle.	5	1,3
Stem cell Biology				
3.		**Introduction to stem cell biology**	**18**	
	3.1	Basic Stem Cell Biology- Introduction to stem cells, Types of stem cells (Embryonic, Adult, and Induced Pluripotent Stem Cells), Stem cell niches, Potency and differentiation.	5	1
	3.2	Animal cloning: Overview; challenges in human therapeutic cloning; somatic cell nuclear transfer in humans: pronuclear early embryonic development.	5	5
	3.3	Stem cell plasticity: Overview; self-renewal potential; differentiation versus stem cell renewal; trans differentiation	4	5
	3.3	Stem cell differentiation: Overview; adult stem cells; fetal stem cells; human embryonic stem cells	4	5
		Application of Stem Cell Therapy& Ethical and legal issues in stem cell Research	**12**	

4	4.1	Stem cell in disease modelling, gene therapy, organ transplantation, Personalized medicine.	6	6
	4.2	Ethical consideration in embryonic stem cell research, Informed consent in stem cell research, Ownership and patenting issues, controversies and public opinion, Regulation of stem cell research- global perspective.	6	6
5		Teacher specific module		

Teaching & Learning Approach	**Classroom Procedure (Mode of transaction)** ICT Enabled Learning, Tutorial, Lecturing, Seminars, Articles and general reviews
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=30marks** Quiz/ Test Papers/ Seminar
	B. End Semester examination **Theory Total 70 marks, Duration 2 hrs** Fill in the blanks -10 x1 = 10 Marks Short questions-(10 out of 12) x 3 = 30 Marks, Short Essays (6 out of 8) x 5 = 30 Marks,

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1. Anderson, W. A., et al. (2018). Advances in Biochemical Engineering/Biotechnology. Springer.
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2. Chaicharoenaudomrung, N., Kunhorm, P., & Noisa, P. (2019). Three-dimensional cell culture systems as an in vitro platform for cancer and stem cell modeling. World journal of stem cells, 11(12), 1065.
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4. McKee, C., & Chaudhry, G. R. (2017). Advances and challenges in stem cell culture. Colloids and surfaces B: Biointerfaces, 159, 62-77.

Programme	**BSc (Honours) Biological Sciences**					
Course Name	FROM LAB TO LIFE					
Typeof Course	VAC					
Course Code	UC6VACBTS300					
Course Level	**300**					
Course Summary	Value added course which aims to bring awareness and understanding of the life skills required to navigate smoothly in the world we live in and its relevance in promoting well being and quality of life.					
Semester	**VI**	Credits			3	Total Hours
Course Details	LearningApproach	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre- requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No
1	Understand the fundamental principles of nervous system in biology and life, its relation to overall well being.	U, K	2,3,10
2	Learning the structure and function of the brain and how it's responsible for maintaining human health and wellness.	U,K	2,3,10
3	Develop the ability to express their thoughts and ideas freely and confidently and learn effective strategies to prioritize tasks on their own.	U,A	2,3,10
4	Understand and manage their emotions and evaluate different perspectives, and make informed decisions	U,An,C	2,3,10
5	Develop strategies and skills to deal with setbacks, manage stress, and cope with adversity, fostering mental and emotional resilience.	A,C	2,3,10
Remember(K),Understand(U),Apply(A), Analyse(An),Evaluate(E),Create(C),Skill(S), Interest(I)and Appreciation(Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1	1.1	Introduction to the nervous system; Sympathetic, parasympathetic and Autonomous system.	3	1,2
	1.2	Structure and functions of the brain (With reference to regions which play roles in stress responses)	3	1,2
	1.3	The role played by neurotransmitters and hormones in stress responses.	3	1,2

	1.4	Understanding the perspectives of life and how it relates to biology and wellness.	3	1,2
2	2.1	Life Skills needed for a healthy life Effective Communication Critical Thinking	3	3
	2.2	Study and motivation, Time management Lifelong learning, Financial literacy Social media, its impact and how it changed our lives.	4	1,4
	2.3	Problem solving, Scientific temper, Resilience Responsibility and Commitment. Emotional intelligence	5	3,4
3	3.1	Role of sleep and mental health	2	1,2,4
	3.2	Managing difficult emotions Anger Management Grief Management Stress management	4	4,5
	3.3	Relaxation Techniques 1. Yoga 2. Cardio training 3. Mindfulness 4. Meditation (Hands on training sessions and teaching)	15	1,2,4,5
4 4		Teacher Specific module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures¸ group interactions¸ group seminar¸ power point presentations Teaching aids used- ICT enabled Audio Visual Presentations, Internet Resources
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory** **Total = 25 marks** Test Papers/Assignments/Seminars
	B. End Semester Examination **Theory Total = 50 marks (Duration 1.5 hrs)** Fill in the blanks (10 X 1) = 10 marks Short Questions (10 out of 12) X 2= 20 marks Short essays (5 out of 7) X 4= 20 marks

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3. Guyton, A. C., & Hall, J. E. (2015). Textbook of Medical Physiology (13th ed.). Philadelphia, PA: Elsevier.
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1. Anderson, C. M., & Miller, E. F. (2019). The microbiome and its implications for human health. Current Biology, 29(16), R719-R722.
2. Brown, K. L., & Davis, R. M. (2021). The impact of nutrition on immune function: A comprehensive review. Nutrition Reviews, 79(2), 144-165.
3. Clark, A. J., & Patel, N. B. (2019). The influence of genetics on disease susceptibility. Current Opinion in Immunology, 60, 98-102.
4. Hall, M. E., & Loprinzi, P. D. (2020). Physical activity and cardiovascular health: An update. American Journal of Lifestyle Medicine, 14(6), 580-586.
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From genes to pathways. Clinical Genetics, 95(1), 6-14.
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Programme	**BSc (Honours) Biological Sciences**					
Course Name	PRACTICAL BIOINFORMATICS					
Type of Course	SEC					
Course Code	UC6SECBTS300					
Course Level	**300**					
Course Summary	Introductory level course for gaining practical experience in Bioinformatics and its relevance in applied life science research.					
Semester	**VI**	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre- requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No
1	To gain practical knowledge on the types of biological databases	U, A	
2	To retrieve, analyze, interpret and annotate molecular data from various biological databases	An, A	
3	To obtain hands on experience in pairwise and multiple sequence alignment	U,A	
4	To understand evolutionary relationships using tools and software in phylogenetic analysis	An, E, U	
5	To use software and tools for visualizing and understanding molecules and to perform molecular docking	U, An, A	

Remember(K),Understand(U),Apply(A), Analyse(An),Evaluate(E),Create(C),Skill(S), Interest(I)and Appreciation(Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1	1.1	Introduction to Biological Databases. Understanding the importance and role of biological databases in modern research and bioinformatics. Types of Biological Databases: Overview of various types of databases Introduction to the NCBI database and its importance in bioinformatics.	5	1

	1.2	PRACTICAL WORKFLOW Navigating databases GenBank, UniProt, and NCBI to retrieve specific information and understand the data format. Retrieving DNA, RNA, and protein sequences from various databases	5	1,2
	1.3	Introduction to different search methods and algorithms used in biological databases, including keyword searches.	3	1,2
	1.4	PRACTICAL WORKFLOW Functional annotation of genes and proteins using databases such as Gene Ontology (GO) and Kyoto Encyclopedia of Genes and Genomes (KEGG).	3	2
2	2.1	Introduction to sequence alignment and its significance. Utilizing BLAST (Basic Local Alignment Search Tool) for sequence similarity searches. Interpreting BLAST results and assessing sequence alignments. Pairwise Sequence Alignment and Phylogenetic Analysis	5	3
	2.2	Performing pairwise alignments using BLAST. Aligning DNA, RNA, or protein sequences and interpreting the results.	3	3
	2.3	Introduction to multiple sequence alignment algorithms. Hands-on practice with ClustalW for multiple sequence alignment. Constructing phylogenetic trees using aligned sequences.	5	3,4
	2.4	PRACTICAL WORKFLOW Construct phylogenetic trees using molecular sequence data by tools MEGA or PhyML and interpreting evolutionary relationships.	3	3,4
3	3.1	Introduction to Molecular Visualization. Understanding Molecular Visualization Software. PRACTICAL WORKFLOW Using molecular visualization software RASMOL, PyMOL, SPDB Viewer and Chimera X. To load protein structures, manipulate them in 3D, and visualize different molecular properties.	5	5
	3.2	Introduction to Computer Aided Drug Design. Stages in Drug Discovery, Structure based drug design. Molecular Docking	3	5
	3.3	Protein Ligand Docking and Workflow PRACTICAL WORKFLOW Molecular docking using freely available software to predict the binding affinity of small molecules to a protein target.	5	5
4		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, group interactions, group seminar, power point presentations Teaching aids used- ICT enabled Audio Visual Presentations, Internet Resources, hands on training of Bioinformatics tools and software
Assessment Types	**MODEOFASSESSMENT** A. **Continuous Comprehensive Assessment (CCA) Theory Total = 25 marks** Test Papers/Assignments/Seminars
	B. End Semester Examinations **Theory Total = 50 marks (Duration 1.5hrs)** Multiple Choice Questions (1X 10) = 10 marks Short Questions (10 out of 12) X 2= 20 marks Short essays (5 out of 7) X 4= 20 marks

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SEMESTER-VII

Programme	**BSc (Honours) Biological Sciences**					
Course Name	MICROBIAL FOOD SAFETY					
Type of Course	DCC					
Course Code	UC7DCCBTS400					
Course Level	**400**					
Course Summary	The course will enable students to apply the learning of microbiology concepts toward the role of microbes in food production. The role of microbes in food spoilage, preservation and various food borne diseases will be discussed. Students will be able to comprehend the microbiological quality control and foodborne illnesses investigation procedures for ensuring food safety and hygiene; to understand current national and international food safety rules and regulations; to know the requirements and components of food safety management system (FSMS)					
Semester	**VII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Developing an understanding about the concept, importance and scope of Food microbiology and food safety	U	2
2	Learners will be able to recognize different types of food safety hazards, including biological, chemical, and physical hazards	U,A	2,3,9,10
3	Students will be able to find the characteristics, related food, and symptoms of each food safety hazards	U,A, An, S	2,3,9,10
3	Learners will be able to implement strategies for ensuring food safety and quality in food processing and production	U, A, An, E	2,3,9,10
4	Helps to examine the appropriateness of food safety management systems in the current job market.	U, A, An, E	2,3,9,10
5	Learners can analyze risks in agri-food value chains	U,A, An, S	2,3,9,10
6	Learners can apply generic principles of quality management to specific situations of food quality assurance management.	U, A, An	2,3,9,10

Remember (K),Understand (U),Apply (A), Analyse (An),Evaluate (E),Create (C),Skill(S), Interest(I) and Appreciation (Ap)

COURSE CONTENT

Content for Class room transaction (Units)

Module	Unit	Course description	Hrs 45	CO No.
1		**Overview and Basic Concepts of Food safety**	**8**	
	1.1	General concepts of food safety: adulteration, filth, microorganisms, chemical additives. Types of adulteration in common foods, impact on human health and tests to detect common adulterants.	2	1
	1.2	Food Safety issues and factors affecting food safety (Physical, chemical and microbiological hazards)	1	1,2
	1.3	***Factors influencing microbial growth in foods: intrinsic and extrinsic parameters.*** Intrinsic parameters of food that affect microbial growth: pH, water activity, oxidation reduction potential, nutrient content, antimicrobial constituents & biological structures.	3	1,2
	1.4	Extrinsic parameters of food that affect microbial growth: relative humidity, storage temperature, gaseous environment.	2	1,2
2		**Microbiological hazards in food**	**12**	
	2.1	Foodborne diseases: infections, poisoning, toxico- infections	3	3
	2.2	Sources and transmission of bacteria in foods: human, animal, and environmental reservoirs; cross- contamination;	3	3
	2.3	*Salmonella, Clostridium botulinum, Vibrio, Hepatitis A, Campylobacter jejuni, Listeria monocytogenes*. Emerging foodborne pathogens: *E. coli* O157.	4	3
	2.4	Fungal Toxins: Aflatoxin, Ochratoxin A, Fumonisins	2	3
		Microbial indicators of food safety and quality	**10**	
	2.5	Enumeration of bacteria from food using different growth media, plating techniques.	3	3
	2.6	Coliforms- detection & enumeration, coliform criteria & standards	2	3
	2.7	Detection of Salmonella in food	1	3
	2.8	Risk associated with ready to eat food (RTF).	1	3
3		**Food Quality Regulations and Food safety management systems**	**15**	
	3.1	***Government regulatory agencies and food policies:*** Food Safety and standards authority of India(FSSAI)	2	4,5
	3.2	United States Food and Drug Administration (US- FDA)	1	4
	3.3	Codex alimentarius Commission	1	4
	3.4	Introduction to Food Safety Management System (FSMS) ISO: 22000	3	4

	3.5	Food Safety Management Systems – Requirements, Goals and use of FSMS (ISO 22000) Methodology for Developing an ISO 22000 and HACCP	3	4
	3.6	***HACCP - A global requirement for food safety assurance*** Hazard analysis criteria control points (HACCP) system for ensuring food safety. Guidelines in the application of HACCP system	**2**	4,5
	3.7	HACCP principles - Conduct a hazard analysis, CCP identification, establish critical limits for each CCP, establish CCP monitoring procedures, establish corrective actions procedures, establish procedures for HACCP verification and validation, documenting the HACCP Program	3	4,5
4		**PRACTICAL**	**30**	
	4.1	1. Detection of adulterants in milk 2. Detection of adulterants in milk based products Detection of adulterants in food grains and their products. 3. Enumerate bacteria from food samples in different growth media using dilution plating technique 4. Enumerate coliforms from water / food Detection of salmonella from food 5. Conduct survey on hygienic and sanitary condition of the quality of food and apply the guidelines for food safety and quality systems. 6. Report on HACCP for Food industry		6
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, group interaction, individual assignments, seminar, presentations A visit **to laboratories/ food business units** to see the function and Operational procedures
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory** **Total=25 marks** Quiz/ Test Papers/ seminars **Practical Total 15 marks** Lab performance/ record/ field visit report
	B. End Semester Examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks –(10 x 1) = 10 marks Short questions-(10 out of 12) x 2 = 20 marks Short Essays (5 out of 7) x 4 = 20 marks **Practicals Total 35 marks Duration- 2 hrs** **Record 10 marks , Examination 25 marks:** Performance of experiments 16 marks Viva-4 marks, research institute visit report- 5 marks

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2. Glazer, A. N., & Nikaido, H. (2007). Microbial biotechnology: fundamentals of applied microbiology. Cambridge University Press.
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4. Industrial microbiology by Patel A.H. (2007). New Age International Publishers.
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6. Quality Control in the Food Industry, Volume 2 edited by S Herschdoerfer.
7. Biotechnology: Expanding Horizons by Singh B.D. (2008). Kalyani Publishers, India.
8. General Microbiology by Stanier R.Y., Ingraham J.L., Wheelis M.L. and Painter R.R. (2008). Macmilian Press London.

Programme	**BSc (Honours) Biological Sciences**					
Course Name	BIOTECHNOLOGY IN CLINICAL DIAGNOSIS					
Type of Course	DCC					
Course Code	UC7DCCBTS401					
Course L evel	**400**					
Course Summary	Biotechnology in clinical diagnosis is a broad field that deals with the exploitation of living organisms to develop products beneficial for sustainable development. It harnesses cellular and molecular processes to develop products and technologies that could help in improving human life on earth. The course will enable students to apply the learning of biotechnology in the health sector. Students will be exposed to various techniques such as Recombinant DNA Technology, Polymerase Chain Reaction (PCR) and Enzyme-Linked Immunosorbent Assay (ELISA), etc. that helps in the early diagnosis of diseases					
Semester	**VII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Student with basic knowledge in molecular biology, Foundations in cell biology, biochemistry and biotechnology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No
1	Developing an understanding about the concept, importance and scope of Biotechnology in diagnosis of diseases	U	2
2	Familiarize students with molecular diagnostic technologies.	U, A	2,3,9,10
3	Enhance understanding of computational methods for analyzing molecular diagnostic data.	U	2,3,9,10
4	Develop skills to interpret molecular test results for clinical decision-making	U, A, I, S	2,3,9,10
5	Students will be able to know how to use the main methodologies and instruments that characterize biotechnologies for the prevention, diagnosis and treatment of human diseases	U, A, An, I, S	2,3,9,10

Remember(K), Understand (U),Apply(A), Analyse (An),Evaluate(E),Create(C),Skill(S), Interest(I) and Appreciation(Ap)

COURSE CONTENT

Content for Class room transaction (Units)

Module	Unit	Course description	Hrs (60)	CO No.
1		**Microbes and parasites**:	**10**	
	1.1	Historical introduction Bacteria, Fungi, Viruses, Protozoa,	2	1
	1.2	Helminthes and Arthropods, Prions;	4	
	1.3	Host-parasite relationship; Infection-mode of transmission in infection, factors predisposing to microbial pathogenicity, types of infectious diseases	4	2,3
2		**Methods of Disease Diagnosis**:	**20**	
	2.1	Sampling site-normally sterile and with normal microflora; Sample collection-method of collection, transport and processing of samples, interpretation of results;	2	2,3,4
	2.2	Diagnostic methods- cultured: microscopy, microbial antigen; non-cultured: PCR based microbial typing:	2	2,3,4
	2.3	Eubacterial identification based on 16s rRNA sequences	2	2,3,4
	2.4	Amplified ribosomal DNA Restriction analysis(ARDRA)-	2	2,3,4
	2.5	Culture independent analysis of bacteria-DGGE and TRFLP	2	2,3,4
	2.6	Molecular diagnosis of fungal pathogens based on 18s rRNA sequences	5	2,3,4
	2.7	Detection of viral pathogens through PCR	3	2,3,4
	2.8	Monoclonal antibodies in therapy.	2	2,3,4
3		**Diagnosis of Infections** :	**18**	
	3.1	Bacteria- *Streptococcus*, Coliforms, *Salmonella*, *Shigella*, *Vibrio* and *Mycobacterium*;	8	5
	3.2	Fungi-Major fungal diseases, Dermatophytoses, Candidiosis and Aspergillosis	5	5
	3.3	DNA and RNA Viruses- POX virus, Rhabdo Virus, Hepatitis Virus and Retro Virus	5	5
4		**Molecular Diagnostics in Genetic and Inherited Disorders**	**12**	5
	4.1	**Genetic testing and inherited diseases** on-Invasive Prenatal testing (NIPT) and reproductive genetics,	8	5
	4.2	Molecular diagnostics in rare genetic disorders	4	5

5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, ICT enabled classes, Group discussions, seminar presentations, case studies and activities **Note:** Teaching aids like photographs, models, videos, short films, documentaries related to the topic may be used
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=30marks** Quiz/ Test Papers/ Seminar/ Case studies
	B. Semester End examination **Theory Total 70 marks, Duration 2 hrs** Fill in the blanks –(10 x 1) = 10 Marks Short questions-(10 out of 12) x 3 = 30 Marks, Short Essays (6 out of 8) x 5 = 30 Marks,

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Programme	**BSc (Honours) Biological Sciences**					
Course Name	BIOSAFETY, BIOETHICS AND IPR					
Type of Course	DCC					
Course Code	UC7DCCBTS402					
Course Level	**400**					
Course Summary	To provide a comprehensive understanding of the ethical, legal, and regulatory aspects associated with the field of biosafety and bioethics, while also equipping students with knowledge about intellectual property rights and their implications in the biotechnology sector.					
Semester	**VII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre- requisites, if any	NO					

COURSE OUTCOMES (CO

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Gain a comprehensive understanding of the concept of biosafety and its importance in scientific research and healthcare.	U, K	2,3,10
2	Acquire the knowledge and skills to identify and manage potential risks and hazards associated with biological materials.	S, E	2,3,10
3	Develop the ability to design and implement biosafety protocols and measures to ensure a safe working environment in laboratory settings.	A, An	2,3,10
4	Comply with national and international regulations and guidelines governing biosafety.	U, K	2,3,10
5	Identify and assess the potential risks associated with genetically modified organisms (GMOs) and their impact on human health and the environment.	U, An, A, E	2,3,10
6	Develop a comprehensive understanding of ethical principles and theories applicable to biological research and healthcare.	U, K	2,3,10
7	Demonstrate ethical conduct and decision-making in scientific research.	A, An, E	2,3,10
8	Understand the significance of intellectual property rights in the field of biosciences.	U, K	2,3,10
9	Understand guidelines to protect biological inventions	U,K	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
1		**BIOSAFETY: INTRODUCTION AND GUIDELINES**	**12**	
	1.1	Introduction, biosafety issues; Biological Safety Cabinets & their types	2	1
	1.2	Primary Containment for Biohazards	2	1,2
	1.3	Biosafety Levels of Specific Microorganisms.	2	2,3
	1.4	Biosafety guidelines and regulations (National and International); Regulatory bodies of India-RCGM and GEAC.	3	3,4
	1.5	GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc	3	4,5
2		**RISK ANALYSIS AND GUIDELINES**	**8**	
	2.1	Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication;	4	5
	2.2	Overview of International Agreements - Cartagena Protocol.	4	4
3		**INTRODUCTION TO BIOETHICS & ETHICAL PRINCIPLES IN BIOLOGICAL RESEARCH**	**15**	
	3.1	Overview of bioethics, ethical principles, such as autonomy, beneficence, non-maleficence, and justice	3	6
	3.2	Ethical Issues in Healthcare- such as end-of-life decisions, genetic testing, and resource allocation. ethical challenges related to patient autonomy, confidentiality, and access to healthcare	3	6,7
	3.3	Ethical Conduct in Scientific Research- importance of integrity, honesty, and transparency in scientific research	5	6,7
	3.4	Ethical implications of genetic engineering, stem cell research, and reproductive technologies	4	6,7
		INTRODUCTION TO INTELLECTUAL PROPERTY	**15**	
		Introduction to Intellectual Property and History. Patents, Trademarks, Copyright, Trade secrets, Trade	6	8
4	4.1	dress, Industrial Design and Traditional Knowledge, Geographical Indications		
	4.2	Importance of IPR – patentable and non-patentable – patenting life	4	8
	4.3	Legal protection of biotechnological inventions – World Intellectual Property, Rights Organization (WIPO),	5	8,9
		GRANT OF PATENT, PATENTING AUTHORITIES AND TREATIES	10	

	4.1	Types of patent applications: provisional and complete specifications	3	8
	4.2	An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement, Rights and Duties of patent owner. Basmati rice patent issue: a Case study.	3	8
	4.3	Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments	4	9
5		Teacher specific module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom lectures¸ group interactions¸ group seminar¸ power point presentations, Article and general reviews Teaching aids used- ICT enabled Audio Visual Presentations, Internet Resources
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory** **Total = 30 marks** Test Papers/Assignments/Seminars
	B. End Semester examination **Theory Total = 70 marks (Duration 2 hrs)** Multiple Choice Questions (1X 10) = 10 marks Short Questions (10 out of 12) X 3= 30 marks Short essays (6 out of 8) X 5 = 30 marks

References

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Programme	**BSc (Honours) Biological Sciences**					
Course Name	PLANT PHYSIOLOGY AND PHYTOCHEMICAL TECHNIQUES					
Typeof Course	DCE					
Course Code	UC7DCEBTS400					
Course Level	**400**					
Course Summary	Introduce students to the basics of plant cell its physiology of growth, function, and development and its interaction with environment. Students also acquire skills on the basic phytochemical techniques.					
Semester	**VII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	CO1: Acquire knowledge on basics on plant cell and its interaction with environment	K,U	2,3,10
2	CO2: To be aware of physiological mechanisms of plant growth, function, and development	An, E	2,3,10
3	CO3: Recognize and describe how plants respond to their environment	U, E	2,3,10
4	CO4: Knowledge and Skills on phytochemical techniques	A, An, S	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
1		**Transport and Translocation of Water and solutes**	**15**	
	1.1	Plant cell: Overview of a plant cell, plant cell organelles, endomembrane systems, cell wall, plant tissues: simple and complex tissues.	5	1
	1.2	Water and Plant cell: Water potential, Water absorption and transport in plants, transpiration Mineral Nutrition: Essential and Non- essential nutrients, its deficiencies and symptoms, Assimilation of mineral nutrients (N,P, S), Biological nitrogen fixation	5	1,2

	1.3	Solute transport: Passiveand active transport, Membrane transport processes and proteins Growth hormones: Auxins, Gibberrellins, Cytokinin, Ethylene, Abscisic acid, Brassinosteroids (discovery, effects, biosynthesis	5	2
2		**Plant physiology**	**15**	
	2.1	Photosynthesis: Light Reaction, Organisation of photosynthetic apparatus, Light absorbing antenna systems, Mechanism of electron transport and ATP synthesis, Repair and Regulation of photosynthetic machinery	6	2
	2.2	Photosynthesis: Dark reaction, Calvin- Benson cycle and its regulation, C2, C4 and CAM cycle, Accumulation and partitioning of photosynthates, Mobilisation of Starch, Surcose biosynthesis, Sugar translocation in Phloem, Phloem loading and unloading	6	2
	2.3	Respiration: Glycolysis, PPP, citric acid cycle, ETC, Environmental factors that alter Respiration	3	2
3		**Secondary metabolites and Plant defense**	**5**	
	3.1	Introduction, terpenes, phenolic compounds, Nitrogen containing compounds, plant defence against pathogens	5	
4		**Photo- periodism and photomorphogenesis, Plant movements and stress physiology**	15	
	4.2	Photoperiodism in short day and long day plants, Phytochrome induced responses, proteins, signaling pa thways, cryptochrome induced photo-responses in plants	5	
		Plant movements: Movement of locomotion, Movement of curvature, Hygroscopic movements	2	3
	4.3	Stress physiology: Physiological basis of abiotic stress tolerance, Plants' responses to drought and salinity stress, Escape and tolerance mechanism, Physiological and	**8**	
		biochemical changes associated with tolerance.		
		Phyto-chemical techniques Methods of Extraction, characterization and purification of secondary metabolites(any one case study)	**15**	3
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, group interactions, group seminar, power point presentations Teaching aids used- ICT enabled Audio Visual Presentations, Internet Resources Hands on training on phytochemical techniques Industrial visit

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 30 marks** Test Papers/Assignments/Seminars
	B. End Semester Examinations **Theory Total = 70 marks (Duration 2 hrs)** Multiple Choice Questions (1X 10) = 10 marks Short Questions (10 out of 12) X 3 = 30 marks Short essays (6 out of 8) X 5 = 30 marks

References

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Programme	**BSc (Honours) Biological Sciences**					
Course Name	CANCER BIOLOGY					
Type of Course	DCE					
Course Code	UC7DCEBTS401					
Course Level	**400**					
Course Summary	By learning Cancer biology the learner will be trained in scientific research methods and learn the techniques used in cell and molecular biology and pathology. Student will study the biology of disease, tumour biology, immunology, molecular oncology, haematological malignancy, plus diagnostic and therapeutic techniques for cancer.					
Semester	VIII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Comprehend the basics of cancer and identify with the concept of cancer as a disease and the process of carcinogenesis	U	2
2	Perform the basic and the advanced molecular techniques used in cancer diagnostics and interpret the results.	U, A	2
3	Choose advanced studies in the field of oncology	U	2,3,9,10
4	Make objective decisions about the harmful effects of cancer causing agents and create awareness about them among the common man	U,A	2,3,9,10
5	Demonstrate core knowledge of the cellular targets and molecular mechanisms of traditional and novel cancer therapies.	U,A	2,3,9,10

Remember(K), Understand (U),Apply(A), Analyse (An),Evaluate(E),Create(C),Skill(S), Interest(I) and Appreciation(Ap)

COURSE CONTENT

Content for Class room transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
		Fundamentals of cancer biology:	**15**	
		Introduction to Cancer Biology, Tumor suppressor		

1	1.1	genes, modulation of cell cycle in cancer,	5	1
	1.2	Different forms of cancers	4	
	1.3	Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer	6	2,3
2		**Principles of carcinogenesis:**	**15**	
	2.1	Theory of Carcinogenesis: Chemical carcinogenesis, principles of physical carcinogenesis,	6	2,3,4
	2.2	X-ray radiation-mechanisms of radiation carcinogenesis,	5	2,3,4
	2.3	Diet and cancer.	4	2,3,4
3		**Principles of molecular cell biology of cancer:**	**15**	2,3,4
	3.1	Signal targets and cancer, activation of kinases;	3	2,3,4
	3.2	Oncogenes, identification of oncogenes, retroviruses and oncogenes	4	2,3,4
	3.3	Oncogenes/proto oncogene activity,	4	5
	3.4	Growth factors related to transformation, Telomerases	4	5
4		**Principles of cancer metastasis :**	**15**	5
	4.1	Clinical significances of invasion	2	5
	4.2	Metastatic cascade	2	5
	4.3	Basement membrane disruption, proteinase and tumor cell invasion.	3	5
	4.4	**New molecules for cancer therapy:** Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer,	4	5
	4.5	Advances in cancer detection.	4	5
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, ICT enabled classes, Group discussions, seminar presentations and activities
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=30marks** Quiz/ Test Papers/ Seminar/ Activity Report (on behavioral study)
	B. Semester End examination **Theory Total 70 marks, Duration 2 hrs** Multiple Choice Questions –(10 x 1) = 10 Marks Short questions- (10 out of 12) x 3 = 30 Marks, Short Essays (6 out of 8) x 5 = 30 Marks

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Programme	**BSc (Honors) Biological Sciences**					
Course Name	CLINICAL RESEARCH AND PHARMACOVIGILANCE					
Type of Course	DCE					
Course Code	UC7DCEBTS402					
Course Level	**400**					
Course Summary	The introductory course provides a comprehensive overview of the key concepts and practices in clinical research and pharmacovigilance. It covers the basics of designing and conducting clinical trials, understanding ethical considerations in research, monitoring and reporting adverse drug reactions. Students will also learn about the regulatory requirements for drug development and post-marketing surveillance. The importance of pharmacovigilance in ensuring drug safety and the effectiveness in communicating and collaborating with healthcare professionals and regulatory agencies are learned.					
Semester	**VII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre- requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To observe understand and evaluate research communications	U,E	2,3,10
2	To understand the basic principles and ethical considerations of clinical research.	U,K	2,3,10
3	To evaluate clinical research studies and assess the validity of their findings.	U,A	2,3,10
4	To gain familiarity with the various stages of drug development	U,K	2,3,10
5	To understand the adverse effects of medicine on a patient through clinical research and pharmacogenomics	U,E	2,3,10
6	To gain knowledge of the regulatory requirements and guidelines governing clinical research and pharmacovigilance.	K,An	2,3,10

Remember(K), Understand(U), Apply(A), Analyse(An), Evaluate(E), Create(C), Skill(S), Interest(I)and Appreciation(Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 60	CO No.
1	1.1	Overview of research methods. Planning a research project, Literature searching and systematic reviews. Quantitative and qualitative research methods,	5	1
	1.2	Understanding data collection and analysis, critical appraisal of published research articles. Presentation skills (written and oral).	5	1
	1.3	Sponsor's Perspective: Managing a Clinical Trial, Selecting Investigators and Monitors Maintaining and Managing Essential Documents (e.g. FDA Form 1572); Case Report Form Data. Transmission and Generation of the Clinical Study Report.	5	1,2
2	2.1	Overview of Medicinal Product Research and Development Drug Discovery and Pre- Clinical Research	5	2,3
	2.2	The Clinical Research and New Drug Application Approval Process; the Biologics Research, Development, and Licensing Process; Medical Device Research, Development, and Marketing.	5	2,3
	2.3	Drug Development Processes: History of drug development, Discovery and selection of compounds for human investigation and toxicological requirements.	5	4
3	3.1	Pharmacokinetics and pharmacodynamics,	5	4,5
	3.2	Pharmacogenomics and its application in clinical research.	5	4,5
4	4.1	Regulatory Affairs and Pharmacovigilance, Regulatory requirements in Europe, the USA and Japan, Regulatory requirements for biotechnology products, medicinal devices and veterinary products	5	6
	4.2	Regulatory requirements for the preparation, packaging, labeling and storage of clinical trial drugs,	5	6
	4.3	Health economics; Pharmacoeconomics and quality of life assessment, Safety reporting. Methods of monitoring drug safety, responding to drug safety alerts, Post marketing surveillance.	5	5,6
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures¸ group interactions¸ group seminar¸ power point presentations Teaching aids used- ICT enabled Audio Visual Presentations, Internet Resources
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory** **Total = 30 marks** Test Papers/Assignments/Seminars

	B. End Semester Examinations **Theory Total = 70 marks (Duration 2 hrs)** Multiple Choice Questions –(10 x 1) = 10 Marks Short questions- (10 out of 12) x 3 = 30 Marks, Short Essays (6 out of 8) x 5 = 30 Marks

References

1. Brown, A. M., & Wilson, P. (2016). Introduction to pharmacovigilance: Principles and practice. American Psychological Association.
2. Davis, J. M., & Wilson, R. (2016). Principles and practice of pharmacovigilance in clinical research. American Psychological Association.
3. Johnson, R. F., & Smith, L. K. (2017). Pharmacogenomics: An introduction and clinical perspective. American Psychological Association.
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5. Smith, K. T., & Johnson, L. (2017). Pharmacogenomics and personalized medicine: Methods and applications. American Psychological Association.
6. Vogenberg, F. R. (2000). Introduction to Applied Pharmacoeconomics. Medical.

Programme	**BSc (Honours) Biological Sciences**					
Course Name	STRESS PHYSIOLOGY					
Type of Course	DCE					
Course Code	UC7DCEBTS403					
Course Level	**400**					
Course Summary	This course provides an in-depth exploration of the physiological mechanisms animals use to respond to stress. It covers the cellular, systemic, and behavioral responses to different types of stressors and examines the impact of stress on health and disease. This course also explores the physiological mechanisms and responses of plants and microbes to various biotic and abiotic stressors. It covers the molecular, cellular, and systemic adaptations that enable plants and microbe to survive and thrive under stress conditions.					
Semester	**VII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre- requisites, if any						

COURSE OUTCOMES

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fundamental principles of stress physiology in animals, plants and microbes	U	2,3,10
2	Able to learn about the molecular and cellular mechanisms underlying stress responses.	U	2,3,10
3	Analyze physiological adaptations to various stressors in animals ,plant and microbes	An	2,3,10
4	Evaluate strategies used by organisms to cope with and adapt to stress.	E	2,3,10
5	Evaluate the applications of stress research in biotechnology and environmental management.	E	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs. 60	CO No.
1	1.1	**Introduction to Stress Physiology** Definition and Types of stress. Historical perspectives on stress research. Concepts of homeostasis and allostasis in animal physiology. stress response mechanism,	3	1
	1.2	**Neuroendocrine Basis of Stress** Structure and function of the hypothalamic- pituitary-adrenal (HPA) axis. Role of glucocorticoids and catecholamines in stress response. Acute vs. chronic stress responses.	10	3
2	2.1	**Cellular and Molecular Mechanisms** Signal transduction pathways in stress response. Role of heat shock proteins and stress proteins. Mechanisms of apoptosis and cell survival during stress.	10	2
	2.2	**Environmental Stressors:** Physiological responses to temperature, hypoxia, and pollution. Human Impact on Animal Stress, Stress and Animal Welfare	4	2,3
3	3.1	**Stress physiology in plants** – Definition and types of plant stress. Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses. Signal Transduction in Plant Stress Responses- Perception of stress signals. Signal transduction pathways: (receptors, second messengers, and transcription factors.) Role of phyto-hormones in stress signaling.	15	3
	3.2	**Agricultural Implications of Plant Stress:** Impact of stress on crop yield and quality. Breeding and biotechnological approaches to improve stress tolerance. Management practices to mitigate stress in agricultural systems	8	1,2,4
4	4.1	**Microbial stress physiology:** Definition and types of stress in microorganisms. Signal Transduction Pathways in Microbial Stress Responses, Applications of Microbial Stress Physiology	10	1,4

5		Teacher specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom lectures Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, , Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory** **Total = 30 marks** Quiz/ Test Papers/ seminars
	B. End Semester Examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks –(10 x 1) = 10 Marks, Short questions- (10 out of 12) x 2 = 20 Marks, Short Essays (5 out of 7) x 4 = 20 Marks

References

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Programme	**BSc (Honors) Biological Sciences**					
Course Name	TOXICOLOGY STUDIES AND TECHNIQUES					
Type of Course	DCE					
Course Code	UC7DCEBTS404					
Course Level	**400**					
Course Summary	This course offers a comprehensive introduction to the field of toxicology, focusing on the principles, methodologies, and applications of toxicological studies. It covers the mechanisms of toxicity, the assessment of chemical hazards, and the evaluation of toxic effects on biological systems. Students will gain hands-on experience with various techniques used in toxicological research and learn to apply these methods to assess the impact of toxicants on human health and the environment.					
Semester	**VII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre- requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No
1	Understand the fundamental principles of toxicology, including dose-response relationships and mechanisms of toxicity	U	2,3,10
2	Learn about the various classes of toxicants and their sources, including environmental pollutants, and industrial chemicals,	U	2,3,10
3	Gain proficiency in the techniques and methodologies used in toxicological research, including in vitro and in vivo testing, biomonitoring, and risk assessment.	R	2,3,10
4	Develop skills in analyzing toxicological data and interpreting results within a regulatory and public health context.	S	2,3,10
5	Explore current issues and advancements in toxicology, including emerging contaminants and novel testing methods.	C	2,3,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs. 60	CO No.
1	1.1	**Principles of Toxicology**: Introduction, definition, brief history, scope and sub-divisions of toxicology , Classification of toxins, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins Basic concepts-Dose and dose response, type of toxic effect (allergic reactions, idiosyncratic ic reactions, reversible and irreversible effects, acute toxicity, sub- acute toxicity, sub chronic effects and Chronic effects)Factors affecting toxicity- Species and strain, age, sex, nutritional status, hormones, circadian rhythms and environmental factors	10	1
	1.2	**Environmental Toxicology**: Air pollution- Classification and properties of air pollutants, Behaviour and fate of air pollutants, photochemical smog acid rain, health effect of air pollutant in man.	5	2
	1.3	Water pollution- Origin of Wastewater, Types of water pollution(domestic, Industrial, agricultural, solid waste, thermal and oil pollution) Toxic water pollutants and .their heaith effects, ground water pollution, health effects of marine pollution, case studies.	5	1,2
	1.4	Radioactive pollution- Sources of radioactive pollution, health effects of radiation. famous incidents of radioactive pollution	5	1,2
2	2.1	**Systemic Toxicology**: cutaneous toxicity- Skin as a barrier against toxins, dermatitis (initant dennatitis, allergic (initant dennatitis, allergic dennatitis, chemical) bums), pigmeutry disturbances, phototoxicity, skin cancer by radiation, arsenic and PAH	5	2,3
	2.2	Hepatotoxicity- mechanism of liver injury, case studies pertaining to carbon tetrachloride and acetaminophen, types of liver injury (fatty liver, , bile duct damage, sinusoidal damage, liver cell death- necrosis and cirrhosis, Liver tumors)Renal toxicity- mechanisms of renal injury, specific nephrotoxins (heavy metals, halogenated hydrocarbons, therapeutic agents), nephropathy.	10	2

3	3.1	**Occupational and Industrial Toxicology**: Occupational hazards- physical, chemical, biological and mechanical hazards. Occupational diseases: Pneumoconiosis, Silicosis, Asbestosis, Anthracosis. Prevention in different environments – Home, Workplace, Pollution of Air, Water and Land. Occupational Cancer – Skin cancer, Lung cancer, Bladder cancer and Leukemia; Prevention of Occupational diseases. Industrial toxicology – history and basic features, Industrial hygiene, Risk assessment and Management of industrial chemicals. Introduction, Legislation and Regulation – Federal government, State government, Legislation and Regulation in other countries.	10	2,3
4	4.1	Techniques: Bioassays, phototoxicity, comet assay, modified Salmonella assay, transgenic bioassays, neonatal bioassays Invitro bioassays: Predictive and mechanistic toxicology, different cell lines their use and Limitations Chromatography(gas and liquid chromatography) Mass spectrometry, spectroscopy(UV-visible spectroscopy, infrared spectroscopy, NMR, HPLC, Toxicogenomics	15	5
5		Teachers Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Classroom lectures Direct Instruction: Brain storming lecture, Explicit Teaching, E-learning, interactive Instruction:, Active co-operative learning, Seminar, Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=25 marks** Quiz/ Test Papers/ seminars
	B. End Semester Examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks –(10 x 1) = 10 Marks, Short questions- (10 out of 12) x 2 = 20 Marks, Short Essays (5 out of 7) x 4 = 20 Marks

REFERENCES

1. Agarwal, A., & Gopal, K. (2010). Principles of toxicology. ibdc publishers India.
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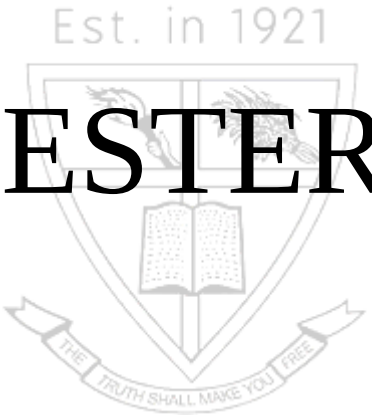

SEMESTER-VIII

Programme	**BSc (Honours) Biological Sciences**					
Course Name	OMICS APPROACHES IN BIOTECHNOLOGY					
Type of Course	DCC					
Course Code	UC8DCCBTS400					
Course Level	**400**					
Course Summary	Omics approaches aim to ensure that students not only acquire theoretical knowledge but also gain practical skills and a broader understanding of the implications of omics approaches in the biotechnology landscape. The course should prepare them to contribute to cutting-edge research, address complex biological questions, and navigate the ethical and practical challenges associated with omics technologies.					
Semester	**VIII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Student with good knowledge and interest of Microbiology and genetics.					

COURSE OUTCOMES

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Demonstrate a comprehensive understanding of genomics, transcriptomics, proteomics, metabolomics, and other omics approaches.	U	2
2	Acquire proficiency in the use of high-throughput technologies such as next-generation sequencing, microarray analysis, and mass spectrometry.	U, S	2,3,9,10
3	Develop the ability to critically interpret omics data and draw meaningful biological conclusions.	U	2
4	Understand how to integrate data from multiple omics technologies to gain a holistic view of biological systems	U	2,3,9,10
5	Explore and evaluate the applications of omics approaches in various biotechnological fields, including medicine, agriculture, and environmental science.	U,A,E	2,3,9,10
6	Acquire practical skills in generating omics data through laboratory techniques and gain proficiency in bioinformatics tools for the analysis and interpretation of large-scale omics datasets.	U,A,S	2,3,9,10
7.	Apply omics approaches to address biological research questions, including the design and execution of experiments, and the interpretation of results.	U,A,S	2,3,9,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1		**Introduction, scope and applications to Omics Technologies**	**5**	
	1.1	Overview of Omics: Introduction to genomics, transcriptomics, proteomics, metabolomics, and other omics fields	2	1
	1.2	High-throughput Technologies: Understanding microarray technology, next-generation sequencing (NGS), mass spectrometry, and other high-throughput methods.	3	2,3
	1.3	**Applications of Omics in Biotechnology** Medical Biotechnology: Omics approaches in personalized medicine, disease diagnostics, and drug discovery. Environmental Biotechnology: Applications in environmental monitoring and remediation. Agricultural Biotechnology: Omics in crop improvement and agriculture.	**10**	4,5
2		**Genomics**	**10**	
	2.1	Genome Sequencing: Principles and applications of whole- genome sequencing, shotgun sequencing, and bioinformatics tools for genome analysis.	6	4
	2.2	Functional Genomics: Study of gene function, RNA interference (RNAi), and CRISPR/Cas9 technology.	4	3,4
		Transcriptomics	**8**	
	2.3	RNA Sequencing (RNA-Seq): Principles, experimental design, and data analysis for transcriptome profiling.	4	5
	2.4	Microarray Analysis: Introduction to microarray technology for gene expression studies	4	2,6,7
3		**Proteomics and Metabolomics**	**12**	
	3..1	Mass Spectrometry: Principles of mass spectrometry for protein identification and quantification.	2	2,6
	3.2	2D Gel Electrophoresis: Techniques for separating and analyzing proteins	4	6,7
	3.3	Metabolite Profiling: Techniques for the comprehensive study of small molecules in biological samples.	3	3,4
	3.4	Metabolic Pathway Analysis: Understanding metabolic pathways and their regulation.	3	3,4
		PRACTICALS	**30**	

4	4.1	1. Database mining of resources in OMICS - SRA, STRING, METACyc, UNIPROT, BIOGRID etc. 2. Analysis of Mnase Sequence data. 13. ATAC-Sequence data analysis. 3. DGE data plotting - PCA plot, T-SNE plot etc. 4. Analysis of Metagenomics NGS data. 5. Preparation of report based on -Databases and data repositories used in systems Biology		6,7
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, ICT enabled classes, Group discussions, assignments, seminar presentations and activities **Note:** Teaching aids like software, models¸ videos related to the topic may be used.
Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA) Theory Total=25 marks** Quiz/ Test Papers/ assignments/seminars **Practical Total 15 marks:** Lab performance/ record/ report/ case studies
	B. End Semester examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks –(10 x 1) = 10 Marks, Short questions- (10 out of 12) x 2 = 20 Marks, Short Essays (5 out of 7) x 4 = 20 **Practicals Total 35 marks Duration- 2 hrs** **Record 10 marks, Examination 25 marks:** Sequence analysis, use of databases 20 marks, Viva-5 marks

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Programme	**BSc (Honours) Biological Sciences**					
Course Name	MICROBIAL BIOTECHNOLOGY					
Type of Course	DCC					
Course Code	UC8DSCBTS401					
CourseLevel	**400**					
Course Summary	The course will enable students to apply the learning of Biotechnology concepts towards the exploitation of microbial population for industrial and human benefits. The students are trained in: Screening for microbial strains from different samples. To prepare and sensitize the students to scope for research, the increasing for skilled scientific manpower with an understanding of research, industrials applications and microbiology ethics.					
Semester	**VIII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Student with basic knowledge and interest of Microbiology and Biotechnology.					

COURSE OUTCOMES

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Developing an understanding about the concept, importance and scope of Microbial Biotechnology.	U	2,3,9,10
2	Empower students with knowledge on Microbial products by highlighting the roles and characteristics of microorganisms in field of Biotechnology	U, A,S	2,3,9,10
3	Giving insight on Fermentation process	U	2,3,9,10
4	Helps students to know the beneficial role of microorganisms in bioprocessing of different types of fermented products	U,A	2,3,9,10
5	Students learn the production of recombinant proteins, vaccines, and biopharmaceuticals by genetic engineering and fermentation processes	U,A	2,3,9,10
6	Helps students to know the different microorganisms and their products (enzymes, polymers, metabolites, etc.) that are used in the biotechnology industry.	U,A, S	2,3,9,10

Remember(K), Understand (U),Apply(A), Analyse (An),Evaluate(E),Create(C),Skill(S), Interest(I) and Appreciation(Ap)

COURSE CONTENT

Content for Class room transaction (Units)

Module	Unit	Course description	Hrs 45	CO No.
1		**Overview of Microbial Biotechnology**	**10**	
	1.1	Historical perspectives, Scope and applications.	2	1
	1.2	Isolation, preservation and maintenance of industrially important microbes	4	
	1.3	Methods of Strain improvement and selection.	4	2,3
2		**Application of Microbes in Agriculture and environment**	**12**	
	2.1	Bio-fertilizers - Mass inoculum production of Rhizobium, Azospirillum, Azotobacter.	2	2,3,4
	2.2	Mycorrhizal inoculants, Blue green algae, Azolla**,** bioinsecticides, biopesticides,	2	2,3,4
	2.3	Abiotic stress tolerant plants – drought, flooding, salt and temperature.	2	2,3,4
	2.4	Biotic stress resistant to insects, fungi, bacteria, viruses, weeds	1	2,3,4
	2.5	Bioremediation of hydrocarbons and xenobiotic compounds, *In situ* and *ex-situ* bioremediation.	1	2,3,4
	2.6	Biodegradation, Bioleaching, Biomining, Biopaints, Bioantifouling agents, Bioelectricity, Biodetergents, Biopolymers**,** Biocement and Bioplastics	4	2,3,4
3		**Application of Microbial Biotechnology in Medicine**	**8**	
	3.1	Recombinant proteins, vaccines, antibiotics, hormones, interferons, lycopene (pigment) and melanin	5	5
	3.2	Microbial biosensors	1	5
	3.3	Bioweapons	2	5
		Industrial Microbial Biotechnology	**15**	
	3.4	Industrial production of Primary metabolites and secondary metabolites-shikimic acid	2	6
	3.5	Production of alcohol, acetone- butanol, citric acid, acetic acid, lactic acid.	4	6
	3.6	Production of Antibiotics- penicillin, streptomycin,	2	6
	3.7	Microbial production of enzymes- amylase, protease, cellulase.	2	6
		PRACTICAL	**30**	
	4.1	1, Design and Preparation of Media for Bioprocesses 2, Isolation of industrially important microorganism from		6

4		different sources using specific substrates 3, Preservation and maintenance of microbial cultures – Refrigeration, Mineral Oil layer, glycerol stocks 4. Immobilization of microbial cells by calcium alginate gel entrapment 5. Solid state fermentation of some microbial products 6.Demonstration of wide diversity of microbes and their potential for use in microbial biotechnology 7. Cultivation and mass multiplication of Azolla (Demonstration)		
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Module 1:** Lectures, ICT enabled classes, Group discussions, seminar presentations and activities **A visit to educational institute/university/industry to see an industrial fermenter, cultivation process and other downstream processing operations.**
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total=25 marks** Quiz/ Test Papers/ seminars/ assignment **Practical Total 15 marks** Lab performance/ record/ industry visit report
	B. End Semester examination **Theory Total 50 marks, Duration 1.5 hrs** Fill in the blanks –(10 x 1) = 10 Marks, Short questions- (10 out of 12) x 2 = 20 Marks, Short Essays (5 out of 7) x 4 = 20 Marks **Practicals Total 35 marks Duration- 2 hrs Record 10 marks, Examination 25 marks:** Performance of experiments 15 marks Viva-5 marks, research institute visit report- 5 marks

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Programme	**BSc (Honours) Biological Sciences**					
Course Name	PLANT BIOTECHNOLOGY					
Type of Course	DCE					
Course Code	UC8DSEBTS400					
Course Level	**400**					
Course Summary	This course in biotechnology describes with the micro propagation plant cell culture and transgenesis of plants Based on the knowledge of vectors, enzymes and applications of transgenesis gained in previous semesters, the learner will study about plant cell, tissue and organ culture, micro propagation, transgenic plant development and applications					
Semester	**VIII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre- requisites, if any	Basic knowledge in plant tissue culture and genetic engineering					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No
1	To understand and compare the traditional and biotechnological methods of plant improvement.	U,K	2,3,10
2	To learn the development of new variety and hybrid plants through plant cell culture.	U,E	2,3,10
3	To learn the vectors and techniques used in transgenic plant production	U,A	2,3,10
4	To understand and evaluate the applications of transgenic plants	U,K	2,3,10
5	To gain know how in metabolic engineering and production of secondary metabolites	E	2,3,10

Remember(K),Understand(U),Apply(A),Analyse(An),Evaluate(E),Create(C),Skill(S), Interest(I) and Appreciation(Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
	1.1	Conventional plant breeding. Introduction to cell and tissue culture; Tissue culture as a technique to produce novel plants and hybrids	3	1

1	1.2	Tissue culture media (Composition and Preparation). Sterilization and agents of sterilization used in tissue culture labs.	3	1
	1.3	Initiation and maintenance of callus and suspension cultures; Single cell clones. Organogenesis; Somatic embryogenesis; Transfer and establishment of whole plants in soil. Shoot tip culture; Rapid clonal propagation and production of virus-free plants. Embryo culture and embryo rescue	5	1
	1.4	Protoplast isolation, culture and fusion; Selection of hybrid cells and regeneration of hybrid plants; Symmetric and asymmetric hybrids, cybrids. Anther, pollen and ovary culture for production of haploid plants and homozygous lines. Somaclonal variation. In vitro mutation – Sexual incompatibility and male sterility. Cryopreservation; Slow growth and DNA banking for germplasm conservation	4	1,2
2	2.1	Plant transformation technology – Basis of tumor formation; Hairy root; Features of Ti and Ri plasmids; Mechanisms of DNA transfer; Role of virulence genes; Use of Ti and Ri as vectors; Use of scaffold attachment regions;	3	2,3
	2.2	Binary vectors; Use of 35S and other promoters; Genetic markers; Use of reporter genes; Reporter gene with introns;	3	3
	2.3	Methods of nuclear transformation; Viral vectors and their applications; Multiple gene transfers; Vector-less or direct DNA transfer; Particle bombardment, electroporation, microinjection. Transformation of monocots	5	3
	3.1	Applications of plant transformation. Herbicide resistance, insect resistance, Bt genes, Non Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated disease resistance, disease resistance, RIP, antifungal proteins, thionins, PR proteins, nematode resistance, abiotic stress	10	4

3				
	3.2	Molecular marker aided breeding –an introduction. Chloroplast transformation – Advantages, Vectors, Success with tobacco and potato	4	4,5
	3.3	Metabolic engineering and industrial products – Plant secondary metabolites, Control mechanisms and manipulation of phenylpropanoid pathway & shikimate pathway. Green house and green home technology	5	5
4		**PRACTICALS**	**30**	
	4.1	Plant tissue culture techniques Surface sterilization Callus culture Anther culture	16	1,2

	4.2	Embryo culture Protoplast isolation Somatic Hybridization	14	1,2,3, 4,5
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, group interactions, seminars, power point presentations. Teaching aids used- Audio Visual Presentation, Photographs, Internet Resources
Assessment Types	**MODEOFASSESSMENT** **A. Continuous Comprehensive Assessment(CCA)** **Theory Total = 25 marks** Test Papers/Assignments/Seminars **Practical Total= 15 marks** Systematic attendance and record submission Skills in practical performance Lab involvement, Viva
	B. End Semester Examinations **Theory Total = 50 marks (Duration 1.5 hrs)** Multiple Choice Questions –(10 x 1) = 10 Marks, Short questions- (10 out of 12) x 2 = 20 Marks, Short Essays (5 out of 7) x 4 = 20 Marks **Practical Total =35 marks (Duration 2hrs)** Record= 10 marks Viva= 5 marks Practical Examination= 20 marks

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1. Chawla, H. S. Biotechnology in crop improvement.
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2. George, E. F., Hall, M. A., & De Klerk, G. J. (2008). Plant propagation by tissue culture. Springer Science & Business Media.
3. Giri, C. C., &Zaheer, M. (2019). Plant tissue culture: An introductory text. CRC Press.
4. Raghavan, V. (2004). Molecular embryology of flowering plants. Cambridge University Press.
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Programme	**BSc(Honours)Biological Sciences**					
Course Name	BIOTECHNOLOGY AND FORENSIC MEDICINE					
Typeof Course	DCE					
Course Code	UC8DCEBTS401					
Course Level	**400**					
Course Summary	The course provides a comprehensive overview of the intersection between biotechnology and forensic science. It includes topics such as DNA analysis, serological tests and analysis, forensic genetics, crime scene investigation techniques and the use of biotechnology in solving criminal cases. Students will learn how to collect and analyze biological evidence, interpret DNA profiles, and apply cutting-edge biotechnological methods in forensic investigations.					
Semester	**VIII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No
1	To recognize the significance of immunoglobulins and lectins in forensic science	U,K	2,3,10
2	To gain understanding in the role played by components of blood in forensic science	U,E	2,3,10
3	To learn and apply techniques in biotechnology for solving cases in forensic science	U,A	1,2,3,10
4	To understand and apply techniques for interpreting and analyzing DNA sequences in forensic sciences.		2,3,8,10
5	To understand ethical and legal implications of using biotechnology in forensic science	A,S	1,2,3,8, 10
Remember(K),Understand(U),Apply(A), Analyse(An),Evaluate(E),Create(C),Skill(S), Interest(I)and Appreciation(Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1	1.1	Immunoglobulin- types, physico-chemical properties and function, raising of anti-sera, Lectins - their forensic significance. Buffers and serological reagents, methods of sterilization employed for serological work.	4	1
	1.2	Composition of blood, Formation of blood, Blood groups – history, biochemistry and genetics of ABO, Rh, Mn and other systems. Methods of ABO blood grouping (absorption-inhibition, mixed agglutination and absorption elution) from blood stains and other body fluids/stains viz. menstrual blood, semen, saliva, sweat, tear, pus, vomit, hair, bone, nail etc. Blood group specific ABH substances. Secretors and non- secretors	4	2
	1.3	Blood groups that make racial distinctions. Lewis antigen, Bombay Blood groups. HLA antigens and HLA typing. Role of sero-genetic markers in individualization and paternity disputes. Pitfalls in red cell typing.	4	1,2
	1.4	Determination of human and animal origin from bones, hair, flesh, nails, skin, teeth body tissue, fluids/ stains viz. blood, menstrual blood, semen, saliva, sweat, tear, pus, vomit, etc., through immunodiffusion and immuno - electrophoresis, cross reactivity among closely related species. Individualization of blood stains: Determination of blood groups, sex age and racialorigin from dried bloodstains	5	2,3
	1.5	Red cell enzymes : Genetics , polymorphism and typing of PGM, GLO-I, ESD, EAP, AK, ADA etc. and their forensic significance. Serum proteins: Genetics, polymorphism and typing of - Hb, HP, Tf, Bf, C3 etc. and their forensic significance.	8	2,3
	2.1	Concept of sequence variation - VNsTR, STRs, Mini STRs , SNPs. Detection techniques- RFLP, PCR amplifications, Amp-FLP, sequence polymorphism, Y-STR, Mitochondrial DNA.	5	3,4
2	2.2	Population databases of DNA markers –STRs, Mini STRs, SNPs. New & Future technologies: Analysis of SNP, DNA chip technology- Microarrays, Cell free DNA ,	5	3,4
		Synthetic DNA, Sequencing technologies		

	2.3	Evaluation of results, frequency estimate calculations and interpretation, Allele frequency determination, Match probability – Database, Quality control, Certification and Accreditation	4	2,3
3	3.1	History of DNA profiling applications in disputed paternity cases, child swapping, missing person's identity, civil immigration, veterinary, wild life and agriculture cases. legal perspectives	3	5
	3.2	Legal standards for admissibility of DNA profiling – procedural & ethical concerns, Status of development of DNA profiling in India & abroad. Limitations of DNA profiling	3	5
4		**PRACTICALS**	**30**	
	4.1	Serological tests for the diagnosis of microbial infections Agglutination and precipitation tests Immunodiffusion in gel ELISA DNA isolation Estimation of DNA Separation of DNA and RNA by Agarose gel electrophoresis PCR amplification of a desired fragment	30	4
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures¸ group interactions¸ group seminar¸ power point presentations, case studies. Teaching aids used- Audio Visual Presentation, Photographs, Internet Resources
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory** **Total = 25 marks** Test Papers/Assignments/Seminars **Practical Total= 15 marks** Systematic attendance and record submission Skills in practical performance, Lab involvement, Viva
	B. End Semester examination **Theory Total = 50 marks (Duration 1.5 hrs)** Multiple Choice Questions –(10 x 1) = 10 Marks,

	Short questions- (10 out of 12) x 2 = 20 Marks, Short Essays (5 out of 7) x 4 = 20 Marks **Practical Total =35 marks (Duration 2hrs)** Record= 10 marks Viva= 5 marks Practical Examination=20 marks

References

1. Budowle, B., & Moretti, T. R. (2004). Forensic DNA typing protocols. Humana Press.
2. Butler, J. M. (2005). Forensic DNA typing: Biology, technology, and genetics of STR markers (2nd ed.). Academic Press.
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4. Mcclintock, J. Thomas; Forensic DNA analysis, Lewis Publications, (2008)
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8. Burke, Terry; DNA Fingerprinting: Approaches and applications, Birkhauser Verlage, (1991)

Programme	**BSc(Honors) Biological Sciences**					
Course Name	PLANT MICROBE INTERACTION					
Type of Course	DCE					
Course Code	UC8DCEBTS402					
Course Level	**400**					
Course Summary	This course aims to give an insight into the consequences, on population and ecosystem level, of compatible and incompatible interactions, to understand infection process and control measures and to familiarize with the microbial production of plant metabolites.					
Semester	**VIII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	None					

COURSEOUTCOMES(CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No
1	To discuss interactions between plants and microbes and the defense mechanism in host plant	U,K	2,3,10
2	To gain insight on genetics of host-pathogen interactions and resistance mechanism in plants.	U,E	2,3,10
3	To use methods to analyse plant diseases and biological methods of disease control	U,An	2,3,10
4	To analyse plant microbe pathogenic and symbiotic interactions	An	2,3,10
5	To understand the role of microbes in developing plant immunity	U,E	2,3,10
6	To gain knowledge on biopesticides and their role in pest control	U,K	2,3,10

Remember(K),Understand(U),Apply(A), Analyse(An),Evaluate(E),Create(C),Skill(S), Interest(I)and Appreciation(Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1	1.1	Different interfaces of interactions -soil-plant-microbe interactions leading to symbiotic (rhizobial and mycorrhizal), associative, endophytic and pathogenic interactions	5	1

	1.2	General concepts of plant immunity. PAMP-triggered immunity (PTI) and Effector triggered immunity (ETI). Outer membrane vesicles (OMVs) and their involvement in plant immunity. The type III secretion system and hypersensitive response.	5	1
	1.3	Genetic basis of plant defences. Quorum-sensing in bacteria and their role in plant defence mechanisms. Phytohormones and antibiotics as plant therapeutics.	7	1,2
2	2.1	Plant pathogens and molecular basis of pathogenesis .Genetics of host-pathogen interactions, resistance genes, resistance mechanisms in plants. Basal and induced defence mechanisms.	6	2,3,4
	2.2	Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR), Recognition mechanism and signal transduction during plant – pathogen interaction	5	2,3,4
	2.3	Virulence determinants of plant pathogenic bacteria- Enzymes, Toxins, pili, siderophores, secretion systems	5	3,4,5
3	3.1	Microbial pest control: Bacillus thuringiensis-mode of action. Biocontrol agents– uses and practical constraints Biofungicide and bioherbicides	6	5,6
	3.2	Plant growth promoting rhizobacteria. Use of plant– microbe symbiosis for remediation of pollutants and carbon (C) sequestration	6	1,4,5
4		**Practical Case study**	**30**	
	4.1	1. The impact of plant-microbe interactions on soil health and ecosystem functioning 2. The role of plant-associated bacteria in promoting plant stress tolerance 3. Endophytic bacteria and their impact on plant health and growth 4. The potential application of microbial inoculants in sustainable agriculture: a case study on biofertilizers 5. The role of plant growth-promoting bacteria in enhancing crop productivity	**30**	4
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures¸ group interactions¸ group seminar¸ power point presentations, case studies Teaching aids used- Audio Visual Presentation, Photographs, Internet Resources.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 25 marks** Test Papers/Assignments/Seminars **Practical Total= 15 marks** Case study presentations and submission of reports

	Chart/Visual presentations
	B. End Semester examination **Theory Total = 50 marks (Duration 1.5 hrs)** Multiple Choice Questions –(10 x 1) = 10 Marks, Short questions- (10 out of 12) x 2 = 20 Marks, Short Essays (5 out of 7) x 4 = 20 Marks **Practical Total =35 marks (Duration 2hrs)** Record= 10 marks Viva= 5 marks Examination based on Case study assigned= 20 marks

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4. Mendes, R., Garbeva, P., &Raaijmakers, J. M. (2013). The Rhizosphere Microbiome: Significance of Plant Beneficial, Plant Pathogenic, and Human Pathogenic Microorganisms. FEMS Microbiology Reviews, 37(5), 634-663.
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Programme	**BSc (Honours) Biological Sciences**					
Course Name	MOLECULAR PHYLOGENY					
Type of Course	DCE					
Course Code	UC8DCEBTS403					
Course Level	**400**					
Course Summary	This elective course deals with the tools and techniques used in molecular phylogeny. The learner will develop a fundamental understanding of sequence analysis in bioinformatics Models of nucleic acid substitution, tree building algorithms, data mining tools and submission tools for nucleic acid are studied for understanding evolutionary relationships					
Semester	**VIII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No.
1	To understand the concepts of evolution and the role of mutation in the emergence of life	U,K	2,3,10
2	To engage in the collection, analysis, and interpretation of genetic data from biological databases	U,S	2,3,10
3	To use bioinformatics tools and software to analyze and interpret genetic sequences.	E, A, An	2,3,9,10
4	To construct and interpret phylogenetic trees based on genetic data and submit sequences to databases	A, An	2,3,9,10
5	To apply the knowledge of sequence analysis in molecular phylogenetics and answer real world research questions	E, A, An	2,3,9,10

Remember(K), Understand(U), Apply(A), Analyse(An), Evaluate(E), Create(C), Skill(S), Interest(I)and Appreciation(Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1	1.1	Basic concepts of molecular evolution: Genetic information, population dynamics, evolution and speciation,	5	1
	1.2	Molecular data as resources. Accessing databases for molecular phylogenetics, phylogenetic tree, methods for inferring phylogenetic trees, networking, RNA world	5	1,2
	1.3	Sequence databases and data base searches: Sequence databases, composite databases, database mirroring, and search tools	5	2
2	2.1	Concept of sequence Alignment, Scoring matrices: PAM &BLOSUM; Alignment of Pairs of sequences: Dot Plot. Alignment Algorithms-Needleman and Wunsch Algorithm, Smith Waterman Algorithm. Search for Homologous sequences using BLAST & FASTA programs.	5	2,3
	2.2	Introduction to BLAST suite; BLAST N,BLASTP,BLASTX and TBLASTN	5	2,3
	2.3	Multiple Sequence Alignment: Dynamic Programming and progressive alignment. Tools: Clustal W from Expasy Website, T-Coffee, Mega, MUSCLE and COBALT	5	2,3
3	3.1	Phylogenetic inference: Genetic distances and nuclear substitution models, phylogenetic inference based on distance methods- UPGMA, Neighbour Joining, Minimum Evolution, Least square	2	3,4
	3.2	Phylogenetic inference: Maximum Likelihood and Bayesian phylogenetic analysis, phylogenetic analysis based on parsimony,	4	3,4
	3.3	Phylogenetic analysis using protein sequences, testing tree reliability – Bootstrapping and jackknifing	4	4
	3.4	Testing models and trees: Models of evolution and phylogeny reconstruction, model fit, likelihood ratio tests, Practising MEGA, Paup*, RaxML, Mr Bayes, J Model Test.	3	4,5
	3.5	Sequence submission tools- SEQUIN and BankIt	2	4
		PRACTICALS	**30**	
		1. Accessing databases and retrieving data NCBI,GENBANK,SWISSPROT,PDB, OMIM 2. To find similarity between the given sequence of		3

4	4.1	protein in a database. 3. To find the similarity between the given protein sequence and a Database using FASTA program 4. To familiarize with the multiple sequence alignment tool CLUSTALW2and MEGA 5. To familiarize with the multiplesequence alignment tool T-COFFEE 6. To do Phylogenetic analysis and evolutionary tree construction of the given protein sequences using PHYLIP 7. Sequence submission using SEQUIN		
5		Teaching Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** • Lectures¸group interactions¸ group seminar¸ power point presentations, Hands on training in Bioinformatics tools and softwares • Teaching aids used- Audio Visual Presentation, Internet Resources
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 25 marks** Test Papers/Assignments/Seminars **Practical Total= 15 marks** Practical ability to perform Bioinformatics work Skill in accessing molecular data and performing sequencing alignment Ability to find solutions to biological problems
	B. End Semester examination **Theory Total = 50 marks (Duration 1.5 hrs)** Multiple Choice Questions –(10 x 1) = 10 Marks, Short questions- (10 out of 12) x 2 = 20 Marks, Short Essays (5 out of 7) x 4 = 20 Marks **Practical Total =35 marks (Duration 2hrs)** Record= 10 marks Viva= 5 marks Bioinformatics Practical Examination= 20 marks

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5. Mount, D. W. (2004). Bioinformatics: Sequence and genome analysis (2nd ed.). Cold Spring Harbor Laboratory Press.
6. Nei, M., & Kumar, S. (2000). Molecular evolution and phylogenetics. Oxford University Press.
7. The phylogenetic Handbook, 2nd Edition, Philippe Lemey, Marco Salemi, Anne - MiekeVandamme, Cambridge University Press.
8. Yang, Z. (2014). Molecular evolution: A statistical approach. Oxford University Press.

SUGGESTED READINGS

1. Baldauf, S. L. (2003). Phylogeny for the faint of heart: a tutorial. Trends in Genetics, 19(6), 345-351.
2. Nei, M., & Kumar, S. (2000). Molecular evolution and phylogenetics. Oxford University Press.

Programme	**BSc (Honours) Biological Sciences**					
Course Name	GENOMICS, PROTEOMICS AND NANOTECHNOLOGY					
Type of Course	DCE					
Course Code	UC8DCEBTS404					
Course Level	**400**					
Course Summary	This introductory course on genomics, proteomics, and nanotechnology is to learn about genes, proteins, and nanoscale materials with the aim of providing students with a broad understanding of the cutting-edge research and applications involved in these rapidly advancing fields.					
Semester	**VIII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	None					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domain*	PO No.
1	To understand the basic principles and concepts of genomics and proteomics	U,K	2,3,10
2	To develop the skills to analyze and interpret genomic and proteomic data.	U,E	1,2,3,10
3	To gain insights in the sequencing technologies employed in genomics and proteomics	U,A	2,3,9,10
4	To understand the basic principles in nanotechnology	U,K	2,3,10
5	To explore the applications and significance of nanotechnology	A,S	2,3,9,10

Remember(K),Understand(U),Apply(A), Analyse(An),Evaluate(E),Create(C),Skill(S), Interest(I)and Appreciation(Ap)

COURSECONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs 45	CO No.
1	1.1	Organization of genome : Single sequence DNA, GC content, Intermediate repeat DNA, Highly repetitive DNA, CpGislands , Gene Families, Pseudogenes, Duplicated genes, SNPs, STS, Tandemly repeated genes. Non protein Coding genes, Split genes, Overlapping genes, Spacer regions, ORF's Cryptic genes.	5	1
	1.2	Multigene Families in Eukaryotes, LINE's, SINE's, Transposons and retrotransposons Molecular markers DNA Fingerprinting & DNA Foot printing	5	1
	1.3	Physical Maps – Clone Maps, RH Maps, EST's, STS Maps, FISH (Fluroscent Insitu Hybridization) Genetic Maps History of sequencing, Early Strategies for sequencing. Maxam and Gilbert Sequencing Sanger's sequencing	5	1,2
2	2.1	Human Genome Project: Timeline, Methods, Outcome, Applications, Advantages and Ethical issues. Making the Clone Map: Generating, Assembling and Finishing the sequence	5	1,2,3
	2.2	Automated whole Genome shotgun sequencing), Nextgeneration sequencing techniques, Introduction to NGS data analysis.	5	1,2,3
	2.3	Annotating genomes: Sequence annotation and bioinformatics tools for genomics and genome comparison; analyzing gene expression-DNA microarray-design, analysis and visualization of data Application of DNA microarrays in prokaryotes,Microarray data analysis.Gene prediction in Prokaryotes and Eukaryotes, ORF prediction	5	2,3
3	3.1	Classification of proteins, Protein separation & analysis; 2D Gel Electrophoresis, Liquid chromatography, Mass spectrometry. Protein structure determination with X-ray Crystallography & NMR spectroscopy.	2	1
	3.2	Protein sequencing protein expression profiling, protein - protein interactions	3	1,2,3
	3.3	Protein databases: UniProtKB/Swiss-Prot, Interpro, PIR, PDB, SCOP & CATH, Pro- Dom, PFAM; Protein visualization tools- Swiss PDB Viewer, Pymol, Expasy proteomic tools	3	2, 3

	3.4	Fundamental Concepts in Nanotechnology: Foundations in nanosciences- introduction- -nanometre, nanoscale-quantum confinement in nanomaterials Rationale behind the downsizing of the materials Prime materials in nanotechnology-nanomaterials: unique properties and defects in nanocrystalline materials. Nano Fabrication**:** Introduction-synthesis of nanopowders using top down and bottom up methods-top down fabrication methods-arc discharge method-laser ablation method –ball milling-inert gas condensation-bottom up fabrication methods STM (principle, construction and working, advantages and disadvantages) - Raman spectroscopy (principle, construction and working)- Nanoindentation	3	4
	3.5	Nanoscale Characterization: Introduction-XRD (principle and theory)–SEM (principle, construction and working, advantages and disadvantages) -TEM (principle, construction and working, advantages and disadvantages)-AFM (principle, construction and working, advantages and disadvantages)	2	4
	3.6	Applications of nanotechnology in cancer, Agriculture, Medicine, Communication technology, Biotechnology and Bioinformatics.	2	5
4		**PRACTICALS**	**30**	
	4.1	1. Gene Structure and Function prediction. 2. ORF Prediction 3. Sequence Similarity Searching 4. Multiple Sequence Alignment 5. Analysis of Nucleic Acid Sequences 6. Bioinformatics tools used in Proteomics		2
5		Teacher Specific Module		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures¸ group interactions¸ group seminar¸ power point presentations, case studies, approaches in bioinformatics using tools in internet Teaching aids used- Audio Visual Presentation, Internet Resources

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory Total = 25 marks** Test Papers/Assignments/Seminars **Practical Total= 15 marks** Skill sets in Bioinformatics Case Studies of real time applications of nanotechnology/

	Submission of Report and Presentation
	B. End Semester examination **Theory Total = 50 marks (Duration 1.5 hrs)** Multiple Choice Questions –(10 x 1) = 10 Marks, Short questions- (10 out of 12) x 2 = 20 Marks, Short Essays (5 out of 7) x 4 = 20 Marks **Practical Total =35 marks (Duration 2hrs)** Record= 10 marks Viva= 5 marks Practical Examination= 20 marks

References

1. Albert, R. (2013). Network biology: Understanding the cell's functional organization. New York, NY: Garland Science.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular biology of the cell (6th ed.). New York, NY: Garland Science.
3. Bhatia, R. (2015). Nanotechnology: Principles and applications. Boca Raton, FL: CRC Press.
4. Brown, T. A. (2012). Genomes (3rd ed.). New York, NY: Oxford University Press.
5. Feller, G. (2014). The extremophiles handbook. Berlin, Germany: Springer.
6. Klug, W. S., Cummings, M. R., Spencer, C. A., &Palladino, M. A. (2017). Concepts of genetics (11th ed.). Boston, MA: Pearson.
7. Koonin, E. V. (2016). The logic of chance: The nature and origin of biological evolution. Upper Saddle River, NJ: Pearson.
8. Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry (7th ed.). New York, NY: W. H. Freeman.
9. Rastogi, R. (2016). Proteomics: Principles and techniques. New Delhi, India: New Age International.
10. Storici, F. (2012). Molecular biology of the cell: Problems book. New York, NY: Garland Science.

SUGGESTED READINGS

1. Bhushan, B. (2002). Nanotribology and Nanomechanics - An introduction. Springer.
2. Misener, S., &Krawetz, S. A. (2000). Bioinformatics Methods and Protocols. Humana Press.
3. Rastogi, S. C., Mendiratta, N., &Rastogi, P. (2004). Bioinformatics Methods and Applications. Prentice Hall of India.
4. Mount, D. W. (2002). Bioinformatics Sequence and Genome Analysis. Cold Spring Harbor Lab Press.

SCHEME OF EVALUATION FOR INTERNSHIP

A. INTERNAL EVALUATION - 15 MARKS

Sl.No	Head	Marks
1	Content & relevance of Dissertation as evidenced from work diary	8
2	Presentation	4
3	Viva	3

B. END SEMESTER EXAMINATION - 35 MARKS

Sl No	Head	Marks
1	Content & relevance of Dissertation as evidenced from work diary	20
2	Presentation	10
3	Viva	5

EVALUATION OF PROJECT IN THE EIGHTH SEMESTER

Evaluation of Project

The project should contain:

1. Title page/Front page (Certified by the HOD)
2. Declaration by the candidate
3. Certificate attested by the Supervising teacher
4. Acknowledgement, if any
5. Table of contents
6. Abbreviation, if any
7. Abstract
8. Introduction & Review of Literature
9. Methodology
10. Results and Discussion
11. Summary and Conclusion
12. References

The project report submitted must be duly attested by the Supervising Teacher and certified by the Head of the Department. There shall be a pre submission presentation and evaluation of the project in the middle of the eighth semester. **Mark for internal evaluation is 60**.

Scheme for internal evaluation

Sl No	Component	Marks
1	Topic/Area selected (relevance)	5
2	Experimentation/Data collection	15
3	Punctuality	5
4	Compilation	10
5	Content	10
6	Presentation	15
	TOTAL	60

The end semester evaluation of the Project shall be according to the Scheme given below.

Sl No	Component	Marks
1	Originality of approach, Introduction & aim of the project/objectives, Organization and Precision of Printed work	10
2	Relevance of the Topic	10
3	Review of Literature	10
4	Methodology	20
5	Involvement	10
6	Result and discussion: tabulation of data, presentation of figure/graphs, clarity of explanations etc.	20
7	Bibliography in correct format	10
8	Conclusions/ Applications to the society	10
9	Presentation of Report and Viva voce	30
10	Exceptional quality of the project	10
	TOTAL	**140**