FYUGP
2024

DEPARTMENT OF BIOTECHNOLOGY

Syllabus for
Undergraduate Programmes (Honours)
Under Credit Semester System
Outcome Based Education
with Effect from 2024 Admissions

St Berchmans College
Founded 1922
AUTONOMOUS | College with Potential for Excellence | A+ in the Fifth Cycle of Reaccreditation by NAAC
Changanassery, Kerala, India 686101 | Affiliated to Mahatma Gandhi University, Kottayam

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ACKNOWLEDGEMENT

The Board of Studies in Biotechnology St Berchmans College expresses sincere thanks to all external experts, Dr. Linu Mathew, Professor, School of Biosciences, Mahatma Gandhi University Kottayam, Kerala, Dr. Ramya R Prabhu, Assistant Professor& Head, Department of Biotechnology, Government Arts College, Thiruvananthapuram, Dr. Viji Mary Varghese, Assistant Professor, Department of Biotechnology, St. Josephs College, Irinjalakuda, Thrissur, Dr.Sherinmol Thomas, Scientist, BASF Innovation Centre, Technology Park 101,9052 Gent Zwijnaarde, Belgium , Mr.Eby John Sr. Product Specialist , Discovery Imaging and Detection Solutions, South East Asia, Perkin Elmer, for the valuable contribution in this syllabus revision endeavour. These overwhelming personalities and their guidance have immensely contributed to the successful completion of the syllabus restructuring.

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Above all we thankfully acknowledge Almighty God for strengthening us to accomplish this work.

Shobin Varghese

Chairman, Board of Studies

BOARD OF STUDIES

CHAIRMAN

Name	Official Address
Mr. Shobin Varghese	Assistant Professor (HOD) Department of Biotechnology St Berchmans College Changanassery, Kottayam - 686101

SUBJECT EXPERTS NOMINATED BY THE COLLEGE ACADEMIC COUNCIL

Name	Official Address
Dr. Viji Mary Varghese	Assistant Professor Department of Biotechnology St. Josephs College, Irinjalakuda, Thrissur
Dr. Ramya R Prabhu	Assistant Professor &Head Department of Biotechnology Government Arts College Thycaud P.O Thiruvananthapuram

EXPERT NOMINATED BY THE VICE-CHANCELLOR

Name	Official Address
Dr Linu Mathew	Professor School of Biosciences Mahatma Gandhi University Kottayam, Kerala

ALUMNI REPRESENTATIVE

Name	Official Address
Dr. Sherinmol Thomas	Scientist, BASF Innovation Centre Technology Park 101,9052 Gent Zwijnaarde, Belgium

REPRESENTATIVE FROM INDUSTRY

Name	Official Address
Eby John	Sr. Product Specialist Discovery Imaging and Detection Solutions, South East Asia PerkinElmer

TEACHERS FROM THE DEPARTMENT NOMINATED BY THE PRINCIPAL TO THE BOARD OF STUDIES

Teacher's Name
Mr. Shobin Varghese
Dr Lijy Jacob
Dr Manju Antony
Mrs Tessmol P George
Miss Sreeja Raj
Mrs Vigimol T Varghese
Dr Reshma John
Miss Shija Jacob

PROGRAMME OUTCOMES

PO1: Develop in-depth conceptual knowledge and skills in the discipline for vertical growth and scholarly pursuits

PO2: Integrate and apply interdisciplinary knowledge incorporating historical, theoretical, scientific, technological, economic, philosophical, cultural, aesthetic and ethical perspectives to address complex challenges in diverse settings

PO3: Demonstrate communication skills promoting adaptability, collaboration and resilience in global and local contexts

PO4: Develop problem solving skills to transfer the knowledge of methods and systems of different disciplines for a sustainable and egalitarian world order

PO5: Cultivate research skills and innovative and critical thinking to contribute to societal development through the creation of sustainable solutions and advancements in the respective fields

PROGRAMME SPECIFIC OUTCOMES

PSO1: Demonstrate a comprehensive understanding of core principles, advanced concepts, and practical applications in biotechnology and allied fields.

PSO2: Discuss the biophysical, biochemical, and molecular aspects of life, including metabolic pathways and the use of various biological techniques and instrumentation.

PSO3: Discuss the significance and influence of biotechnological practices in diverse fields, advocating for sustainable growth and development.

PSO4: Develop proficiency in practical knowledge, research skills, instrumentation techniques, and scientific writing to meet industry, academia, and societal demands, at the same time adhering to ethical standards and biosafety regulations.

PSO5: Demonstrate in-depth knowledge in biotechnology, laying a strong foundation for further studies, research exploration, and the ability to initiate and sustain biotechnological ventures.

OUTLINE OF DISCIPLINE SPECIFIC COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24BT1DSC100	Major/Minor	Essentials of Biotechnology	5	75	4
SBU24BT1DSC101	Major/Minor	Biotechnology In Day to Day Life	5	75	4
Semester II (Course Level: 100 - 199)					
SBU24BT2DSC100	Major/Minor	Overview of Biotechnology	5	75	4
SBU24BT2DSC101	Minor	Tools and Techniques in Biotechnology	5	75	4
Semester III (Course Level: 200 - 299)					
SBU24BT3DSC200	Major	Cell Biology and Genetics	5	75	4
SBU24BT3DSC201	Major	Biomolecules	5	75	4
SBU24BT3DSC202	Minor	Bioprocess Technology	5	75	4
Semester IV (Course Level: 200 - 299)					
SBU24BT4DSC201	Major	Molecular Biology	5	75	4
SBU24BT4DSC202	Major	Microbiology	5	75	4
SBU24BT4DSC203	Minor	Tissue Culture Technology	5	75	4
SBU24BT4INT200	Major	Internship	-	-	2
Semester V (Course Level: 300 - 399)					
SBU24BT5DSC300	Major/Minor	Plant Biotechnology	5	75	4
SBU24BT5DSC301	Major/Minor	Enzymology and Metabolism	5	75	4
Semester VI (Course Level: 300 - 399)					
SBU24BT6DSC300	Major/Minor	Recombinant DNA Technology	5	75	4
SBU24BT6DSC301	Major/Minor	Bioinformatics	5	75	4
SBU24BT6DSC302	Major/Minor	Industrial and Environmental Biotechnology	5	75	4
Semester VII (Course Level: 400 - 499)					
SBU24BT7DSC400	Major/Minor	Genomics, Metagenomics and Transcriptomics	4	60	4
SBU24BT7DSC401	Major/Minor	Advanced cell and Molecular Biology	5	75	4
SBU24BT7DSC402	Major/Minor	Research Methodology and Biostatistics	4	60	4
SBU24BT7DSC403	Major/Minor	Biopharmaceutics and Drug Designing	4	60	4
SBU24BT7DSC404	Major/Minor	Medical Biotechnology and Molecular Diagnostics	4	60	4
SBU24BT7DSC405	Major/Minor	Tissue Engineering and Regenerative Medicines	4	60	4
Semester VIII (Course Level: 400 - 499)					
SBU24BT8DSC400	Major	Advanced Instrumentation Techniques	5	75	4
SBU24BT8DSC401	Major	Enzyme Technology	5	75	4
SBU24BT8DSC402	Major	Advances in Genetic Engineering	5	75	4
SBU24BT8PRJ400	Major	Project	-	-	12

OUTLINE OF DISCIPLINE SPECIFIC ELECTIVE COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24BT3DSE200	Elective	Food Biotechnology	4	60	4
SBU24BT3DSE201	Elective	Biophysics and Basic Techniques	4	60	4
Semester IV (Course Level: 200 - 299)					
SBU24BT4DSE200	Elective	Neurobiology	4	60	4
SBU24BT4DSE201	Elective	Nanotechnology	4	60	4
Semester V (Course Level: 300 - 399)					
SBU24BT5DSE300	Elective	Biotechnology and Entrepreneurship	4	60	4

SBU24BT5DSE301	Elective	Biosafety and Bioethics	4	60	4
SBU24BT5DSE302	Elective	Animal Biotechnology	4	60	4
SBU24BT5DSE303	Elective	Microbial Technology	4	60	4
SBU24BT5DSE304	Elective	Immunology	4	60	4
Semester VI (Course Level: 300 - 399)					
SBU24BT6DSE300	Elective	Cancer Biology and Cell Signalling	4	60	4
SBU24BT6DSE301	Elective	Proteomics	4	60	4

OUTLINE OF MULTIDISCIPLINARY COURSES (MDC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24BT1MDC100	MDC	Ecosystem Conservation and Empowerment	4	60	3
Semester II (Course Level: 100 - 199)					
SBU24BT2MDC100	MDC	Lifestyle Disease and Management	4	60	3
Semester III (Course Level: 200 - 299)					
SBU24BT3MDC200	MDC	Nutritional Biotechnology	3	45	3

OUTLINE OF SKILL ENHANCEMENT COURSES (SEC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester IV (Course Level: 200 - 299)					
SBU24BT4SEC200	SEC	Quality Control in Biology	3	45	3
Semester V (Course Level: 300 - 399)					
SBU24BT5SEC300	SEC	IPR and Patenting	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24BT6SEC300	SEC	Scientific Communication in Research	3	45	3

OUTLINE OF VALUE ADDITION COURSES (VAC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24BT3VAC200	VAC	Innovation and Technology Transfer for Science	3	45	3
Semester IV (Course Level: 200 - 299)					
SBU24BT4VAC200	VAC	Nutrition and Health	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24BT6VAC300	VAC	Environmental Science and Human Rights	3	45	3

SEMESTER I

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BT1DSC100	Major/Minor	Essentials of Biotechnology	5	75	4
SBU24BT1DSC101	Major/Minor	Biotechnology In Day to Day Life	5	75	4
SBU24BT1MDC100	MDC	Ecosystem Conservation and Empowerment	4	60	3

SBU24BT1DSC100: ESSENTIALS OF BIOTECHNOLOGY

Type of Course	Major / Minor		
Course Level	100 - 199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the basic concept of biotechnology, historical developments and familiarise with techniques used in biotechnology.	U
CO2	Describe the interdisciplinary nature of biotechnology which helps them to connect various domains of life sciences.	U
CO3	Summarize the historical milestones and breakthrough discoveries in the field of biotechnology.	U
CO4	Outline basic instrumentation techniques and its applications.	U
CO5	Apply principles of Good Laboratory Practices (GLP) which will help them to practice safe chemical handling, proper waste disposal, prevent laboratory accidents and understand the significance of accuracy and precision in experimental results.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	-	2	2	1	-	1	-
CO2	2	1	-	-	2	2	2	-	1	-
CO3	2	-	1	-	2	2	1	-	1	-
CO4	2	2	1	-	2	2	1	-	1	-
CO5	2	1	1	-	2	2	2	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Poster	Assignment	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	x	x
CO2	-	x	x	x	x	x
CO3	-	-	x	x	x	x
CO4	-	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

COURSE CONTENT & TRANSACTION MECHANISM

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to biotechnology (3 Hrs)				
Biotechnology: An overview, Historical perspectives	1.1	1	1	Lecture
Scope and Tools in biotechnology, Conventional and modern Biotechnology.	1.2	1	2	Lecture
Module 2: Multidisciplinary fields of Biotechnology (24 Hrs)				
Cell biology and genetics - A typical prokaryotic and eukaryotic, Cell structure and function, Introduction to mendelian genetics- mendelian law & terminology in genetics.	2.1	2	4	Lecture/Video
Microbiology and immunology - Introduction to microbiology, microbial diversity – bacteria, fungi, viruses and protozoa, An overview to immunology- antigen, antibody, cells of immune system.	2.2	2	4	Lecture
Biochemistry- General structure and classification of Carbohydrates, Proteins Lipids and Nucleic acids.	2.3	2	6	Lecture
Molecular biology and r-DNA technology –brief outline of DNA replication, transcription, translation, and gene expression. Introduction and basic steps in rDNA technology.	2.4	2	5	Lecture/Video
Bioinformatics- definition, History and evolution of bioinformatics, Databases- various types of databases, Biological Databases- Importance of databases in biotechnology, NCBI, Gene bank, PubMed.	2.5	2	5	Lecture
Module 3: Milestones in Biotechnology (10 Hrs)				
Human genome project a brief introduction, PCR, Recombinant therapeutic proteins, Recombinant vaccines, Gene therapy, Animal cloning, Stem cells and Regenerative medicine.	3.1	1, 3	5	Lecture/Video
Genetically modified crops –BT cotton, Golden rice, Transgenic animals – transgenic mice and transgenic fish	3.2	1, 3	5	Lecture/Video
Module 4: Basic Instrumentation in Biotechnology (8 Hrs)				
pH meter, Autoclave, Hot air oven, Deep freezer, Refrigerator, Orbital shaker, Laminar air flow, Incubator, Bright field microscope, Analytical Balance, Water bath- Working principle and Application	4.1	1, 4	8	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. G. Karp, Cell and Molecular Biology: Concepts and Experiments, 6th Edition, John Wiley & Sons. Inc. 2009.

2. L.M Prescott, J.P Harley and D.A Klein, Microbiology ,5th edition, McGraw Hill, New York, 2003.
3. D.Peter Snustad, Michael J Simmons, Principles of Genetics, 6th Ed, Wiley, 2011
4. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Molecular Biology of the Gene, 7th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA ,2014
5. David L. Nelson, Cox, Leininger, Principles of Biochemistry, Fourth edition; Publisher: W. H. Freeman,2004

Reference

1. Satyanarayana U, Biotechnology. Books and Allied (P) Ltd, 2020
2. Singh B.D. Biotechnology: Expanding Horizons ,4th edition, Kalyani Publishers, 2015
3. Dubey R.C. A Textbook of Biotechnology ,5th edition, S Chand and Company Ltd, 2014
4. S.B.P Primrose, R. M Twyman, Principles of gene manipulation and Genomics, 7th edn, Blackwell Scientific publishers, 2006
5. Arthur Lesk, Introduction to Bioinformatics, Oxford University Press, Third edition,2008.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Good Lab Practices and Instrument handling (15 Hrs)				
Good Lab practices- general rules and regulations, SOP, Maintenance of lab records	6.1	5	5	Lecture, Lab Practice
pH meter- Calibration, operation, maintenance	6.2	5	3	Lab practice
Use of centrifuge for biological separations	6.3	5	3	Lab practice
Weighing balance- Operation, maintenance	6.4	5	2	Lab practice
Light microscope- Operation, maintenance	6.5	5	2	Lab practice
Module 7: Laboratory safety (7 Hrs)				
Basic laboratory safety practices- personnel safety and other safety equipment	7.1	5	2	Lab practice
Storage and disposal of chemicals, Hazard identification and classification	7.2	5	3	Lab practice
Material safety data sheets, Labels and pictograms	7.3	5	2	Lab practice
Module 8: Laboratory Maths (8 Hrs)				
Preparation of solutions, Calculation of molar, normal, molal solutions, Percentage solutions	8.1	5	8	Lab practice

Textbook

1. Milton A. Anderson, GLP Essentials: A Concise Guide to Good Laboratory Practice. Second Edition. Interpharm Press ,2002

Reference

1. Lisa Moran, Tina Masciangioli , Chemical Laboratory Safety and Security: A Guide to Prudent Chemical Management, first edition, The National Academies Press,2010.
2. Handbook of Good Laboratory Practices, TDR, WHO, UNICEF, UNDP, 2009.

Course designed by: Dr. Reshma John, Mr. Shobin Varghese

SBU24BT1DSC101: BIOTECHNOLOGY IN DAY TO DAY LIFE

Type of Course	Major/Minor		
Course Level	100 – 199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline various biotechnological approaches used for environmental management and conservation.	U
CO2	Explain the applications of biotechnological in agriculture and industry for enhancing crop yield and sustainable food supply.	U
CO3	rize the principles of medical biotechnology, its diagnostic and therapeutic applications in every day health care.	U
CO4	Describe various biotechnological strategies in biodefense and understand potential biothreats to public safety.	U
CO5	Develop practical skills in basic laboratory experiments in biotechnology.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	-	2	2	1	-	1	-
CO2	2	-	2	-	2	2	1	-	1	-
CO3	2	-	2	-	2	2	1	-	1	-
CO4	2	-	2	1	2	2	1	-	1	-
CO5	2	-	2	-	2	-	2	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Poster	Assignment	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	x	x
CO2	-	x	x	x	x	x
CO3	-	x	x	-	x	x
CO4	x	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Biotechnology: An Overview (17 Hrs)				
Introduction and historical Perspectives of biotechnology, Global market and Biotech Products	1.1	1	2	Lecture
Environmental management: Biofuels production-Bioethanol, Biodiesel production: Microbial Electrochemical Cells: Principles, their applications, Microbial fuel cells (MFC).	1.2	1	4	Lecture
Bioremediation of soil & water contaminated with oil spills, GMOs for bioremediation and phytoremediation, their roles (*Pseudomonas aeruginosa*, *Pseudomonas putida* and degradative plasmids).	1.3	1	4	Lecture
Biodiversity and Biotechnology, conservation and preservation approaches to biodiversity, DNA barcode, DNA barcoding in ecology and conservation biology.	1.4	1	3	Lecture
Biodegradable Plastics production by microorganisms: polyesters, polylactic acid, poly hydroxyl butyrate, Identification and manipulation of microorganisms for biodegradation of plastics.	1.5	1	4	Lecture
Module 2: Agricultural and Industrial Applications (13 Hrs)				
Fermented foods (cheese, yoghurt,), prebiotics and probiotics, Alcoholic beverages (beer, wines), Nutraceuticals, and genetically modified foods.	2.1	2	3	Lecture
Genetically modified Plants -BT cotton, Golden rice	2.2	2	4	Lecture
Enzyme Engineering, Artificial enzymes, Abzymes, Commercial applications of enzymes in detergent, leather, medical and pharmaceutical industries. Production and applications of Proteases, Cellulase.	2.3	2	4	Lecture
Industrial applications: pathway engineering strategies for overproduction of some commercially important primary and secondary metabolites (e.g. amino acids)	2.4	2	2	Lecture
Module 3: Medicine and Health Care (10 Hrs)				
Vaccinology: Vaccine types-recombinant vaccines, modern vaccines, New emerging diseases and vaccine needs.	3.1	3	4	Lecture
Monoclonal antibodies, Tailoring antibodies for specific applications. Immunodiagnostics (ELISA) and DNA probe for disease identification, DNA phenotyping	3.2	3	4	Lecture
Clinical applications of recombinant technology-recombinant Insulin and human growth hormone.	3.3	3	2	Lecture
Module 4: Biodefense and Public Safety (5 Hrs)				
Bioterrorism Weapons and Techniques, Characteristics of microbes and the reasons for their Use; Pathogenicity, Epidemiology-natural and targeted release, Case studies of Anthrax, Plague, Botulism, Smallpox, and Tularemia and	4.1	4	5	Lecture

Viral Haemorrhagic Fever. Prevention and Control of Bioterrorism.				
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. B.D Singh, Biotechnology: Expanding Horizon, Kalyani Publications,2007.
2. Satyanarayana U, Biotechnology, Books and Allied (P) Ltd, 2020
3. H.S Chawla, Introduction to Plant Biotechnology. 3rd edition, Oxford and IBH Publishing CO.Pvt.Ltd.,2009
4. R. Sasidhara, Animal Biotechnology, MJP publishers, 2006

Reference

1. Stanbury PF, Whitaker A and Hall SJ. Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.2006
2. David E Bruns, Edward R Ashwood, & Carl A Burtis; Fundamentals of Molecular Diagnostics, Saunders/Elsevier ,2007
3. N Shakuntala Manay, M. Shadakshara Swamy, Food-Facts and Principles, 2 Ed, New Age International Pub,2008.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Isolation of microbes from soil (8 Hrs)				
Serial dilution and agar plating techniques	6.1	5	8	Lab Practice
Module 7: Blood grouping (7 Hrs)				
Identification of blood groups	7.1	5	7	Lab Practice
Module 8: Production of Biofertilizer (5 Hrs)				
Formulation and production of biofertilizer	8.1	5	5	Lab Practice
Module 9: Fermentation of milk for value added products (10 Hrs)				
Production of Cheese, yogurt, butter and other value-added products from milk.	9.1	5	10	Lab Practice

Textbooks

1. Peter F. Stanbury, Allan Whitaker, Stephen J Hall. Principles of Fermentation Technology, 2nd Edition Elsevier, 2013.
2. Narendra Tuteja and Sarvajeet Singh Gill, Biofertilizers and Biopesticides: A Sustainable Approach, Springer, 2019.
3. Alok Adholeya, Harshad Lade, "Biofertilizers in Sustainable Agriculture: An Overview on Concepts, Approaches, and Research" Springer, Cham, 2019

Reference

1. Pauline M. Doran, Bioprocess Engineering: Principles, Academic Press,2012
2. Dhananjaya Pratap Singh, Harikesh Bahadur Singh, Ratna Prabha, Microbial Inoculants in Sustainable Agricultural Productivity: Vol. 2: Functional Applications, Springer,2016

Course designed by: Dr. Reshma John, Mr. Shobin Varghese

SBU24BT1MDC100: ECOSYSTEM CONSERVATION AND EMPOWERMENT

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	30	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Interpret the dynamics of the biosphere and biotic community.	U
CO2	Critically examine biodiversity, conservation, and human linkages, and help policy formulating for conservation	U
CO3	Critically appreciate the contemporary environmental concerns.	R
CO4	Acquire a comprehensive understanding of the environment and the pivotal role of human beings in its evolution and transformation.	R
CO5	Demonstrate and articulate the methodologies and results of diverse experiments	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	1	-	-	-
CO2	1	-	-	-	-	1	2	-	1	-
CO3	1	-	-	-	-	1	-	-	-	-
CO4	1	-	-	-	-	1	1	-	-	1
CO5	1	-	-	-	-	1	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Assignment	Viva	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	x	x	x	x	x	x
CO3	-	x	x	x	x	x
CO4	-	x	x	-	-	x
CO5	-	x	x	x	-	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1 - Ecosystems: Structure and Function (5 Hrs)				
Ecosystem components- abiotic and biotic**,** Energy flow: Ecological energetics, trophic levels, food chain and food web and ecological pyramids. Productivity – primary, secondary, and net productivity	1.1	1	3	Lecture
Nutrient cycles: Biogeochemical cycles of C, N, and S. Habitat, ecological niche, and microclimate.	1.2	1	2	Lecture
Module 2: Biodiversity And Conservation (5 Hrs)				
Biodiversity: definition, types, examples, Endemism: Definition, types, Biodiversity hotspots in India, Western Ghats as a hot spot, Wetlands and their importance. IUCN-threat categories, Red data book, Biodiversity loss: Causes and rate of biodiversity loss, extinction causes; habitat destruction, invasive species, over exploitation and pollution	2.1	2	3	Lecture
National parks and wild life sanctuaries of Kerala. Joint Forest Management (JFM). Types of resources-renewable and non-renewable, Sustainable development and ecological footprints. Ecotourism- positive and negative impacts.	2.2	2	2	Lecture
Module 3: Ecosystem Restoration Projects (10 Hrs)				
Ecosystem restoration globally: Various ecosystem restoration projects around the globe: Arabian Oryx Reintroduction (Oman).	3.1	3,4	5	Lecture
Ecosystem restoration projects-India.:Ecosystem restoration projects and strategies in India: Periyar Tiger Reserve, Nilgiri Tahr Project (2023). Sundarbans Mangrove Restoration Project, Green India Mission, National River Conservation Plan (NRCP). CAMPA (Compensatory Afforestation Fund Management and Planning Authority), Himalayan Landscape Conservation and Livelihoods Support Project.	3.2	3,4	5	Lecture
Module 4: Environmental Protection Movements (10 Hrs)				
Environmental protection Movements and mission in India. Clean India Mission (Swachh Bharat Abhiyan), Save the Western Ghats Movement, National River Conservation Plan (NRCP).	4.1	4	5	Lecture
Ecosystem Restoration Projects.: Ecological rehabilitation of the Aravalli hills, Chambal River Conservation-Madhya Pradesh and Rajasthan	4.2	4	5	Lecture
Module 5: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Chapman JL, Reiss MJ, Ecology: Principles and Applications, Cambridge University Press,2005.
2. Richardson, David & Pyšek, Petr. Elton, C.S., The ecology of invasions by animals and plants. London: Methuen. Progress in Physical Geography - Prog Phys Geog. 31. 659-666. 10.1177/0309133307087089, 2007.

Reference

1. H.D Kumar, Modern Concepts of Ecology Vikas Publishing House, New Delhi, 2000
2. Krebs C J, Ecology: The Experimental Analysis of Distribution and Abundance, VI Edn, Benjamin Cummings Publications, 2008.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Ecosystem Conservation and Empowerment Practical (30 Hrs)				
Estimation of Salinity, and total alkalinity of water samples (Titrimetry) Determination of pH of soil and water Assessment of diversity, abundance, and frequency of plant/animal species by using suitable methods. EIA case studies (Sampling – line transect, Quadrate) Study of anatomical, morphological, physiological adaptation of plants to the environment (Xerophytic, Hydrophytic and Epiphytic)	6.1	5	30	Demonstration/ Hands-on training
Visit any forest types including grasslands and preparation of the list of Rare and threatened (R&T) plants (no collection of specimens) OR visit any ecotourism centre in Kerala and prepare a report on the project. Collection, identification and preparation of the list of exotic species in the locality.	6.2	5		Field visit Outside Teaching hours

Textbooks

1. Krishnamurthy K V, An Advanced Textbook on Biodiversity: Principles and Practice, Oxford and IBH. Publ. Co.,2004.

Reference

1. Odum E P, Barrett G W, Fundamentals of Ecology, Thomson Asia Pvt. Ltd.,2005.
2. Peter Stiling, Ecology: Global insights and investigations Mc Graw Hill, 2012.

Couse designed by Sreeja Raj

SEMESTER II

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BT2DSC100	Major/Minor	Overview of Biotechnology	5	75	4
SBU24BT2DSC101	Minor	Tools and Techniques in Biotechnology	5	75	4
SBU24BT2MDC100	MDC	Lifestyle Disease and Management	4	60	3

SBU24BT2DSC100: OVERVIEW OF BIOTECHNOLOGY

Type of Course	Major/Minor		
Course Level	100 – 199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline the fundamentals of biotechnology, scope, ongoing advancements and its beneficial impacts on society.	U
CO2	Differentiate between the diverse fields of biotechnology and explore its role in health care, agriculture, food sector and environmental sustainability.	U
CO3	Identify the prominent biotechnology institutions in India and understand the innovations of biotechnology start up by analysing the case studies of successful biotechnology startups.	U
CO4	Explain the ethical, legal and biosafety aspects of biotechnological inventions.	U
CO5	Apply practical skills for the production of beneficial products like biofertilizer, wine and mushroom cultivation.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	1	-	1	-
CO2	2	-	2	-	2	2	1	-	1	-
CO3	2	1	1	-	2	2	1	-	1	-
CO4	1	-	1	1	2	2	1	-	1	-
CO5	2	1	1	2	2	2	2	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Poster	Assignment	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	x	x
CO2	-	x	x	x	x	x
CO3	-	-	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Biotechnology (3 Hrs)				
An Introduction to biotechnology, Biotechnology- an interdisciplinary pursuit, public perception of biotechnology, Biotechnology in India and its global trends.	1.1	1	3	Lecture
Module 2: Branches of Biotechnology (30 Hrs)				
Colour codes of Biotechnology, Rainbow of Biotechnology	2.1	2	2	Lecture
Agricultural biotechnology**:** Introduction to agricultural biotechnology, Transgenic plants, Genetic engineering and crop improvement, Examples: Golden rice, Glyphosate resistant, plants as bioreactors. Merits and demerits of GM plants.	2.2	1, 2	4	Lecture
Medical Biotechnology**:** Biotechnology in medicine and health care, Vaccine production, Nano Medicine, Organ culture, Stem cell therapy, 3D cell culture, Artificial skin, blood and tissues.	2.3	1, 2	4	Lecture
Biotechnology in Forensic Science**:** DNA fingerprinting, DNA analysis in disputed paternity, importance of DNA studies in solving genetic issues—real life examples.	2.4	1, 2	4	Lecture
Food Biotechnology**:** Basic principle of Fermentation, Bioreactor – Definition and applications, Production of fermented food products- Bread, wines. Fermented milk products(cheese) and High value food products, single cell proteins.	2.5	1, 2	4	Lecture
Environmental Biotechnology: Biodegradation of toxic substances, Biopesticides - *Bacillus thuringiensis, Trichoderma,* Biocomposting, Biosensors - applications in environmental pollution detection, Biofuel production as an alternative energy	2.6	1, 2	4	Lecture
Microbial biotechnology: Genetic engineering of microbes to improve production of antibiotics and secondary metabolites. Biopolymers and bioplastics	2.7	1, 2	4	Lecture
Marine Biotechnology: Production of transgenic fishes, Algal Products - Fuels from Algae, Medical Application	2.8	1, 2	4	Lecture
Module 3: Biotechnology Institutions and Startups (6 Hrs)				
An introduction to bio-startups and institutions in India- public and private sectors, Bio-startups and Industries – case study.	3.1	3	6	Lecture
Module:4 Protection and safety of biotechnological inventions (6 Hrs)				
IPR and Patents in Biotechnology- basic concepts of IPR, patents and copyrights, plagiarism	4.1	4	3	Lecture
Biological and physical containment, and problems of organism pathogenesis and biologically active biotechnology products.	4.2	4	3	Lecture

Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**

Textbooks

1. H.S Chawla, Introduction to Plant Biotechnology. 3rd edition, Oxford and IBH Publishing CO ,2009
2. R. Sasidhara, Animal Biotechnology, MJP publishers, 2006
3. R. Ian Freshney: Culture of Animal Cells: A Manual of basic techniques and specialized applications, 7 th edition, Wiley-Blackwell, 2016.
4. Deepa Goel and Shomini Parashar, IPR, Biosafety and Bioethics, Pearson Education India, 2013
5. B.D Singh, Biotechnology: Expanding Horizon, Kalyani Publications,2007.
6. Satyanarayana U, Biotechnology, Books and Allied (P) Ltd, 2020
7. Stanbury, P.F.A. Whitaker and S.J. Hall, Principles of fermentation technology, Pergamon Press, 1995.

Reference

1. Keshavachandran R & Peter KV. Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient & Longman (Universal Press),2008.
2. Stanbury PF, Whitaker A and Hall SJ. Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd,2006

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Alcoholic fermentation (8 Hrs)				
Wine production from fruits	6.1	5	6	Lab Practice
Estimation of alcohol content in wine	6.2	5	2	Lab Practice
Module 7: Mushroom cultivation (15 Hrs)				
Substrate preparation, Inoculation, Incubation and harvesting of mushrooms	7.1	5	15	Lab Practice
Module 8: Production of Biofertilizer (7 Hrs)				
Formulation and production of biofertilizer	8.1	5	7	Lab Practice

Textbooks

1. Alok Adholeya, Harshad Lade, "Biofertilizers in Sustainable Agriculture: An Overview on Concepts, Approaches, and Research" Springer, Cham, 2019
2. Narendra Tuteja and Sarvajeet Singh Gill, Biofertilizers and Biopesticides: A Sustainable Approach, Springer, 2019
3. Peter F. Stanbury, Allan Whitaker, Stephen J Hall. Principles of Fermentation Technology, 2nd Edition, Elsevier, 2013.

Reference

1. Dhananjaya Pratap Singh, Harikesh Bahadur Singh, Ratna Prabha, Microbial Inoculants in Sustainable Agricultural Productivity: Vol. 2: Functional Applications, Springer,2016
2. Pauline M. Doran, Bioprocess Engineering: Principles, Academic Press,2012

Course designed by: Dr. Reshma John, Mr. Shobin Varghese

SBU24BT2DSC101: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY

Type of Course	Minor		
Course Level	100 -199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline the basic concept of biotechnology and gain insights into various innovations in the field.	U
CO2	Demonstrate proficiency in methodology behind molecular and analytical techniques in biotechnological research.	U
CO3	Explain aseptic methods used of culturing and maintenance of animal and plant cells, in *in vitro* conditions.	U
CO4	Demonstrate an in-depth knowledge in emerging trends in biotechnology, novel methodologies and its potential applications.	U
CO5	Apply microscopic technique for observation of prokaryotes and eukaryotes cells.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	-	2	2	1	-	1	-
CO2	2	2	1	-	2	2	1	-	1	-
CO3	2	2	1	-	2	2	1	-	1	-
CO4	2	2	2	-	2	2	1	-	1	-
CO5	2	2	2	-	2	2	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Poster	Assignment	Viva	Exam 1	Exam 2	
CO1	-	x	x	x	x	x
CO2	-	x	x	x	x	x
CO3	-	-	x	-	x	x
CO4	x	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Biotechnology (5 Hrs)				
Definition of biotechnology. Eminent contributors to biotechnology Antoni Van Leeuwenhoek, Karry Mullis, Ian Wilmut.	1.1	1	3	Lecture
Biotechnological Innovations, Importance of Innovations in Biotechnology, Business of Biotechnology. Major biotechnology institutes and companies in India	1.2	1	2	Lecture
Module 2: Techniques in biotechnology (21 Hrs)				
Polymerase Chain Reaction: Principles of PCR, steps, and applications	2.1	1, 2	3	Lecture
DNA Sequencing, Blotting techniques- southern blotting	2.2	1, 2	2	Lecture
DNA finger printing, Fluorescence in situ hybridization	2.3	1, 2	2	Lecture
Principles and applications, simple, compound, microscopes.	2.4	1, 2	4	Lecture
Centrifugation Techniques: Principles, type of centrifuges, density gradient centrifugation in isolation of cells, cell organelles and biomolecules.	2.5	1, 2	5	Lecture
Electrophoresis: Paper and gel electrophoresis, Polyacrylamide gel electrophoresis, Agarose gel electrophoresis	2.6	1, 2	5	Lecture
Module 3: Cell culture techniques (14 Hrs)				
Plant cell culture techniques: Totipotency; Regeneration of plants; Plant Tissue culture and cell suspension culture system, Protoplast, protoplast fusion - somatic hybrid,	3.1	3	5	Lecture
Transgenic plants, Biosafety of transgenic plants	3.2	3	2	Lecture
Animal cell culture techniques, Culture media composition and growth conditions, Anchorage dependent and anchorage in dependent cell culture; Primary and secondary culture, Preservation of cells.	3.3	3	5	Lecture
Transgenic animals -ethical issues	3.4	3	2	Lecture
Module 4: Recent advances in Biotechnology (5 Hrs)				
CRISPR-Cas9, Synthetic biology - Artificial Cell, Types and its applications, personalised medicines, Bioprinting, Tissue engineering, Nanobiotechnology and its applications in health and environment. AI in Biotechnology	4.1	1, 4	5	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Avinash Upadhyay, Kakoli Upadhyay and Nirmaledu Nath, Biophysical Chemistry (Principles and techniques), Revised Edition, Himalaya publishing House, 2009.

2. S.B.P Primrose, R. M Twyman, Principles of gene manipulation and Genomics, 7th edn, Blackwell Scientific publishers, 2006.
3. Keith Wilson, John Walker, Principles and Techniques of Biochemistry & Molecular Biology, 7 th edition, Cambridge University Press, 2010.
4. H.S Chawla, Introduction to Plant Biotechnology. 3rd edition, Oxford and IBH Publishing CO.Pvt.Ltd.,2009

Reference

1. Rodney Cotterill, Biophysics: An Introduction, Ist edition, Wiley Publisher, 2002.
2. T.A Brown, Gene Cloning and DNA Analysis: An Introduction, 7th edn, Wiley-Blackwell,2016
3. R. Sasidhara, Animal Biotechnology, MJP publishers, 2006

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Handling of Microscope (6 Hrs)				
Identification of parts of a microscope	6.1	5	3	Lab Practice
Use of microscope in viewing cells	6.2	5	3	Lab Practice
Module 7: Staining of Microorganisms (9 Hrs)				
Simple staining	7.1	5	4	Lab Practice
Gram Staining	7.2	5	5	Lab Practice
Module 8: Blood cell Isolation (10 Hrs)				
Blood cell isolation by centrifugation	8.1	5	5	Lab Practice
Use of Haemocytometer	8.2	5	5	Lab Practice
Module 9: Chloroplast isolation (5 Hrs)				
Chloroplast isolation and identification using microscope	9.1	5	5	Lab Practice

Textbooks

1. Keith Wilson, John Walker: Principles and Techniques of Biochemistry & Molecular Biology: 7 th edition: Cambridge University Press: 2010.
2. H.S Chawla, Introduction to Plant Biotechnology. 3rd edition, Oxford and IBH Publishing CO.Pvt.Ltd.,2009

Reference

1. A Satyanarayana U, Biotechnology, Books and Allied (P) Ltd, 2020
2. H.S Chawla, Introduction to Plant Biotechnology. 3rd edition, Oxford and IBH Publishing CO.Pvt.Ltd.,2009
3. R. Sasidhara, Animal Biotechnology, MJP publishers, 2006

Course designed by: Dr. Reshma John, Mr. Shobin Varghese

SBU24BT2MDC100: LIFESTYLE DISEASES AND MANAGEMENT

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	30	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the impact of various lifestyle factors on health and how it contributes towards disorders such as diabetes, cardiovascular diseases, stroke and cancer.	U
CO2	Demonstrate an understanding of causes and symptoms of various lifestyle disorders	U
CO3	Explain various diagnostic methods in identifying various lifestyle disorders	U
CO4	Discuss the importance of education and general awareness in health promotion, emphasizing the role of diet and exercise in reducing the incidence of lifestyle related diseases	U
CO5	Demonstrate the role of laboratory tests in diagnosis of lifestyle disorders and discuss the importance of this knowledge to promote healthier lifestyle choices for individuals and communities.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	-	-	-	2	-	-	-	-
CO2	2	1	-	-	-	2	-	-	1	-
CO3	2	1	-	1	-	2	-	-	-	-
CO4	2	1	-	-	-	2	-	-	1	-
CO5	2	1	-	2	-	2	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Assignment	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	-	x
CO2	x	-	x	x	-	x
CO3	-	-	x	-	x	x
CO4	-	x	x	-	x	x
CO5	-	-	x	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Lab involvement	Viva	Record	Lab Test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to lifestyle diseases (4 Hrs)				
Lifestyle diseases- definition and overview of lifestyle diseases	1.1	1	1.5	Lecture
Risk factors – food habits, smoking, drinking, stress, lack of physical activity, genetic predisposition	1.2	1,2	2.5	Lecture
Module 2: Metabolic and cardiovascular diseases - diagnosis and prevention (14 Hrs)				
Metabolic diseases: 1)Type II diabetes: Diagnosis (fasting blood glucose test, HbA1c test)	2.1	3	1.5	Lecture
2)Obesity-Diagnosis (BMI, waist conference measurement) Management/prevention of metabolic diseases - healthy diet and exercise	2.2	3.4	2	Lecture
Cardiovascular diseases: 1)Coronary artery disease: diagnosis (Electrocardiogram, stress test, coronary angiography) Prevention (healthy diet and exercise, smoking cessation, management of blood pressure and cholesterol levels)	2.3	3,4, 5	4	Lecture
2)Hypertension-Diagnosis (measuring blood pressure), Prevention (low sodium diet, physical activity, stress management, weight management)	2.4	3,4	2	Lecture
3)Stroke-Diagnosis (imaging techniques such as CT and MRI scans, blood tests) Prevention (management of blood pressure and sugar, healthy diet and regular exercise)	2.5	3	4.5	Lecture
Module 3: Cancer and respiratory disorders- diagnosis and prevention (8 Hrs)				
CANCER: Types of cancer (benign, malignant), causes of cancer (associated with lifestyle factors such as smoking, diet and physical activity)	3.1	1,2	2	Lecture
Screening/ diagnosis of cancer (physical exam, blood test, biopsy, imaging techniques (only brief description needed) Treatment methods in cancer (surgery, radiation, chemotherapy, hormone therapy)	3.2	3	2	Lecture
Respiratory diseases: asthma, chronic obstructive pulmonary disease causes (smoking, pollution, occupational exposure)	3.3	1,2	2	Lecture
Diagnosis (pulmonary function tests, imaging techniques) management (medication, lifestyle changes, pulmonary rehabilitation)	3.4	3.4	2	Lecture
Module 4: Management of lifestyle disorders (4 Hrs)				
Prevention strategies for lifestyle related diseases, Non-pharmacological management approaches- Balanced diet and physical exercise	4.1	4	2.5	Lecture
Role of healthcare professionals in disease management and public education, use of life style medicine to treat disorders	4.2	4,5	1.5	Lecture
Module 5: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. James M.R, Lifestyle Medicine, 2nd Edition, CRC Press, 2013.
2. Akira Miyazaki and Michio Imavari, New Frontiers in Lifestyle-Related Disease, Springer, 2008.
3. U. Satyanarayana, U. Chakrapani, Biochemistry, 3rd edition, Biochemistry Elsevier, 2021.

Reference

1. Arthur C Guyton, John E Hall, Textbook of Medical Physiology, Prism Saunders 9th Edition,2006.
2. Gerald Karp, Cell and Molecular Biology, John Wiley & Son, 2013.
3. Sharma M and Majumdar, P. K, Occupational lifestyle diseases: An emerging issue. Indian journal of occupational and environmental medicine, 13(3), 109–112. WHO Projections of mortality and burden of disease to 2030 (Geneva: 2007), 2009

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Lifestyle diseases Practicals (30 Hrs)				
Qualitative analysis of sugars	6.1	5	15	Lab practice
Qualitative analysis of lipids	6.2	5	15	Lab practice

Reference

1. 1.Joel C Allemann, Adrianne Bendich, Handbook of Lifestyle Medicine, CRC Press, 2012.
2. James M Rippe, Nutrition in Lifestyle Medicine, CRC Press, 2017.

Course designed by: Dr. Lijy Jacob

SEMESTER III

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BT3DSC200	Major	Cell Biology and Genetics	5	75	4
SBU24BT3DSC201	Major	Biomolecules	5	75	4
SBU24BT3DSC202	Minor	Bioprocess Technology	5	75	4
SBU24BT3DSE200	Elective	Food Biotechnology	4	60	4
SBU24BT3DSE201	Elective	Biophysics and Basic Techniques	4	60	4
SBU24BT3MDC200	MDC	Nutritional Biotechnology	3	45	3
SBU24BT3VAC200	VAC	Innovation and Technology Transfer for Science	3	45	3

SBU24BT3DSC200: CELL BIOLOGY AND GENETICS

Type of Course	Major		
Course Level	200 – 299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline the basic structure and components of prokaryotic and eukaryotic cells and to explain the structure of cell organelles and their role in cellular activities.	U
CO2	Explain structure of nucleus and chromosome and describe various events of cell cycle and programmed cell death	U
CO3	Describe the basic principles of heredity, Mendelian and non-Mendelian pattern of inheritance, Linkage and crossing over using appropriate examples	U
CO4	Explain karyotype, pedigree symbols and chromosomal anomalies associated with Down's syndrome, Turner's syndrome and Klinefelter's syndrome and understand Hardy-Weinberg law	U
CO5	Identify the stages of mitosis and meiosis, isolate chloroplast, abnormal karyotypes and pedigree charts and work out problems based on monohybrid and dihybrid crosses	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	2	2	-	-	-	-
CO2	2	-	-	-	2	2	-	-	-	-
CO3	2	-	-	-	2	2	-	-	-	-
CO4	2	-	-	-	2	2	-	-	-	-
CO5	-	-	-	3	2	2	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Oral presentation	Exam 1	Exam 2	
CO1	-	x	x	x	-	x
CO2	-	x	-	x	-	x
CO3	-	x	x	-	x	x
CO4	-	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab Involvement	Assignment	Viva	Record	Lab Exam	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Cell and cellular organelles (15 Hrs)				
Historical perspectives. Discovery of cell, the cell theory, ultra structure of a eukaryotic cell- (both plant and animal cells), structural organization and functions of cell wall and plasma membrane.	1.1	1	3	Lecture
Structure and functions of cell organelles: Cytosol, endoplasmic reticulum, Golgi complex, mitochondria, chloroplast, ribosomes, lysosomes, peroxisomes, cytoskeletal structures (microtubules, microfilaments and intermediate filaments).	1.2	1	12	Lecture
Module 2: Chromosomes and cell division (10 Hrs)				
Structure of nucleus, euchromatin and heterochromatin Metaphase chromosome-Centromere, secondary constriction, telomere.	2.1	2	3	Lecture
Cell cycle, mitosis and meiosis, senescence and programmed cell death	2.2	2	7	Lecture
Module 3: Inheritance and gene interaction (12 Hrs)				
Mendel's experiments, Principle of segregation, Monohybrid cross, Principle of independent assortment, Dihybrid ratio, Testcross, Back cross. Chromosome theory of inheritance. Incomplete dominance, Codominance, lethal, multiple alleles, ABO blood typing. Extrachromosomal inheritance - mitochondria and chloroplast	3.1	3	4	Lecture
Gene interactions – Supplementary gene interaction, Complementary gene interaction and epistasis	3.2	3	3	Lecture
Coupling and repulsion hypothesis, linkage in Drosophila, mechanism of crossing over and its importance, chromosome mapping-linkage map in maize.	3.3	3	5	Lecture
Module 4: Human genetics and Population genetics (8 Hrs)				
Karyotype study & Pedigree analysis	4.1	4	2	Lecture
Chromosomal anomalies and human disorders - autosomal anomalies - Down's syndrome, Sex chromosome anomalies - Klinefelters syndrome, Turners syndrome. Hardy Weinberg principle, Allele frequencies and its changes	4.2	4	6	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Cooper GM and Hausman, The Cell, a molecular approach, 6th Edition, Sinauer Associates, Sunderland, 2013

2. Gupta, P. K. Cell and Molecular Biology (2nd Ed.), Rastogi Publication, Meerut, 2003
3. G. Karp, Cell and Molecular Biology: Concepts and Experiments, 6th Edition, John Wiley & Sons. Inc. 2009.
4. Becker, W. M. and Klein smith, L. J., World of the Cell ,6th Ed, Benjamin Cummings,2005
5. Benjamin A Pierce, Genetics: A Conceptual Approach, 6th edition, WH Freeman, 2017
6. D. Peter Snustad, Michael J Simmons, Principles of Genetics, 6th Ed, Wiley, 2011

Reference

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell ,4th Ed, Garland Science, New York, 2002.
2. Harvey, L., Arnold, B., Lawrence, S., Zipursky, Paul, M., David, B., and James, D, Molecular Cell Biology ,4th Ed, W. H. Freeman, New York, 2000
3. Lodish, Molecular Cell Biology, Scientific American Book, 2004
4. Robert Brooker, Concepts of Genetics, 2nd edition, McGraw-Hill Publishing Company,2016
5. LH Heartwell, Genetics: From Genes to Genomes, 5th edition, McGraw-Hill Education,2014
6. Peter J, Snustad, M.J. Simmons, Principles of Genetics, 7th edition, 2015
7. Ricki Lewis, Human Genetics, 12th edition, McGraw-Hill Education, 2020

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Cell Biology and Genetics (30 Hrs)				
Study of plant cell structure using Onion epidermal peel	6.1	5	5	Lab practice
Isolation of chloroplast	6.2	5	5	Lab practice
Study of the different stages of mitosis using onion root tip squash	6.3	5	5	Lab practice
Study of the different stages of meiosis using permanent slides	6.4	5	5	Lab practice
Work out problems in: Monohybrid and dihybrid crosses.	6.5	5	5	Lab practice
Study of normal human karyotype and differentiating it with the karyotypes of Down's, Klinefelter's and Turner's syndromes	6.6	5	2	Lab practice
Pedigree Analysis	6.7	5	3	Lab practice

Textbooks

1. K.V. Chaitanya, Cell and Molecular Biology: A Lab Manual, PHI Learning Private Limited. 2013.
2. G. Shanmugam, Cell Biology: A Laboratory Manual, Macmillan,1988.
3. Benjamin A Pierce, Genetics: A Conceptual Approach, 6th edition, WH Freeman, 2017
4. D. Peter Snustad, Michael J Simmons, Principles of Genetics, 6th Ed, Wiley, 2011

Course designed by: Dr Manju Antony

SBU24BT3DSC201: BIOMOLECULES

Type of Course	Major		
Course Level	200 -299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline the role of biomolecules in living systems	U
CO2	Explain the structure and functions of carbohydrates in living systems	U
CO3	Explain the structure and functions of amino acids, proteins and lipids	U
CO4	Explain the role of nucleic acids, vitamins, hormones and minerals in metabolism	U
CO5	Analyse schematically various biomolecules (carbohydrates, proteins, non-protein nitrogenous substances (NPN) qualitatively and identify its presence in test samples	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	-	-	2	-	-	-	-
CO2	2	2	-	-	-	2	-	-	-	-
CO3	2	2	-	-	-	2	-	-	-	-
CO4	2	2	-	-	-	2	-	-	-	-
CO5	2	2	-	-	1	2	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Assignment	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	-	x
CO2	x	-	x	x	-	x
CO3	-	-	x	-	x	x
CO4	-	x	x	-	x	x
CO5	-	-	x	-	-	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Lab involvement	Viva	Record	Lab Test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Carbohydrates (15 Hrs)				
Isomerism of carbohydrates –D and L forms Monosaccharides (glucose, fructose, mannose)	1.1	1,2	4	Lecture
Epimers and anomers with examples, Mutarotation and its explanation	1.2	1, 2	3	Lecture
Reactions of sugars- oxidation, reduction & osazone reaction, reducing actions of sugars, Structure of methyl α-D glucopyranose, 2- deoxy α- D ribofuranose. amino sugars	1.3	1,2	2	Lecture
Structure and biological importance of disaccharides- sucrose, lactose, maltose, isomaltose, trehalose and cellobiose	1.4	1,2	2	Lecture
Classification of polysaccharides (based on composition and function)– homopolysaccharides (starch, glycogen, cellulose, chitin), heteropolysaccharides (hyaluronic acid, chondroitin sulphate and heparin).	1.5	1, 2	4	Lecture
Module 2: Lipids (10 Hrs)				
Fatty acids and their classification, physical and chemical properties of fatty acids, Structure of the following fatty acids- stearic acid, oleic acid, linoleic acid, linolenic acid arachidonic acid, essential and non-essential fatty acids with examples	2.1	1, 3	3	Lecture
Simple, compound and derived lipids, sturucture and biological functions of triacylglycerols (simple and mixed triglycerides), saponification number, acid number and iodine number of fats, phospholipids (phosphatidic acid, lecithin, cephalin, and phosphatidyl serine)	2.2	1, 3	5	Lecture
Sterols (cholesterol and ergosterol) and waxes	2.3	1, 3	2	Lecture
Module 3: Amino acids and proteins (10 Hrs)				
Amino acids: Definition, stereoisomerism, structure of standard amino acids, classification of amino acids based on charge and polarity, essential and non-essential amino acids	3.1	1,3	3	Lecture
Ionization of amino acids, isoelectric pH (pI) and concept of zwitterion; Peptides: Formation of peptide bond, classification of proteins, denaturation of proteins	3.2	1,3	4.5	Lecture
Protein structure: primary, secondary, tertiary and quaternary structure of proteins, forces stabilizing protein structure, outline of protein sequencing	3.3	1,3	2.5	Lecture
Module 4: Nucleic acids, vitamins, minerals and hormones (10 Hrs)				
Nature of nucleic acids: Structure of nitrogen bases, nucleosides and nucleotides; Phosphodiester linkages	4.1	1,4	2	Lecture
Structure of nucleic acids- Watson-Crick DNA double helix structure, brief study of DNA and RNA types, Denaturation of nucleic acids	4.2	1,4	4	Lecture

Vitamins: Fat-soluble and water-soluble vitamins: sources, functions and deficiency disorders (outline study)	4.3	1,4	2	Lecture
Minerals: functions of macro and micro minerals	4.4	1,4	1	Lecture
Hormones: Classification and functions (outline study)	4.5	1,4	1	Lecture
Module 5: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Lehninger, Nelson & Cox, Principles of Biochemistry, 8th Edition W. H. Freeman & Company,2021.
2. D. Voet and J.G. Voet, Biochemistry, 4th/3rd edition, Wiley, 2010.
3. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Biochemistry, W. H. Freeman, 2010.
4. Mathews, Biochemistry, Pearson Education, 1996
5. Lubert Stryer, Bio chemistry, Freeman & Co, NY, 2010

Reference

1. Hames, B.D. (Ed.), Biochemistry, Viva Books, 1998
2. Metzler, David E. Biochemistry: The Chemical Reactions of Living Cells. Elsevier, 2003.
3. Tymoczko, John L, Jeremy M. Berg, and Lubert Stryer, Biochemistry, Macmillan, 2011.

Practical

Course content	**Unit**	**CO**	**Hrs**	**Transaction mechanism**
Module 6: Qualitative analysis of biomolecules (30 Hrs)				
Analysis of reducing and non-reducing sugars	6.1	5	12	Lab practice
Analysis of lipids	6.2	5	4	Lab practice
Analysis of amino acids and proteins	6.3	5	8	Lab practice
Analysis of non-protein nitrogenous substances (urea, uric acid, creatinine)	6.4	5	6	Lab practice

Reference

1. 1.Practical Handbook of Biochemistry and Molecular Biology, Gerald D Fasman, CRC Press, 2009.
2. 2.Biochemical analysis- a modern approach, David J Holme and Hazel Pack, Prentice Hall, 1998.

Course designed by Dr. Lijy Jacob

SBU24BT3DSC202: BIOPROCESS TECHNOLOGY

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Define the fundamental principles of fermentation process and methods used for screening and strain improvement of industrially important microbes.	U
CO2	Discuss the design and types of fermentors, equipments and instruments used in fermentation and sterilization processes.	U
CO3	Acquire knowledge in downstream processing.	U
CO4	Explain roles of microbes in fermentation and characterize the production strategies for industrial products.	U
CO5	Apply the use of microbes in the production of industrially valuable products.	A

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	-	1	2	1	-	-	1
CO2	2	-	1	-	1	2	1	-	-	1
CO3	2	-	1	-	1	2	1	-	-	1
CO4	2	-	1	-	1	2	1	-	-	1
CO5	2	1	1	1	1	2	1	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	x	x
CO2	-	x	x	x	x	x
CO3	-	-	x	-	x	x
CO4	-	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva	Record	Lab Test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Fermentation Technology (13 Hrs)				
History of fermentation. Introduction to fermentation processes	1.1	1	2	Lecture
Fermentation types – Submerged and solid state fermentation; Fermentation media and sterilization.	1.2	1	4	Lecture
Basic concepts- batch, continuous and fed batch culture.	1.3	1	2	Lecture
Screening methods for industrially important microorganism; strain improvement and preservation of industrial strains.	1.4	1	5	Lecture
Module 2: Fermentor – Design, Types & Control (12 Hrs)				
Design and operation of Fermentors	2.1	2	4	Lecture
Types of fermenters: CSTR, airlift fermentor, packed bed reactor and fluidized bed reactor.	2.2	2	4	Lecture
Factors affecting fermentation- Aeration, Agitation, Temperature regulation, Mass transfer, Oxygen transfer.	2.3	2	4	Lecture
Module 3: Down-stream Processing (7 Hrs)				
Biomass separation by centrifugation, filtration, flocculation and other methods.	3.1	3	2	Lecture
Cell disintegration: Physical, chemical and enzymatic methods.	3.2	3	1	Lecture
Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction.	3.3	3	1	Lecture
Purification by chromatography.	3.4	3	1	Lecture
Concentration by precipitation, ultrafiltration, reverse osmosis, drying and crystallization.	3.5	3	2	Lecture
Module 4: Production Strategies for Industrial Products (13 Hrs)				
Fermented Foods –Yoghurt and Cheese, Microbial Foods – Single cell proteins (SCP), Single cell oils (SCO), Polysaccharides-Xanthan gum and Polyesters-Polyhydroxyalkanoates (PHA)	4.1	4	5	Lecture
Fermentative production of Alcoholic Beverage–Beer, Organic acid–Citric acid, Antibiotic –Penicillin, Amino acids–Glutamic acid and Vitamin–B12	4.2	4	8	Lecture
Module 5: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Cruger and Annilesse Cruger, A textbook of industrial microbiology, 3rd Edition, Sinaser associates. Inc, 1990.
2. Mansi and CFA. Bryce. Fermentation Microbiology and Biotechnology, 3rd Edition, Taylor & Francis Ltd. 2004.

3. Enfors, S. O. and Häggström, L,Bioprocess Technology: Fundamentals and Applications, 2nd Edition, Royal Institute of technology, Stockholm, Sweden, 2000.
4. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology,2nd Edition, Cambridge University, Press, New York,2001.

Reference

1. P.F. Stanbury, A Whitaker and S.J. Hall, Principles of Fermentation Technology, 3rd Edition, Elsevier, 2008.
2. P.T. Kalichelvan and I Arul Pandi, Bioprocess Technology, 1st Edition, MJP Publishers, Chennai, 2009.
3. M. Shuler and F. Kargi, Bioprocess Engineering, Prentice Hall (I) Ltd., N. Delhi,2002.
4. Antan Moser and Philip Manor, Bioprocess Technology- Kinetics and reactors, Springer, 1998.
5. E.M.T. Mansi, C.F.A. Bryce, A.L. Dmain, A.R. Alliman, Fermentation Microbiology and Biotechnology,4th Edition, Taylor and Francis. New York, 2009.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Bioprocess technology Practical (30 Hrs)				
Fermentative production of industrially useful enzyme	6.1	5	6	Lab practice
Screening of enzyme producers	6.2	5	8	Lab practice
Fermentative production of wine and estimation of alcohol content	6.3	5	4	Lab practice
Immobilization of enzyme	6.4	5	6	Lab practice
Immobilization of microbial cells for enzyme production	6.5	5	6	Lab practice

Reference

1. Baltz, R. H., Davies, J. E. and Demain, A. L, Manual of Industrial Microbiology and Biotechnology, 3rd Edition, Washington DC: American Society of Microbiology, 2012.
2. Dubey, R. C and Maheshwari, D. K, Practical Microbiology, 2nd Edition,S. Chand & Company Limited, 2002.
3. Kalaichelvan P. T, Microbiology and Biotechnology Laboratory manual, 3rd Edition, MJP Publishers, Chennai,2005.
4. Murugalatha N, Microbiological techniques,5th Edition, MJP Publishers, Chennai,2012.

Course designed by: Tessmol P. George

SBU24BT3DSE200: FOOD BIOTECHNOLOGY

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand about the importance of biotechnology in the food processing sector.	U
CO2	Describe the Industrial production of commercially important value added products	U
CO3	Understand the creation of food products and the newest developments in biotechnology.	U
CO4	Discuss the reason for food spoilage and enumerate the different methods of food preservation	U
CO5	Appraise the social and safety concerns as well as the applications and effects of genetically modified food.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1	1	2	2	2	-	1	1
CO2	2	1	2	1	2	2	2	-	1	1
CO3	2	1	1	1	2	2	2	-	1	1
CO4	2	1	2	1	1	2	1	-	2	1
CO5	1	1	1	1	1	2	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Home assignment	Viva	Quiz	Written Test	MCQ	
CO1	-	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	-	x	x	-	x	x
CO4	-	x	x	x	x	x
CO5	-	x	x	-	x	x

Course Content Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Principles of Food Biotechnology (5 Hrs)				
Food related biotechnology - Role of bio process engineering in biotechnology industry.	1.1	1	2	Lecture

The social and regulatory implications of food biotechnology. Utilising biotechnology in the food industry's waste management	1.2	1	3	Lecture
Module 2: Industrial Production of Value Added Products (15 Hrs)				
Types of cheese and their production processes.	2.1	2	2	Lecture/Demonstration
Fermented dairy products and beverage.	2.2	2	3	Lecture
Technological aspects of industrial production of lactic acid, baker's yeast, single-cell proteins. Bacteriocin production and its use in food preservation.	2.3	2	5	Lecture
Biotechnological methods for modifying genes to increase the nutritional value and storage life of fruits and vegetables.	2.4	2	5	Lecture
Module 3: Biotechnological Applications in Food Production (10 Hrs)				
Bovine somatotropin and its role in milk production	3.1	3	2	Lecture
Transgenic plants in food production	3.2	3	2	Lecture
Transgenic fish production and its implications	3.3	3	3	Lecture
Emerging trends in food biotechnology	3.4	3	3	Lecture
Module 4: Food Spoilage and Preservation (15Hrs)				
Causes and prevention of contamination	4.1	4	3	Lecture
Microbial contamination and spoilage of food	4.2	4	4	Lecture
Food borne illnesses and prevention	4.3	4	3	Lecture
Preservation methods low temperature, freezing, heat, drying concentration, fermentation, canning, radiation, and chemical preservatives	4.4	4	5	Lecture
Module 5: Food Safety and Ethical issues in Biotechnology (15 Hrs)				
Risk associated with GM foods – Allergens, toxins, antibiotic resistance, soil contamination	5.1	5	2	Lecture
GMOs- current guidelines for the production, release and movement of GMOs; labelling and traceability; trade related aspects.	5.2	5	5	Lecture
Significance of food safety assessments and surveillance	5.3	5	2	Lecture
Government regulatory agencies: FDA, CDC. EPA	5.4	5	2	Lecture
Hazard Analysis and Critical Control Points (HACCP) concepts, Risk assessment in food production	5.5	5	4	Lecture
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Joshi, V.K. and Singh, R.S., A, Food Biotechnology- Principles and practices, I.K.International Publishing House Pvt. Ltd., New Delhi, 2013.
2. Ravishankar Rai, V, Advances in Food Biotechnology, (First edition), John Wiley & Sons, Inc, 2015.

3. Foster, G.N., Food Biotechnology, (First edition), CBS Publishers & Distributors Pvt Ltd, 2020.

Reference

1. Sivasankar, B.,Food Processing and Preservation, Prentice Hall of India Pvt.Ltd., New Delhi. 2002.
2. P J Fellows, Food Processing Technology, 3rd Edition, Woodhead Publishing, 2009
3. Gould G. W. New Methods of Food Preservation, Springer U.S ,1995.
4. Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin, Food Biotechnology, 2 nd edition, CRC Press,2005.
5. Perry Johnson-Green, Introduction to Food Biotechnology, Special Indian Edition, CRC Press, 2018.

Course designed by: Mrs. Vigimol T. Varghese

SBU24BT3DSE201: BIOPHYSICS AND BASIC TECHNIQUES

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Define the characteristics of atomic structure and properties of bonding in molecules.	U
CO2	Recall the basic concepts of thermodynamics and bioenergetics in biological system.	U
CO3	Describe the structure, properties and biological importance of water along with its fluid properties.	U
CO4	Discuss the structural features and kinetics of nucleic acid and proteins	U
CO5	Demonstrate the basic principle and applications of different separation and analytical techniques.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	-	-	1	2	-	-	-	-
CO2	2	1	-	-	1	2	-	-	-	-
CO3	2	2	-	-	1	2	-	-	-	-
CO4	2	1	-	-	1	2	-	-	-	-
CO5	2	2	-	-	1	2	1	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Poster	Viva	Exam 1	Exam 2	
CO1	-	-	x	x	-	x
CO2	x	-	x	x	-	x
CO3	-	-	x	-	x	x
CO4	-	x	x	-	x	x
CO5	-	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Atomic and Molecular Structure (12Hrs)				
Structure of atom, Schrödinger's theory, Quantum numbers	1.1	1	3	Lecture & Discussion
Pauli's exclusion principle, Hund's rule	1.2	1	2	Lecture & Discussion

Concept of bonding and valency	1.3	1	2	Lecture & Discussion
Hybridizations of carbon, nitrogen and oxygen, secondary bonding and weak interactions	1.4	1	3	Lecture & Discussion
Bond lengths, bond energies and bond angles	1.5	1	2	Lecture & Discussion
Module 2: Thermodynamics and Bioenergetics (12Hrs)				
Laws of thermodynamics	2.1	2	3	Lecture & Discussion
Concept of free energy, unavailable energy, entropy	2.2	2	1	Lecture & Discussion
Thermodynamic equilibrium, redox potential, oxidation-reduction reactions and redox potential, chemical kinetics – rate, order, molecularity of reactions and energy of activation.	2.3	2	2	Lecture & Discussion
Biological systems as open, non-equilibrium systems	2.4	2	1	Lecture & Discussion
Energy generation and energy transfer processes in biochemical reactions	2.5	2	2	Lecture & Discussion
High energy compounds	2.6	2	1	Lecture & Discussion
Energy requirements in cell metabolism- structure and role of mitochondria	2.7	2	2	Lecture & Discussion
Module 3: Biophysics of Water (12Hrs)				
Molecular structure and bonding in water, water as a liquid and solvent	3.1	3	3	Lecture & Discussion
Physicochemical properties of water, surface tension, viscosity	3.2	3	3	Lecture & Discussion
State of water in biostructures and its significance	3.3	3	2	Lecture & Discussion
Aqueous Environment of the cell- protein hydration, the hydration shell, specific roles of water in protein structure and function; involvement of bound water in catalytic action; water and nucleic acids.	3.4	3	4	Lecture & Discussion
Module 4: Proteins and Nucleic Acids (10Hrs)				
Nucleic acids: Watson and Crick model of DNA	4.1	4	1	Lecture & Discussion
DNA polymorphism	4.2	4	1	Lecture
Non-canonical forms of DNA- triple helix DNA, G-quartet	4.3	4	1	Lecture
DNA supercoiling	4.4	4	2	Lecture
Proteins: different level of protein structure - primary, secondary, tertiary and quaternary	4.5	4	2	Lecture & Discussion
Ramachandran plot	4.6	4	1	Lecture
Motifs, domains	4.7	4	1	Lecture
Protein-protein interaction	4.8	4	1	Lecture
Module 5: Instrumentation Techniques (14Hrs)				
Basic principle of pH meter, potentiometer	5.1	5	2	Lecture

Colorimetry, dialysis and ultrafiltration	5.2	5	2	Lecture
Centrifugation- basic principles and types	5.3	5	2	Lecture
Chromatography- basic concepts of adsorption and partition chromatography- paper and column chromatography	5.4	5	3	Lecture
Electrophoresis-principle and types (outline study of AGE, PAGE)	5.5	5	3	Lecture
Basic concepts of microscopy and spectroscopy- UV-visible spectroscopy.	5.6	5	2	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Avinash Upadhyay, Kakoli Upadhyay and Nirmaledu Nath: Biophysical Chemistry (Principles and techniques): Revised Edition: Himalaya publishing House: 2009.
2. Keith Wilson, John Walker: Principles and Techniques of Biochemistry & Molecular Biology: 7th edition: Cambridge University Press: 2010.

Reference

1. Rodney Cotterill, Biophysics: An Introduction, Ist edition, Wiley Publisher, 2002.
2. Roland Glaser, Biophysics, 5th edition, Springer, 2001.
3. Vasantha Pattabhi, N. Gautham, Biophysics, Kluwer Academic, Narosa, 2002.
4. Jose Luis R. Arrondo, Alicia Alonso, Advanced Techniques in Biophysics, 1 st edition: Springer, 2006.
5. Pranav Kumar, Fundamental & Techniques of Biophysics & Molecular Biolog,: 2nd edition, Pathfinder Publication, 2018.

Course designed by: Shija Jacob

SBU24BT3MDC200: NUTRITIONAL BIOTECHNOLOGY

Type of Course	MDC		
Course Level	200 – 299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain basics of nutrition and diseases associated with nutrition	U
CO2	Describe genetically modified foods and its advantages and disadvantages	R
CO3	Explain various methods for enhancing the nutritional quality of foods	U
CO4	Describe various methods for the removal of toxic content from food	R
CO5	Explain Nutrigenetics and Nutrigenomics	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	1	-	-	1
CO2	2	-	2	-	2	2	1	-	-	1
CO3	2	-	2	-	2	2	1	-	-	1
CO4	2	-	2	-	2	2	1	-	-	1
CO5	2	-	2	-	2	2	1	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Oral presentation	Exam 1	Exam 2	
CO1	-	x	x	x	-	x
CO2	-	x	-	x	-	x
CO3	-	x	x	-	x	x
CO4	-	x	x	-	x	x
CO5	-	x	x	-	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basics of Nutrition and Diseases Associated with Nutrition (10 Hrs)				
Energy content of foods. Factors affecting energy expenditure and requirements, - Energy imbalance.	1.1	1	2	Lecture
Calorific value, definition of BMR and SDA and their affecting factors, Respiratory quotient, RDA, calorigenic action of the foods.	1.2	1	4	Lecture

Disorders related to nutrition- Starvation, underweight, Obesity, genetic and environmental factors leading to obesity, management of obesity, Malnutrition- Marasmus and Kwashiorker	1.3	1	4	Lecture
Module 2: Genetically Modified Food (10 Hrs)				
Genetically modified food: Risks, public perception- facts and myths. Bovine Somatotropin in Milk; Chymosin -Lite beer. Transgenic plants-tomato. Methionine-enriched oil. Frost-resistant food.	2.1	2	4	Lecture, Discussion
Insect Resistance-Bacillus thuringiensis toxin - B.t. maize Plant Pharmaceuticals -beta -carotene in rice. Edible vaccines -Hepatitis B vaccine in maize-Cholera vaccine in potatoes.	2.2	2	4	Lecture, Discussion
Transgenic Animals -Growth hormone gene in pigs - alpha-lactalbumin and lactoferrin in milk; Transgenic Fish -Atlantic salmon.	2.3	2	2	Lecture Discussion
Module 3: Enhancing the Nutritional Quality of Foods (10 Hrs)				
Biofortification, manipulation of fatty acid composition of oils, increasing the content of methionine and lysine in feed storage proteins and increasing the levels of vitamins and minerals.	3.1	3	4	Lecture
Increasing the shelf life of the fruits. Development of food value metabolites, sweeteners etc.	3.2	3	4	Lecture
Animal biotechnology for increasing meat quality and meat production	3.3	3	2	Lecture
Module 4: Removal of Toxic Content from Food (5 Hrs)				
Removal or minimizing the phytate, oxalic acids and neurotoxins.	4.1	4	3	Lecture
Decreasing the contents of pesticides, herbicides and heavy metals.	4.2	4	2	Lecture
Module 5: Nutrigenetics and Nutrigenomics (10 Hrs)				
Nutrigenetics, Nutrigenomics, its aims and advantages, Nutrient-gene interactions. The effect of nutrients in genetic and epigenetic events	5.1	5	5	Lecture
Nutrigenomics and personalized nutrition. The challenges in applying nutrigenomic data to nutrition	5.2	5	5	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. M.N. Chatterjea and R. Shindea, A Text Book of Medical Biochemistry, Jaypee pub, 2016.
2. C. C. Chatterjee,Human Physiology, Medical Allied Agency,2017
3. Byong H.Lee, Fundamentals of food biotechnology, Wiley-Blackwell, 2015.

Reference

1. Medical Physiology- A.C. Guyton and J. E. Hall, Saunders pub.2011

2. Lindsay, Willis Biotechnology, Challenges for the flavour and food industries, Elsevier Applied Science, 1988
3. Roger A., Gorden B., and John T., Food Biotechnology, 1989
4. George J.B, Basic Food Microbiology, CBS Publishers & Distributors, 1987

Course designed by: Dr Manju Antony

SBU24BT3VAC200: INNOVATION AND TECHNOLOGY TRANSFER FOR SCIENCE

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the concepts, historical evolution and key stoke holders of innovation and technology transfer	U
CO2	Interpret the role of Intellectual Property Rights in technology transfer	U
CO3	Infer effective commercialization strategies for innovations	U
CO4	Explain different technology transfer mechanisms	U
CO5	Understand policy and legal frameworks impacting technology transfer	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	1	-	1	1
CO2	2	-	2	-	2	2	1	-	-	1
CO3	2	-	2	-	2	2	1	-	1	-
CO4	2	2	2	-	2	2	1	-	-	-
CO5	2	2	2	-	2	2	1	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Oral presentation	Assignments	Viva	Exam 1	Exam 2	
CO1	-	-	x	x	x	x
CO2	-	x	x	x	x	x
CO3	-	-	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	x	-	-	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Innovation and Technology Transfer (8 Hrs)				
Understanding the concepts of innovation and technology transfer, Historical perspectives and evolution of technology transfer	1.1	1	3	Lecture

Importance and benefits of technology transfer for economic development	1.2	1	2	Lecture
Key stakeholders involved in the technology transfer process, Case studies highlighting successful technology transfer initiatives	1.3	1	3	Video lecture
Module 2: Intellectual Property Rights (IPR) and Technology Transfer (8 Hrs)				
Overview of intellectual property rights (patents, copyrights, trademarks, etc.), Role of IPR in protecting and commercializing innovations	2.1	2	3	Lecture
Licensing agreements and their importance in technology transfer, Strategies for managing and maximizing value from intellectual property	2.2	2	3	Lecture
Ethical considerations and challenges in IP management and technology transfer	2.3	2	2	Lecture
Module 3: Commercialization Strategies (9 Hrs)				
Market analysis and identification of commercialization opportunities, Technology valuation methods and techniques	3.1	3	4	Lecture
Funding sources for technology commercialization (venture capital, grants, etc.), Business models for technology start-ups and spin-offs, Developing effective commercialization plans and strategies	3.2	3	5	Lecture
Module 4: Technology Transfer Mechanisms (11 Hrs)				
Overview of technology transfer mechanisms (licensing, joint ventures, spin-offs, etc.)	4.1	4	3	Lecture
Technology transfer offices (TTOs) and their role in facilitating technology transfer, Collaborative research agreements and partnerships	4.2	4	4	Lecture
Case studies on successful technology transfer mechanisms in various industries, Challenges and best practices in implementing technology transfer agreements	4.3	4	4	Lecture
Module 5: Policy and Legal Frameworks (9 Hrs)				
Government policies and regulations impacting technology transfer	5.1	5	3	Lecture
International treaties and agreements related to intellectual property and technology transfer, Role of universities, research institutions, and government agencies in technology transfer	5.2	5	3	Lecture
Legal considerations in drafting technology transfer agreements, Future trends and emerging issues in innovation and technology transfer	5.3	5	3	Lecture
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Thomas N. Duening, Robert A. Hisrich, and John S. Stewart, Technology Transfer: From Invention to Innovation, Academic Press, 2017.

2. Eric Ries . The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Currency, 2011.

Reference

1. Alexander Osterwalder, Yves Pigneur Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Wiley, 2010.
2. Arti Rai, Rebecca Eisenberg, Robert Cook-Deegan, Managing University Intellectual Property in the Public Interest, Cambridge University Press, 2010.
3. Thomas H. Byers, Richard C. Dorf, Andrew J. Nelson, Technology Ventures: From Idea to Enterprise, McGraw-Hill Education, 2020.

Course designed by: Shobin Varghese

SEMESTER IV

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BT4DSC201	Major	Molecular Biology	5	75	4
SBU24BT4DSC202	Major	Microbiology	5	75	4
SBU24BT4DSC203	Minor	Tissue Culture Technology	5	75	4
SBU24BT4DSE200	Elective	Neurobiology	4	60	4
SBU24BT4DSE201	Elective	Nanotechnology	4	60	4
SBU24BT4SEC200	SEC	Quality Control in Biology	3	45	3
SBU24BT4VAC200	VAC	Nutrition and Health	3	45	3

SBU24BT4DSC201: MOLECULAR BIOLOGY

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the characteristics of genetic material and outline the major contributions towards the finding of genetic material.	U
CO2	Describe the mechanism of replication and recombination in prokaryotes and eukaryotes.	U
CO3	Discuss molecular basis of mutation, types of mutations and DNA repair mechanisms.	U
CO4	Explain the concept of gene, genetic code, gene expression and different gene regulatory mechanisms in organisms.	U
CO5	Apply the procedure for the isolation, quantification/estimation and visualization of genetic material and solve the basic problems of molecular biology.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	-	1	2	-	-	-	-
CO2	2	2	-	-	1	2	-	-	-	-
CO3	2	2	-	-	1	2	-	-	-	-
CO4	2	2	-	-	1	2	-	-	-	-
CO5	2	2	-	2	1	2	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Poster	Viva-voce	Exam 1	Exam 2	
CO1	-	-	x	-	-	x
CO2	-	-	x	-	-	x
CO3	x	-	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Practical Assignment	Lab Involvement	Viva	Record	Lab Test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Genetic Material (5Hrs)				
Early studies on DNA (works of F. Miescher and Erwin Chargaff, Griffith's experiment, Avery, MacLeod and McCarty's experiment, Hershey and Chase experiment)	1.1	1	1	Lecture & Discussion
Discovery of RNA as the genetic material in some organisms (Heinz Fraenkal Conrat's experiment)	1.2	1	1	Lecture
Types of RNAs and their function (mRNA, tRNA, rRNA)	1.3	1	1	Lecture
Introduction to genetic material and characteristics of genetic material, features of Watson and Crick's model of DNA double helix	1.4	1	1	Lecture & Discussion
Different secondary structures (A, B and Z).	1.5	1	1	Lecture
Module 2: DNA Replication and Recombination (11Hrs)				
Suspected forms of DNA replication and Meselson and Stahl's Experiment	2.1	2	1	Lecture & Discussion
Prokaryotic DNA replication- requirements for replication; template, raw materials, enzymes and other proteins	2.2	2	3	Lecture
Eukaryotic DNA replication- requirements for replication; template, raw materials, enzymes and other proteins	2.3	2	3	Lecture
DNA replication inhibitors	2.4	2	1	Lecture
Recombination- homologous recombination and site specific recombination.	2.5	2	3	Lecture
Module 3: Mutation and DNA Repair (5Hrs)				
Molecular basis of gene mutation- mutagenesis and mutagens, types of mutations	3.1	3	2	Lecture & Discussion
DNA repair- mismatch repair, base excision repair, nucleotide excision repair	3.2	3	2	Lecture
Direct repair, photoreactivation, SOS response.	3.3	3	1	Lecture
Module 4: Transcription and Translation (11Hrs)				
Genetic code and its characteristics	4.1	4	2	Lecture
Mechanism of transcription in prokaryotes & eukaryotes	4.2	4	2	Lecture
Post transcriptional modification	4.3	4	1	Lecture
Translation in prokaryotes & eukaryotes	4.4	4	2	Lecture
Post translational modification	4.5	4	2	Lecture
Transcription and translation inhibitors	4.6	4	1	Lecture
mRNA surveillance.	4.7	4	1	Lecture
Module 5: Gene Regulation (13Hrs)				
Levels of gene regulation, gene regulation in bacterial cells	5.1	4	1	Lecture
Operon concept, negative and positive control, inducible and repressible operons- lac operon and trp operon of E.coli	5.2	4	4	Lecture
Gene regulations in eukaryotes: chromatin remodelling, histone acetylation, DNA methylation, alternative splicing of Mrna	5.3	4	3	Lecture
RNA silencing, Si RNA, mi RNA	5.4	4	1	Lecture

Transcriptional Control by hormones	5.5	4	2	Lecture
Regulation mediated through transcription factors, regulation of enhancer activity	5.6	4	1	Lecture
Epigenetics.	5.7	4	1	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Pal J.K. and Saroj Ghaskadbi, Fundamentals of Molecular Biology, Oxford University Press. India, 2009
2. U. Satyanarayana, U. Chakrapani, Biotechnology, 15th Edition, Books and Allied Private Limited, 2021

Reference

1. Benjamin Lewin, Genes XII, 12th edition, Jones and Barlett Inc. USA, 2017
2. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Molecular Biology of the Gene, 7th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA ,2014
3. Weaver R, Molecular Biology, 5th Edition, McGrew Hill Science. USA ,2011
4. Burton E Tropp, Molecular Biology: genes to proteins, 4th edition, Jones & Bartlett Learning, USA ,2011

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 7: Molecular Biology Practicals (30Hrs)				
Isolation of genomic DNA from plant	7.1	5	5	Lab Practice
Isolation of DNA from bacteria	7.2	5	5	Lab Practice
Isolation of RNA	7.3	5	7	Lab Practice
Estimation of DNA by diphenylamine method	7.4	5	5	Lab Practice
Estimation of RNA by orcinol method	7.5	5	5	Lab Practice
Problems	7.6	5	3	Lab Practice

Textbooks

1. Sambrook, Joseph, Molecular Cloning: a Laboratory Manual, Cold Spring Harbor Laboratory Press, 2001.

Reference

1. Primrose and Twyman, Principles of Gene Manipulation & Genomics, 7th Edition, Blackwell Publishing, USA, 2006.
2. A. Gerstein, Molecular Biology Problem solver: A laboratory guide, A John Wiley & Sons, Inc., Publication, USA, 2004.

Course designed by: Shija Jacob

SBU24BT4DSC202: MICROBIOLOGY

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Define basic concepts of Microbiology and classify microorganisms into different groups	U
CO2	Explain the ultrastructure of a prokaryotic cell and identify nutritional types of microorganisms and methods to culture and control microbes	U
CO3	Outline genetic recombination in prokaryotes	U
CO4	Interpret the morphology and multiplication of viruses	U
CO5	Apply knowledge of microbial identification, culturing and sterilization methods	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	-	2	1	-	1	-
CO2	2	-	-	-	-	2	1	-	1	-
CO3	2	-	-	-	-	2	1	-	1	-
CO4	2	-	2	2	-	2	1	-	1	1
CO5	2	-	2	2	-	2	1	-	1	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Oral Presentation	Exam 1	Exam 2	
CO1	-	x	-	x	x	x
CO2	x	x	-	x	x	x
CO3	-	x	x	-	x	x
CO4	-	x	x	x	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Microbiology and Diversity of Microbial World (5 Hrs)				
Microbiology: A brief historical prelude with milestones and scope of microbiology.Classification of microorganisms – general principles and nomenclature – Haeckel's three kingdom concept, Whittaker's five kingdom concept. Brief account of classification and characterization of bacteria according to Bergey's Manual of Systematic Bacteriology (9^{th} edition).	1.1	1	5	Lecture/ICT enable class
Module 2: Structure of Bacterial Cell (8 Hrs)				
Morphology of bacteria: Size range of bacterial cells, shape and arrangement of bacterial cells. Structures external to cell wall: Glycocalyx Cell wall: composition, structure, function of cell wall.	2.1	2	3	Lecture/ICT enable class
Flagella: structure of flagella, different types of arrangements of flagella, fimbriae and pili	2.2	2	2	Lecture/ICT enable class
Structures internal to cell wall: Plasma membrane - composition, structure and function, Spheroplast, cytoplasm, ribosome, nucleoid, plasmid, inclusions, endospores	2.3	2	3	Lecture/ICT enable class
Module 3: Microbial Staining Techniques (5 Hrs)				
Staining: Principle, Types - Simple staining, differential staining, Gram staining, acid fast staining and negative staining for capsules.	3.1	3	5	Lecture
Module 4: Culturing Bacteria (10 Hrs)				
Nutritional types of Microorganisms: phototrophs, chemotrophs, autotrophs, heterotrophs, obligate parasites.	4.1	4	3	Lecture
Microbial growth: Growth curve and generation time. Effect of environment on microbial growth: -Temperature, pH, water activity, oxygen concentration and salt concentration.	4.2	4	3	Lecture
Bacteriological Media: requirements of bacterial culture media, media types: simple, defined and differential. Methods to obtain pure culture: streak plate method, pour plate and spread plate. Measurement of bacterial growth: direct microscopic count and turbidometric method. Preserving bacterial culture: Glycerol stock, deep freezing and lyophilisation	4.3	4	4	Lecture
Module 5: Control of Microbial Growth (5 Hrs)				
Overview of Sterilization and methods of sterilization. Heat treatment: thermal death point, thermal death time, moist heat and dry heat. Radiation; Filtration: membrane filters. Chemical methods: alcohols, halogens and hypochlorites.	5.1	4	5	Lecture
Module 6: Genetic Recombination in Bacteria (4 Hrs)				
Genetic recombination in bacteria- Transformation, conjugation and transduction.	6.1	4	4	Lecture

Module 7: Viruses (8 Hrs)				
Characteristics of viruses, size range, host range.Classification and multiplication of viruses.Structure of viruses: general morphology, nucleic acids, capsid and envelope. Structure of TMV and Bacteriophage (λ). Culturing bacteriophages in the laboratory, culturing animal viruses: in living animals, in embryonated eggs and in cell cultures.Viral multiplication: Multiplication of bacteriophages; lytic cycle and lysogenic cycles.	7.1	4	8	Lecture
Module 8: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. G.J Tortora, B.R Funke, and C.L Case, Microbiology - An Introduction,11th Edition. Pearson Education,2012.
2. L.M Prescott, J.P Harley and D.A Klein, Microbiology ,5th edition, McGraw Hill, New York, 2003.
3. M.J Pelczar Jr, E.C. S Chan and Noel R Krieg, Microbiology, Mc. Graw Hill Inc, NewYork,2006.

Reference

1. James G. Cappucino and Natalie Sherman, Microbiology-A laboratory manual, The Benjamin (Cummings Publishing Company, Inc.),1996.
2. Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton: Prescott, Harley, and Klein's Microbiology, McGraw Hill Higher Education, 7th Edition, 2007.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 9: Sterilization & Staining procedures (8 Hrs)				
Cleaning and Sterilization of glasswares.	9.1	5	4	Lecture, Lab Practice
Staining of bacteria- Simple staining and Gram staining	9.2	5	4	Lab practice
Module 10: Culturing of Bacteria (12 hrs)				
Preparation of media- Nutrient Agar and Broth.	10.1	5	6	Lecture, Lab practice
Inoculation and culturing of bacteria in Nutrient agar.	10.2	5	4	Lab practice
Growth of Bacteria in liquid media.	10.3	5	2	Lab practice
Module 11: Culture purification& Enumeration of Bacteria from soil (10 Hrs)				
Purification techniques- streak plating methods- T streaking and Quadrant streaking.	11.1	5	5	Lab practice
Enumeration of bacteria in a given soil sample using pour plate method.	11.2	5	5	Lab practice

Textbooks

1. K R Aneja, Laboratory Manual of Microbiology and Biotechnology, Med tech Publication, 2014.
2. R.C Dubey and D.K Maheswari, A Text book of Microbiology, S. Chand & Company Ltd., New Delhi, 2005.

Reference

1. P Gunasekaran, Laboratory Manual in Microbiology, New Age International Private Limited,1995.

Course designed by: Shobin Varghese

SBU24BT4DSC203: TISSUE CULTURE TECHNOLOGY

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline the basic design and requirement of a plant tissue culture lab and to describe different tissue culture media and sterilization technique/procedures for maintaining aseptic conditions for plant growth.	U
CO2	Describe the types of plant tissue culture and its applications	U
CO3	Outline the basic design and requirement of an animal tissue culture lab and to describe different tissue culture media and sterilization technique/procedures for maintaining aseptic conditions	U
CO4	Describe the types of animal tissue culture and its applications	U
CO5	Apply the micropropagation techniques for plant propagation and immobilization technique for production of artificial seeds.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	1	-	-	1	-
CO2	2	-	2	-	2	1	-	-	1	-
CO3	2	-	2	-	2	1	-	-	1	-
CO4	2	-	2	-	2	1	-	-	1	-
CO5	-	-	-	2	2	1	-	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Oral presentation	Exam 1	Exam 2	
CO1	-	x	x	x	-	x
CO2	-	x	-	x	-	x
CO3	-	x	x	-	x	x
CO4	-	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab test	Viva	Record	Exam 1	Exam 2	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Plant cell culture (10 Hrs)				
Design and basic requirements of plant tissue culture lab	1.1	1	2	Lecture
Media preparation, sterilization technique in plant tissue culture	1.2	1	4	Lecture
Role of growth hormones, totipotency and Cyto-differentiation.	1.3	1	4	Lecture
Module 2: Types of Plant cell culture and Applications (15 Hrs)				
Callus culture, suspension culture and single cell. Somaclonal variation, organogenesis and embryogenesis.	2.1	1	10	Lecture
Meristem culture, Haploid production- Ovary, ovule, anther and pollen culture.	2.2	1	4	Lecture
Applications of plant cell culture	2.3	1,2	1	Lecture, Discussion
Module 3: Introduction to Animal Cell Culture (10 Hrs)				
Design and basic requirements of animal cell culture Laboratory. Cell culture media, Types and its composition	3.1	2	5	Lecture
Disaggregation of tissues, Primary cell culture, anchorage dependant and anchorage independant cell, Passaging. Secondary cell culture, cell lines-Types and characterisation of cell lines. Scale up of animal cell culture, Maintenance of cell culture	3.2	2	5	Lecture
Module 4: Applications of Animal Cell culture (10 Hrs)				
Applications of animal cell culture - Stem cells and their applications, Production of monoclonal antibodies, vaccines and pharmaceutical products	4.1	3,4	5	Lecture and Discussion
Transgenic animals: Mice, fish, and cow	4.2	4	5	Lecture and Discussion
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. M. K Razdan, Introduction to Plant Tissue Culture, Science Publishers Inc 2nd edition, 2003.
2. J. H Mantell, J. A. Matthews, McKee RA. Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants, Oxford Blackwell Scientific Publications 1985.
3. H.S Chawla, Introduction to Plant Biotechnology. 3rd edition, Oxford and IBH Publishing CO. Pvt. Ltd,2009
4. R. Sasidhara: Animal Biotechnology: MJP publishers,2006.
5. R. Ian Freshney, Culture of Animal Cells: A Manual of basic techniques and specialized applications, 7 th edition, Wiley-Blackwell, 2016.

Reference

1. Birbal Singh, Gorakh Mal, Sanjeev K Gautham, Manishi Mukesh: Advances in Animal Biotechnology, 1 st edition, Springer, 2019.
2. Ralf Portner: Animal Cell Biotechnology Methods & Protocols: 4 th edition, Springer US Humana, 2020.
3. Muhammad Abubakar, Ali Saeed, Oguz Kul(eds): The role of biotechnology in improvement of livestock Animal Health and Biotechnology, 1 st edition, Springer-Verlag Berlin Heidelberg, 2015
4. R. Keshavachandran, K.V Peter, Plant Biotechnology: Methods in Tissue Culture and Gene Transfer, Orient & Longman, Universal Press,2008.
5. B.D Singh, Biotechnology: Expanding Horizon. Kalyani Publications,2007.
6. John Hammond, Peter McGarvey, Vidaldi Yusibov, Plant Biotechnology: New Products and Applications, Springer-Verlag Berlin Heidelberg, 2000.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module: 6 Tissue culture technology (30 Hrs)				
Preparation of nutrient medium – Murashige and Skoog medium	6.1	5	6	Lab practice
Establishing shoot tip, axillary bud cultures	6.2	5	6	Lab practice
Determination of appropriate flower bud containing uninucleate pollen for anther	6.3	5	6	Lab practice
Immobilization of whole cells or tissues in sodium alginate	6.4	5	6	Lab practice
Isolation of lymphocytes from peripheral blood	6.5	5	6	Lab practice

Textbooks

1. Reinert J, M.M. Yeoman M M, Plant Cell and Tissue Culture: A Laboratory Manual, Springer.1982
2. Hirenkumar Sherathiya, Practical Manual for Plant Tissue Culture, Basic Techniques of Plant Tissue Culture and Molecular Biology, GRIN Verlag,2013.
3. R. Ian Freshney, Culture of Animal Cells, A Manual of basic techniques and specialized applications,7th edition, Wiley-Blackwell,2016.

Course designed by: Dr Manju Antony

SBU24BT4DSE200: NEUROBIOLOGY

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Identify and explain the structures of the central and peripheral nervous systems and to understand the role of neurons and other cells of nervous system in signal transmission, maintenance of neuronal environment and protection.	U
CO2	Understand the processes involved in the generation and propagation of action potentials along neurons and the role of ion channels in neurotransmission.	R
CO3	Discuss the major neurotransmitters and their functions in synaptic transmission, including their synthesis, release, and postsynaptic effects.	R
CO4	Explain how the nervous system processes sensory information, including the pathways and structures involved in vision, hearing, and other sensory modalities.	U
CO5	Identify and understand various disorders of the nervous system, including neurodegenerative diseases and to discuss ethical issues related to the field.	R

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	-	-	2	-	-	-	-
CO2	2	2	-	-	-	2	-	-	-	-
CO3	2	2	-	-	-	2	-	-	-	-
CO4	2	2	-	-	-	2	-	-	-	-
CO5	2	2	-	-	-	2	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ	Viva	Exam 1	Exam 2	
CO1	-	-	x	x	-	x
CO2	-	-	x	x	-	x
CO3	-	x	x	x	-	x
CO4	-	x	x	-	x	x
CO5	-	-	x	-	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Nervous system- an Overview (9 Hrs)				
Nervous system components - Central and peripheral nervous systems	1.1	1	2	Lecture
Cells of the nervous system- neurons and neuroglia	1.2	1	2	Lecture
General morphology of a typical neuron	1.3	1	1	Lecture
Classification of neurons	1.4	1	2	Lecture
Blood brain barrier	1.5	1	1	Lecture
Cerebrospinal fluid	1.6	1	1	Lecture
Module 2: Neuronal Signalling (10Hrs)				
Membrane potentials	2.1	2	2	Lecture
Ion channels and pumps	2.2	2	2	Lecture
Ionic basis of resting potential and action potential	2.3	2	2	Lecture
Propagation of action potential	2.4	2	2	Lecture
Recording neuronal signals – EEG, EMG	2.5	2	1	Lecture
Dynamic Brain Imaging: PET, MRI	2.6	2	1	Lecture
Module 3: Synaptic Transmission (14 Hrs)				
Synapse - structure and function	3.1	3	2	Lecture
Mechanisms for release and clearance of neurotransmitters	3.2	3	3	Lecture
Synapses- chemical and electrical synapses	3.3	3	2	Lecture
Synaptic potentials (graded potentials) and their integration (EPSP, IPSP)	3.4	3	3	Lecture
Molecular mechanism of synaptic transmission	3.5	3	2	Lecture
Synaptic delay, synaptic plasticity	3.6	3	1	Lecture
Myoneural junction	3.7	3	1	Lecture
Module 4: Neurotransmitters (12 Hrs)				
Synthesis, storage, release and metabolism of neurotransmitters	4.1	4	4	Lecture
Major neurotransmitters- acetylcholine, catecholamines, glutamate	4.2	4	3	Lecture
Major neurotransmitters - asparatic acid, GABA, glycine	4.3	4	3	Lecture
Neuropeptides, nitric oxide	4.4	4	2	Lecture
Module 5: Neural Processing, Neurodegenerative Disorders and Neuroethics (15 Hrs)				
Molecular biology of hearing	5.1	5	2	Lecture
Molecular biology of vision	5.2	5	2	Lecture
Molecular biology of olfaction and taste	5.3	5	2	Lecture
Learning and memory	5.4	5	2	Lecture
Neurodegenerative disorders -Parkinson’s disorder, Alzheimer’s disorder, Senile Dementia.	5.5	5	1	Lecture
Current treatments and emerging therapies	5.6	5	4	Lecture
Neuroethics- ethical considerations and challenges in neurodegenerative disease research	5.7	5	2	Lecture

Module 6: Teacher specific content

(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)

This content will be evaluated internally

Textbooks

1. George J. Siegel, Bernard W. Agranoff, R. Wayne Albers, Stephen K. Fisher& Michael D Uhler, Basic Neurochemistry. Molecular, Cellular and Medical aspects, 6th edition, Philadelphia: Lippincott-Raven, 1999.
2. John G. Nicholls, A. Robert Martin, Bruce G. Wallace & Paul A, From Neuron to Brain ,4th edition, Sinauer Associates, USA, 2000.

Reference

1. David J. Sidley & Peter R. Stanfield, lon channels. Molecules in Action ,1st edition, Cambridge University Press, 1996.
2. Gary G. Matthews, Neurobiology Molecules, Cells and System, 2nd edition, 2001.
3. Yadin Dudai, The Neurobiology of Memory, Concepts, Findings, Trends, Oxford University Press, 1989.
4. David J Aidley, The physiology of Excitable Cells, 2nd edition, Cambridge University Press, 1989.

Couse designed by: Dr. Lijy Jacob

SBU24BT4DSE201: NANOTECHNOLOGY

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain synthesize and characterization of nanoparticles with a desired property/application.	U
CO2	Discuss about the types of nanoparticles being used for Environmental and medical applications	U
CO3	Discuss about the types of nanoparticles and its applications in various Industries.	U
CO4	Comprehend the Ethical and Societal Issues in Nanotechnology Regulatory Frameworks and Guidelines.	U
CO5	Provide broad education necessary to understand Current Trends and Future Prospects	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	-	1	2	1	-	1	1
CO2	2	2	1	2	1	2	1	-	1	2
CO3	2	1	1	2	1	2	1	-	1	2
CO4	2	1	1	2	1	1	1	1`	1	2
CO5	2	1	1	1	1	2	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Quiz	Written test	MCQ	
CO1	-	x	x	x	x	x
CO2	-	x	x	-	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	-	x	x	-	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Nanotechnology (15 Hrs)				
Introduction to nano-size, Surface to volume ratio of nanoparticles,	1.1	1	3	Lecture
Generation of Nanotechnology- Classification of Nanomaterials, OD, 1D, 2D and 3D types of nanomaterials	1.2	1	6	Lecture

(Quantum dots, Quantum wires, Carbon Nano Tubes, Bucky balls, Quantum confinement (Quantum size effect), Fullerenes etc.)				
Synthesis of nanoparticles: Top down and bottom-up approaches and its characterizations	1.3	1	6	Lecture
Module 2: Nanotechnology in Environmental and Medical Applications (10 Hrs)				
Nanomaterials for Water Treatment Nanotechnology for Pollution Control Nanosensors for Environmental Monitoring Sustainability and Nanotechnology	2.1	2	2	Lecture /Demonstration
Polymeric and Protein nanostructures, DNA nanostructures,	2.2	2	2	Lecture
Dendrimers, Lipid based nanoparticles- Liposomes & solid lipid nanoparticles	2.3	3	2	Lecture
Nanoparticles for medical imaging; Nanotechnology for nerve regeneration.	2.4	3	2	Lecture
Nanoparticles for drug delivery – Targeted delivery, nanoparticles for crossing blood brain barrier; Nanoparticles in vaccines; Nanoparticles for gene delivery	2.5	3	2	Lecture
Module 3: Applications of Industrial Nanotechnology (10 Hrs)				
Introduction to nanocomposites, Applications in paints, coatings, and catalysts, Nanoelectronics and Nanophotonics - Semiconductor nanomaterials, Nanoelectronic devices, Nanophotonic applications	3.1	3	5	Lecture
Nanotechnology in energy- nanomaterials for solar cells, energy storage using nanotechnology, fuel cells and nanocatalysts.	3.2	3	5	Lecture
Module 4: Safety and Ethical Considerations (15 Hrs)				
Nanomaterial Safety Environmental and Health Risks Ethical and Societal Issues in Nanotechnology Regulatory Frameworks and Guidelines.	4.1	4	5	Lecture
Nanotoxicology – Potential risks due to nanoparticles to human health,	4.2	4	5	Lecture
Techniques to asses toxicity, Translation of medical nanotechnology to clinical practice –Nanotechnology translated to clinical practice, Challenges in translation.	4.3	4	5	Lecture
Module 5: Current Trends and Future Prospects (10 Hrs)				
Emerging trends in industrial nanotechnology. commercialization and business aspects, challenges and opportunities, future directions in nanotechnology research	5.1	5	10	Lecture
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Text book

1. Ratner, M. Ratner. D, Nanobiotechnology: A Gentle Introduction to the Next Big Idea, Prentice Hall,2015.

Reference

1. Jesse Adams, Sumita Pennathur, Ben Rogers, Nanotechnology: Understanding Small Systems, Third Edition, by CRC Press,2017.

2. Guozhang Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press, 2004.
3. Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press ,2008.
4. Harry F. Tibbals, Medical Nanotechnology and Nanomedicine, CRC Press,2010.
5. Claudio Nicolini, Nanobiotechnology & Nanobiosciences, Pan Stanford Publishing, Ltd.2009.

Course designed by: Mrs. Vigimol T. Varghese

SBU24BT4SEC200: QUALITY CONTROL IN BIOLOGY

Type of Course	SEC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the basic concepts of Biosafety, GMP, Aseptic Operation and containment.	U
CO2	Explain principles and practices followed in quality control in biology	U
CO3	Describe principles of quality assurance and quality control to food and beverage industries.	U
CO4	Discuss the quality control principles and guidelines in pharmaceutical industry for production and handling of products.	U
CO5	Summarize methods for documentation, assessing and evaluating the QC/QA norms for various industries	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	-	-	1	-
CO2	2	-	2	-	2	2	-	-	1	-
CO3	2	-	2	-	2	2	1	-	1	-
CO4	2	2	2	-	2	2	1	-	1	-
CO5	2	2	2	2	2	2	2	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Assignment	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	x	x
CO2	x	-	x	x	x	x
CO3	-	-	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	-	-	-	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Basic Concepts of Quality Control (11 Hrs)				
Quality Assurance, Quality Control, Role of Quality Assurance, QA testing, Role of Quality Control, Test for quality control. Practice of cGMP- Overview of ICH Guidelines – QSEM, with special emphasis on Q-series guidelines.	1.1	1	5	Lecture

Industrial Safety and Hazard Management in Bio-Technology & related industry - live viruses, bacteria.	1.2	1	2	Lecture
Aseptic Operation and Containment. Biosafety in Industrial Biotechnology. Health hazards in biotechnology, Freeze-drying of biohazardous products	1.3	1	4	Lecture
Module 2: Principles and Practices in Quality Control in Biology (6 Hrs)				
Quality assurance and Quality control in industry – basic principles involved. Good Manufacturing Practices and Hazard Analysis Critical Control Points (HACCP) in foods, cosmetics and pharmaceuticals. Skills required of a Quality Control Biologist as per national occupational standards	2.1	2	6	Lecture
Module 3: Quality Control in Food and Beverage Industry (11 Hrs)				
Microbiological criteria of food products, beverages and water. Microbial quality assurance, monitoring of factory hygiene and sanitation, microbiological quality of ingredients, processing and finished products with regard to specified standards.	3.1	3	5	Lecture
Quality assurance and validation principles and their applications in industries related to food and beverage. FDA rationale, Good Practices and documentation requirements	3.2	3	6	Lecture
Module 4: Quality Control of Microbial and Pharmaceutical Products (10 Hrs)				
International Biological standards, safety testing of pharmaceuticals, Quality control of antibiotics. Sterile Pharmaceutical Products: GMP aspects related to sterile products- General guidelines, personnel, building and premises, equipment, sanitation, processing, sterilization, Quality control and validation, Documentation.	4.1	4	5	Lecture
Introduction to Laboratory Safety Safe laboratory practices, regulatory agencies, handling & storage of chemicals, reagents, microbial specimens and its preservation. Quality control in Microbiology Laboratory, assessment of aseptic condition, evaluation of possible channels of contamination, QC /QA norms for handling pathological samples.	4.2	4	5	Lecture/ video
Module 5: Documentation, Assessment and Evaluation of QC / QA (7 Hrs)				
Document preparation for QC/QA norms of different sectors. Internal and external assessment methods, Quality management systems, evaluation and process improvement	5.1	5	7	Lecture
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Principles of Fermentation Technology, Second Edition, Pergamon,2013
2. James P. Agalloco, Frederick J. Carleton, Validation of Pharmaceutical Processes, Third Edition, CRC press,2013
3. Quality assurance of pharmaceuticals, A compendium of guidelines and related materials - Good manufacturing practices and inspection, 2nd edition, 2006

Reference

1. Kenneth E. Avis, Carmen M. Wagner, Vincent L. Wu, Biotechnology: Quality Assurance and Validation, CRC Press, 1998
2. Stephanie Clark, Stephanie Jung, Buddhi Lamsal, Food Processing: Principles and applications, 2nd Edition, Wiley publishers, 2014

Course designed by: Shobin Varghese

SBU24BT4VAC200: NUTRITION AND HEALTH

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the fundamentals of diet and nutrition and how they affect health.	U
CO2	Investigate the roles and functions of nutrients, as well as the effects of excess and deficiency.	U
CO3	Employ the knowledge on how to get the most out of the food resources that are accessible.	A
CO4	Describe the fundamental understanding of sufficient diet and nutrition to prepare meals without nutrient losses.	U
CO5	Discover and enhance the nutritional health of populations by interpreting and applying nutrition ideas.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1	-	1	2	1	-	1	-
CO2	2	1	1	-	1	2	1	-	1	-
CO3	2	1	1	-	1	2	1	-	1	-
CO4	2	1	1	-	1	2	1	-	1	-
CO5	2	1	1	1	2	2	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Quiz	Exam 1	Exam 2	
CO1	-	x	x	x	x	x
CO2	-	x	x	x	x	x
CO3	x	x	x	-	x	x
CO4	-	x	x	-	x	x
CO5	-	x	x	-	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basic Concepts in Food and Nutrition (5Hrs)				
Basic terms used in study of food and nutrition	1.1	1	1	Lecture
Understanding relationship between food, nutrition and health functions of food - physiological, psychological and social	1.2	1	4	Lecture

Module 2: Nutrients (10 Hrs)				
Functions, dietary sources and clinical manifestations of deficiency/excess of the following nutrients: carbohydrates, lipids and proteins	2.1	2	2	Lecture
Fat soluble vitamins - A, D, E and K	2.2	2	2	Lecture
Water soluble vitamins – Thiamine, Riboflavin, Niacin, Pyridoxine, Folate, Vitamin B12 And Vitamin C	2.3	2	4	Lecture
Macro and micro-Minerals in mineral nutrition	2.4	2	2	Lecture
Module 3: Food Groups (10 Hrs)				
Selection, nutritional contribution and changes during cooking of the following food groups: Cereals and pulses	3.1	3	2	Lecture
Fruits and vegetables	3.2	3	2	Lecture
Milk & milk products	3.3	3	2	Lecture
Eggs meat, poultry and fish fats and oils	3.4	3	4	Lecture
Module 4: Methods of Cooking and Preventing Nutrient Losses (10 Hrs)				
Dry, moist, frying and microwave cooking advantages, disadvantages.	4.1	4	5	Video /lecture
Effect of various methods of cooking on nutrients minimizing nutrient losses	4.2	4	5	Video /lecture
Module 5: Nutrition for Special Conditions (10 Hrs)				
Introduction to nutrition for physical fitness and sport	5.1	5	3	Video /lecture
Feeding problems in children with special needs	5.2	5	3	Video /lecture
Nutritional considerations during natural and man-made disasters: floods and war	5.3	5	4	Video /lecture
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. Mudambi, S.R and Rajagopal, M V. Fundamentals of foods, nutrition and diet therapy, fifth ed, New Age international publishers, 2012.

Reference

1. Mudambi, S. R, rao, S.M and Rajagopal, M.V. Food science, second ed,New age international publishers,2006
2. Srilakshmi, B. Nutrition science, New Age international (p) ltd,2012.
3. Srilakshmi, B. Food science, fourth ed, New Age international (p) ltd,2006.
4. Swaminathan, M. Hand book of foods and nutrition, fifth ed, bappco,1986.

Course designed by: Mrs. Vigimol T.Varghese

SEMESTER V

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BT5DSC300	Major/Minor	Plant Biotechnology	5	75	4
SBU24BT5DSC301	Major/Minor	Enzymology and Metabolism	5	75	4
SBU24BT5DSE300	Elective	Biotechnology and Entrepreneurship	4	60	4
SBU24BT5DSE301	Elective	Biosafety and Bioethics	4	60	4
SBU24BT5DSE302	Elective	Animal Biotechnology	4	60	4
SBU24BT5DSE303	Elective	Microbial Technology	4	60	4
SBU24BT5DSE304	Elective	Immunology	4	60	4
SBU24BT5SEC300	SEC	IPR and Patenting	3	45	3

SBU24BT5DSC300: PLANT BIOTECHNOLOGY

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline the basic concept of cellular totipotency, tissue culture media and sterilization technique used in plant tissue culture.	U
CO2	Describe different *in vitro* culture techniques for crop improvement.	U
CO3	Explain the methods/procedures for establishment of cell suspension culture for secondary metabolite production	U
CO4	Explain the process of genetic engineering for developing transgenic plants with novel traits and discuss biosafety and ethical issues related to it.	U
CO5	Apply learned methodologies for the preparation of plant tissue culture medium and develop skills needed for *in vitro* plant propagation.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	-	-	1	-
CO2	2	-	2	-	2	2	-	-	1	-
CO3	2	-	2	-	2	2	-	-	1	-
CO4	2	2	2	1	2	2	-	-	1	-
CO5	2	1	2	2	2	2	-	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Poster	Assignment	Oral presentation	Exam 1	Exam 2	
CO1	x	-	x	x	x	x
CO2	x	x	x	x	x	x
CO3	-	-	x	-	x	x
CO4	-	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical assignment	Viva	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Plant Tissue Culture (5 Hrs)				
History, Tissue culture media: Types, Composition and Preparations, culture conditions	1.1	1	2	Lecture
Basic requirements and layout of a tissue culture laboratory	1.2	1	1	Lecture
Aseptic techniques in tissue culture, Sterilization and agents of sterilization used in tissue culture labs	1.3	1	2	Lecture
Module 2: Types of Plant Tissue Culture (19 Hrs)				
Cellular totipotency, Callus culture	2.1	2	1	Lecture
Micropropagation, axillary bud proliferation, meristem culture, organogenesis, hardening, transplantation and field evaluation	2.2	2	3	Lecture
Somatic embryogenesis, Artificial seeds	2.3	2	2	Lecture
Soma clonal variation	2.4	2	2	Lecture
Haploid culture- anther, pollen and ovary culture	2.5	2	3	Lecture
Embryo culture and embryo rescue	2.6	2	1	Lecture
Cryopreservation of plant cells	2.7	2	1	Lecture
Protoplast isolation, osmoticum, protoplast purification, protoplast viability testing, protoplast culture techniques and medium.	2.8	2	3	Lecture
Somatic hybridization, spontaneous fusion, induced fusion, selection of hybrids, cybrids, applications of protoplast fusion.	2.9	2	3	Lecture
Module 3: Cell Suspension Culture and Secondary Metabolite Production (6 Hrs)				
Cell suspension culture: types, batch culture, continuous culture, Synchronization of cells in suspension culture	3.1	3	3	Lecture
Single cell culture	3.2	3	1	Lecture
Production of secondary metabolites, medium composition for secondary metabolite production, cell immobilization, biotransformation	3.3	3	2	Lecture
Module 4: Plant Genetic Engineering (15 Hrs)				
Genetic engineering: Vectors for plant transformation, *Agrobacterium tumefaciens*, features of Ti Plasmid, molecular mechanism of T-DNA transfer. Binary and Cointegrate vector systems	4.1	4	2	Lecture
Direct gene-transfer methods (particle bombardment, electroporation, PEG-mediated transformation, silicon carbide fibres) Chloroplast and mitochondrial DNA transformation	4.2	4	3	Lecture
Selectable markers and scorable markers	4.3	4	2	Lecture
Plant genome editing CRISPR-Cas9	4.4	4	2	Lecture
Generation of transgenic insect-resistant, disease-resistant, herbicide-resistant plants; increasing shelf life of fruits;	4.5	4	3	Lecture

provitamin A content enhancement in plants (e.g. Golden Rice)				
Molecular farming, Edible vaccines	4.6	4	1	Lecture
Biosafety issues, testing of transgenics, regulatory procedure for commercial approval. Ecological impact of transgenic plants	4.7	4	2	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Razdan M.K. Introduction to Plant Tissue Culture, Science Publishers Inc 2nd edition, 2003
2. Mantell JH, J. A. Matthews, McKee RA. Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants Oxford: Blackwell Scientific Publications, 1985.
3. Chawla, H. S. Introduction to Plant Biotechnology. 3rd edition, Oxford and IBH Publishing CO.Pvt.Ltd.,2009

Reference

1. Keshavachandran R & Peter KV. Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient & Longman, Universal Press,2008.
2. Singh BD. Biotechnology: Expanding Horizon. Kalyani Publications,2007.
3. John Hammond, Peter McGarvey, Vidaldi Yusibov, Plant Biotechnology: New Products and Applications, Springer-Verlag Berlin Heidelberg, 2000.

Practical (30 Hrs)

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Plant Biotechnology - practicals (30 Hrs)				
Preparation of nutrient medium – Murashige and Skoog medium	6.1	5	5	Lab Practice
Establishing shoot tip, axillary bud cultures	6.2	5	5	Lab Practice
Establishing cell suspension culture	6.3	5	5	Lab Practice
Immobilization of whole cells or tissues in sodium alginate.	6.4	5	5	Lab Practice
Protoplast isolation	6.5	5	5	Lab Practice
Establishment of the axenic culture of any one crop plant	6.6	5	5	Lab Practice

Textbooks

1. Reinert J, M.M. Yeoman M M, Plant Cell and Tissue Culture: A Laboratory Manual, Springer.1982
2. Hirenkumar Sherathiya, Practical Manual for Plant Tissue Culture, Basic Techniques of Plant Tissue Culture and Molecular Biology, GRIN Verlag,2013.

Course designed by: Dr. Reshma John

SBU24BT5DSC301: ENZYMOLOGY AND METABOLISM

Type of Course	Major/Minor		
Course Level	300 -399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline chemical nature of enzymes, catalytic properties and their role in metabolic reactions.	U
CO2	Describe models of enzyme action, factors influencing enzyme activity	U
CO3	Discuss different types of enzyme inhibitions and applications in various fields.	U
CO4	Explain the major metabolic pathways involved in the synthesis and breakdown of carbohydrates, lipids and proteins and to study the importance of electron transport chain synthesis of ATP under aerobic and anaerobic conditions.	U
CO5	Analyse quantitatively, the amount of proteins, lipids and carbohydrates in samples	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	-	1	2	-	-	-	-
CO2	2	2	-	-	1	2	-	-	-	-
CO3	2	2	-	-	1	2	-	-	-	-
CO4	2	2	-	-	1	2	-	-	-	-
CO5	2	2	-	-	1	2	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Assignment	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	-	x
CO2	x	-	x	x	-	x
CO3	-	x	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Lab involvement	Viva	Record	Lab Test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to enzymes (10 Hrs)				
General introduction to enzymes, nomenclature and classification of enzymes	1.1	1	2.5	Lecture
Chemical nature of enzymes, apoenzyme, holoenzyme, Coenzymes (FAD, NAD, PLP) and cofactors Non protein enzymes and metalloenzymes, Isozymes, abzymes, synzyme	1.2	1	3.5	Lecture
Isolation of enzymes from plant, animal and microbial sources (outline study), Criteria of purity of enzymes- specific activity, Enzyme units- katal and IU, Models of enzyme action - Lock and key model, induced fit model, Proenzymes	1.3	1	4	Lecture
Module 2: Enzyme kinetics (10 Hrs)				
Factors affecting enzyme activity- substrate concentration, enzyme concentration, pH and temperature (explanation with graphical representation), Michealis- Menten Equation, Km, Vmax, Lineweaver-Burk plot, Turnover number, kcat	2.1	2	3.5	Lecture
Reversible Inhibition of enzymes- competitive, non competitive and uncompetitive inhibition (explanation based on L-B plot)	2.2	3	3	Lecture
Irreversible Inhibition, Covalent modification of enzymes, Allosteric regulation of enzymes (eg: ATCase)	2.3	3	3.5	Lecture
Module 3: Carbohydrate metabolism (15 Hrs)				
Digestion and absorption of carbohydrates, glycolysis, fate of pyruvate in alcoholic fermentation	3.1	4	4	Lecture
Calculation of energy yield (as ATP) of aerobic and anaerobic oxidation of carbohydrates, substrate level phosphorylation	3.2	4	4.5	Lecture
Electron transport chain, oxidative phosphorylation	3.3	4	3.5	Lecture
Gluconeogenesis	3.4	4	3	Lecture
Module 4: Lipid and protein metabolism (10Hrs)				
Digestion and absorption of lipids β-oxidation of fatty acids, Biosynthesis of fatty acids- acetyl CoA carboxylase reaction, fatty acid synthase complex, formation of palmitate Cholesterol biosynthesis	4.1	4	6	Lecture
Digestion and absorption of proteins, Biodegradation of amino acids - decarboxylation, deamination and transamination of amino acids, Role of carbamoyl phosphate synthetase in amino acid metabolism, Urea cycle	4.2	4	4	Lecture
Module 5: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Trevor Palmer, Understanding Enzymes, Pearson, 2008.
2. Dixon, M and E. C. Webb, Enzyme inhibition and activation, Enzymes 3, 1979.
3. Lehninger, Nelson and Cox, Principles of Biochemistry, 5th Edition, W.H. Freeman & Company, 2008.
4. D. Voet & J.G. Voet, Biochemistry, 4th/3rd edition, Wiley, 2010.

Reference

1. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer. Biochemistry, W. H. Freeman, 2010.
2. Price, Nicholas C., and Lewis Stevens. Fundamentals of Enzymology, Second edition, Oxford Science Publications, New York, 2001.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Laboratory practice (30 Hrs)				
Estimation of reducing sugar by DNS method	6.1	5	6	Lab Practice
Estimation of sugar by anthrone method	6.2	5	6	Lab Practice
Estimation of protein by Biuret method	6.3	5	6	Lab Practice
Estimation of protein by Lowry's method	6.4	5	6	Lab Practice
Estimation of lipids by Zak's method	6.5	5	6	Lab Practice

Reference

1. P.G Gupta, Practical Manual of Biochemistry, CBS Publishers, 2017.
2. Ranjna Chawla, Practical Clinical Biochemistry: Methods and Interpretations, Jaypee Brothers Medical Publishers, 2014.
3. Holme, Fundamentals of Analytical Biochemistry, Academic Press,1998.

Course designed by: Dr. Lijy Jacob

SBU24BT5DSE300: BIOTECHNOLOGY AND ENTREPRENEURSHIP

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the principles and concepts of entrepreneurship of biotechnology and the role of innovation in the biotechnology industry	U
CO2	Summarize the factors that contribute to successful biotech entrepreneurship	U
CO3	Understand the importance of intellectual property rights, strategies and policies for promoting bioscience research and entrepreneurship	U
CO4	Understand the role of technology business incubation in fostering entrepreneurship in India including challenges and strategies for supporting social enterprise in the biotechnology field	U
CO5	Develop an entrepreneurial mindset and explore opportunities for innovation in the life sciences field and gain knowledge about the national and international perspectives on biotechnology and entrepreneurship	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	-	-	1	-
CO2	2	-	2	-	2	2	-	-	1	-
CO3	2	-	2	-	2	2	1	-	1	-
CO4	2	2	2	-	2	2	1	-	1	-
CO5	2	2	2	-	2	2	-	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignments	Viva	Oral Presentations	Exam 1	Exam 2	
CO1	-	x	x	x	x	x
CO2	-	x	x	x	x	x
CO3	x	x	x		x	x
CO4	x	x	-	-	x	x
CO5	-	-	-	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Fundamentals of Bioentrepreneurship (9 Hrs)				
Introduction and definition of Bioentrepreneurship; Historical perspective, Significance and scope of Bioentrepreneurship	1.1	1	3	Lecture
Link between Biotechnology and Entrepreneurship; Contributions to Economic Growth and Innovation Emerging trends and opportunities	1.2	1	3	Lecture
Key players and institutions in the Indian biotech industry	1.3	1	3	Lecture
Module 2: Bioentrepreneurial Characteristics and Development (14 Hrs)				
Essential Bioentrepreneurial Characteristics; Nature and importance of Entrepreneurs, Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology, Building resilience and Adaptability	2.1	2	6	Lecture
Identifying opportunities in biotechnology Business planning and strategy	2.2	2	4	Lecture
Small-Scale Development of Product; Ideation and Conceptualization; Research and Development in Bioentrepreneurship.	2.3	2	4	Lecture
Module 3: Legal, Ethical and Market Perspectives (12 Hrs)				
Intellectual Property Rights; Understanding Patents, Trademarks, and Copyrights; Legal and Ethical Implications	3.1	3	6	Lecture
Bioentrepreneurship Market Development; Market Research in Biotechnology; Branding and Marketing Strategies, global market trends and opportunities	3.2	3	6	Lecture
Module 4: Government and Global Influences (13 Hrs)				
The Role of the Indian Government in Bioentrepreneurship; Policies and Initiatives Supporting Bioentrepreneurs; Funding Opportunities and Grants; Foreign Investors in Bioentrepreneurship in India; Attracting Foreign Investment in Biotechnology; Global Partnerships and Collaborations.	4.1	4	7	Lecture
Support mechanisms for entrepreneurship (Bioentrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, funding agencies in India, biotech policy initiatives)	4.2	4	6	Lecture
Module 5: Specialized Biotechnologies and Global Outlook (12 Hrs)				
Biotech enterprises: Desirables in start-up, Setting up Small, Medium & Large scale industry, Quality control in Biotech industries, Location of an enterprise, steps for starting a small industry, incentives and subsidies, exploring export possibilities	5.1	5	12	Lecture, Video presentation, Case study
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Richard Dana Ono, The Business of Biotechnology: From the Bench of the Street, Butterworth- Heinemann, 1991
2. Martin Gross Mann, Entrepreneurship in Biotechnology: Managing for growth from start-up, 2003

Reference

1. D. Hyne, John Kapeleris, Innovation and entrepreneurship in biotechnology: Concepts, theories & cases, Edward Elgar Publishing House, 2006
1. Vasant Desai, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, 2005.
2. Yali Friedman, Best Practices in Biotechnology Education, Logos Press, 2008.

Course designed by: Shobin Varghese

SBU24BT5DSE301: BIOSAFETY AND BIOETHICS

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline the principles and guidelines of bioethics and biosafety in the field of Biotechnology	U
CO2	Demonstrate knowledge in challenges associated with handling, research and containment of live culture, disposal of infectious waste in laboratories and its impact on public health and environment.	U
CO3	Demonstrate knowledge on risk assessment strategies and regulations associated with research in the field of Biotechnology.	U
CO4	Explain international agreements, regulations and treaties related to Bioethics and Biosafety and its application in different fields of Biotechnology	U
CO5	Explain the ethical implications of cloning, medicine and research	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	2	1	2	-	-	-	1
CO2	2	2	-	2	1	2	-	-	-	1
CO3	2	2	-	2	1	2	-	-	-	1
CO4	2	2	-	2	1	2	-	-	-	1
CO5	2	2	-	2	1	2	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Assignment	Viva-voce	Exam 1	Exam 2	
CO1	x	-	x	x	-	x
CO2	x	-	x	x	-	x
CO3	-	-	x	-	x	x
CO4	-	x	x	-	x	x
CO5	-	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Biosafety: Introduction and Guidelines (12 Hrs)				
Introduction to biosafety and health hazards concerning Biotechnology	1.1	1	2	Lecture
Biological Safety Cabinets	1.2	1,2	2	Lecture

Introduction to the concept of containment level Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP)	1.3	1,2	3	Lecture
Concept of biosafety levels and their application in different laboratory settings	1.4	1,2	3	Lecture
Biosafety guidelines and regulations (National and International).	1.5	1,2	2	Lecture
Module 2: Risk Analysis and Guidelines (14 Hrs)				
GMOs/LMOs - Definition, Concerns and Challenges; Environmental release of GMOs	2.1	2,3	2	Lecture
Risk analysis; Risk assessment; Risk management and communication	2.2	2	3	Lecture
Overview of National regulations and international agreements - Cartagena Protocol	2.3	4	2	Lecture
Animal and human cloning and their ethical aspects; testing of drugs on human volunteers	2.4	4	2	Lecture
Public and Non-Governmental Organizations (NGOs) in Biosafety and protection of biodiversity	2.5	4	2	Lecture
Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC for GMO applications in food and agriculture.	2.6	4	3	Lecture
Module 3: Introduction to Bioethics (12 Hrs)				
Definition and history of Bioethics	3.1	4	0.5	Lecture
Scientific and legislative principles of Bioethics	3.2	4	1	Lecture
National and international biosafety regulations and its importance	3.3	4	2	Lecture
Bioethical issues - Ecological ethics, ethics related to research on human subjects and animal samples	3.4	4	2	Lecture
Ethical challenges related to access to medicines and the role of intellectual property rights in drug development	3.5	4	2	Lecture
Bio-safety- environmental impacts	3.6	4	1	Lecture
Biological weapons and their social and ethical implications	3.7	4	2	Lecture
NGOs for bioethics: Public sector organizations, private sector organizations and national NGOs.	3.8	4	1.5	Lecture
Module 4: Bioethics and Environmental Science (8 Hrs)				
Principles of environmental ethics: stewardship and sustainability of ecosystem	4.1	2	2	Lecture
Importance of biodiversity for ecosystem functioning and human well being	4.2	5	4	Lecture
Ethical considerations in bioprospecting and conservation of biodiversity	4.3	5	2	Lecture
Module 5: Bioethics in Cloning, Medicine and Research (14 Hrs)				
Protocols of ethical concerns related to prenatal diagnosis	5.1	5	1	Lecture
Gene therapy, Organ transplantation, xenotransplantation	5.2	5	3	Lecture
Ethics in patient care, Informed consent	5.3	5	1	Lecture
Permissions and Procedures in Animal Cloning	5.4	5	2	Lecture
Human cloning, risks and hopes in human cloning	5.5	5	1	Lecture
Stem cell research	5.6	5	2	Lecture
Human Genome Project	5.7	5	2	Lecture

Use of animals in research and testing, human volunteers for clinical research	5.8	5	2	Lecture
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Sasson A, Biotechnologies in developing countries present and future, UNESCO publishers, 1993.
2. H S Chawla, Introduction to Plant Biotechnology, 3rd edition, Oxford & IBH publishers,2020.
3. Shomini Parashar, Deepa Goel; IPR, Biosafety and Bioethics, Pearson India, 2013

Reference

1. Shaleesha A. Stanley, Bioethics, Wisdom Educational Service, 2010
2. U. Sathyanarayana, Biotechnology, Books and Allied (P) Limited, 2017.
3. B. D. Singh, Biotechnology, Kalyani publishers, 2009

Course designed by: Dr. Lijy Jacob

SBU24BT5DSE302: ANIMAL BIOTECHNOLOGY

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the basic concepts, laboratory requirements and different techniques of animal cell culture	U
CO2	Describe the importance and applications of animal cell culture in research and industrial field	U
CO3	Illustrate the importance of in vitro fertilization and artificial insemination in livestock improvement	U
CO4	Infer the basic concepts of cloning, transgenesis and identify the various social and ethical issuesassociated with the technique.	U
CO5	Explain the methods in gene therapy and its application in the treatment of various diseases.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1	1	1	2	1	-	-	-
CO2	2	-	1	1	1	2	-	-	-	-
CO3	2	1	1	-	1	2	-	-	-	-
CO4	2	1	1	1	1	2	-	-	-	-
CO5	2	1	1	-	1	2	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Poster	Viva	Exam 1	Exam 2	
CO1	-	-	x	x	-	x
CO2	x	-	x	-	x	x
CO3	-	-	x	x	-	x
CO4	-	x	x	-	x	x
CO5	-	-	x	-	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basics of Animal Cell Culture (15 Hrs)				
Structure of animal cell	1.1	1	1	Lecture & Discussion
History of animal cell culture	1.2	1	1	Lecture

Infrastructure requirements for a cell culture lab	1.3	1	2	Lecture
Cell culture media- composition and types with examples	1.4	1	2	Lecture
Cell culture- types, behaviour of cells in culture conditions, division, their growth pattern and quantitation	1.5	1	2	Lecture
Hayflick's limit	1.6	1	1	Lecture
Common cell culture contaminants	1.7	1	1	Lecture
Cell lines types- finite and continuous cell lines, characterization and maintenance of cell lines	1.8	1	2	Lecture
Properties of stem cells- adult and embryonic stem cell culture	1.9	1	1	Lecture
Three dimensional culture: organ culture, histotypic culture, organotypic culture, microfluidics 3D culture.	1.10	1	2	Lecture
Module 2: Applications of Animal Cell Culture (6 Hrs)				
Application of animal cell culture for in vitro testing of drugs and cytotoxicity assay, testing of toxicity of environmental pollutants in cell culture	2.1	2	3	Lecture
Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.	2.2	2	3	Lecture
Module 3: In vitro Fertilization and Animal Cloning (15 Hrs)				
Structure of sperms and ovum	3.1	3	1	Lecture & Discussion
Cryopreservation of sperms and ova of livestock	3.2	3	1	Lecture
Genetic characterization of livestock breeds, marker assisted breeding of livestock	3.3	3	2	Lecture
Artificial insemination, super ovulation, in vitro fertilization	3.4	3	3	Lecture
Culture of embryos, cryopreservation of embryos, embryo transfer, embryo- splitting	3.5	3	2	Lecture
Basic concepts of animal cloning	3.6	4	1	Lecture
Cloning from embryonic cells and adult cells, cloning of different animals	3.7	4	3	Lecture
Cloning for conservation of endangered species	3.8	4	1	Lecture
Ethical, social and moral issues related to cloning.	3.9	4	1	Lecture
Module 4: Transgenic Animals (15 Hrs)				
Transgenic manipulation of animal embryos	4.1	4	4	Lecture
Gene transfer: vector mediated (animal viral vectors)	4.2	4	4	Lecture
Gene knock out technology	4.3	4	2	Lecture
Applications of transgenic animal technology- transgenic animal for human health purpose- animal models for human diseases, biopharming, xenotransplantation	4.4	4	4	Lecture
Ethical, social and moral issues related to the production of transgenic animals.	4.5	4	1	Lecture
Module 5: Gene Therapy (9 Hrs)				
Gene therapy, initial trials and observations, current status of gene therapy	5.1	5	2	Lecture
Types of gene therapy- somatic cell therapy, germline therapy, gene augmentation therapy, gene replacement therapy	5.2	5	3	Lecture

Ex vivo and In vivo gene therapy-candidate diseases for gene therapy	5.3	5	1	Lecture
Cell based gene therapy: CAR T cell therapy, RNA therapy, epigenetic therapy.	5.4	5	3	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. R. Sasidhara, Animal Biotechnology, MJP publishers, 2006.
2. R. Ian Freshney, Culture of Animal Cells: A Manual of basic techniques and specialized applications, 7 th edition, Wiley-Blackwell, 2016.

Reference

1. Birbal Singh, Gorakh Mal, Sanjeev K Gautham, Manishi Mukesh, Advances in Animal Biotechnology, 1st edition, Springer, 2019.
2. Ralf Portner, Animal Cell Biotechnology Methods & Protocols, 4thedition, Springer US; Human, 2020.
3. Muhammad Abubakar, Ali Saeed, Oguz Kul(eds), The role of biotechnology in improvement of livestock; Animal Health and Biotechnology, 1st edition, Springer- Verlag Berlin Heidelberg,2015.
4. Butler, M, Animal cell culture and technology: The basics, 2nd Edition, Bios scientific publishers, 2004.

Course designed by: Shija Jacob

SBU24BT5DSE303: MICROBIAL TECHNOLOGY

Type of Course	DSE		
Course Level	300 – 399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the methods for studying microbial genome and describe how metabolic & protein engineering help to enhance the production of microbial metabolites	U
CO2	Describe the methods, process & production of various microbial based food and dairy products also students have able to explain microbes are food for animal and human	U
CO3	Explain the role of microbes as biofertilizer, biopesticide, fungicide, and herbicide and also able to describe the various plant microbe interactions	U
CO4	Explain the methods and mechanism of microbes apply to protect various environmental sector.	U
CO5	Illustrate the utilization of microbes in the production of industrial and pharmaceutical products	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	1	-	-	1
CO2	2	-	2	-	2	2	1	-	-	1
CO3	2	-	2	-	2	2	1	-	-	1
CO4	2	-	2	-	2	2	1	-	-	1
CO5	2	-	2	-	2	2	1	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Oral presentation	Exam 1	Exam 2	
CO1	x	x	x	x	-	x
CO2	-	x	-	x	-	x
CO3	-	x	x	-	x	x
CO4	-	x	x	-	x	x
CO5	-	x	x	-	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Microbial Genomics (10 Hrs)				
Introduction to Microbial genomics	1.1	1	1	Lecture

Structural Genomics, Functional genomics, Comparative Genomics, Meta Genomics - Genome analysis of extremophiles	1.2	1	4	Lecture
Metabolic engineering and protein engineering for optimization of microbial products	1.3	1	5	Lecture
Module 2: Microbes in Food & Dairy Industry (15 Hrs)				
Fermented foods-Introduction, Role & Advantages of fermented foods.	2.1	2	3	Lecture
Production of cheese, yoghurt, koji & Idli. Knowledge of other fermented dairy products. Single cell proteins-algae, bacteria, fungi, yeast & actinomycetes.	2.2	2	8	Lecture
Alcoholic beverages-Distilled and non distilled, Production of beer, wine & ethanol. Microbe as animal feed additives. Probiotics, Prebiotic & Synbiotics	2.3	2	4	Lecture
Module 3: Microbes in Agriculture (15 Hrs)				
Nitrogen fixation; Symbiotic & Non symbiotic Mechanism	3.1	3	3	Lecture
Biofertilizers-Rhizobium, Azolla, Azospirillum, Algal Biofertilizers; Phosphate solubilizing microorganisms	3.2	3	6	Lecture
Microbial biopesticide, biofungicide and herbicide Micorrhiza; Plant –Microbe Interactions.	3.3	3	6	Lecture
Module 4: Microbes & Environment (10 Hrs)				
Biotechnology and pollution control; Use of immobilized microbial cell & enzyme in waste water treatment.	4.1	4	4	Lecture
Microbial biotransformation-Steroid, Microbial degradation of Herbicides, Insecticides & Pesticides; Bioremediation & Bioleaching	4.2	4	6	Lecture
Module 5: Industrial & Pharmaceutical Applications (10 Hrs)				
Methanogens & Biogas Production; Microbial Hydrogen production	5.1	5	2	Lecture
Microbes in plastic industry - Bioplastics; Microbial biosensors- Micro oxygen electrode. Biochips; Biofilm; Bioactive compounds from microbes.	5.2	5	4	Lecture
Bioethanol & biodiesel production. Microorganism for Bioassay & as Bio weapon	5.3	5	4	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Peppler H.J. and Periman D, Microbial Technology, Vol. 1 microbial processes, Academic Press, 1979.
2. Perman, D., Advance in Applied Microbiology, Vol. 25, Academic Press,1979.
3. Stansbury and Whittaker, Principles of Fermentation Technology. Pergamon Press, 2006.
4. Alexander N Glazer & Hiroshi Nikaido, Microbial Biotechnology Cambridge University Press, 2007.

Reference

1. Y. Murroka, T. Imanuka, Recombinant microbes for industrial and agricultural application (eds), Marcel Dekker Inc,1994.

2. Demain, A.L. and Soloman INA Manual of Industrial Microbiology and Biotechnology, American society for Microbiology, Washington DC, 1986.
3. Crueger and Crueger, A, Biotechnology: A text book of Industrial Microbiology, 2nd edition, Sinavos association, InoSundeland, 1989.
4. Kumar, Sachin, Sani, and Rajesh K, Biorefining of Biomass to Biofuels, Springer Publisher, 2018.
5. MejdiJeguirim and Lionel Limousy, Biomass Chars: Elaboration, Characterization and Applications, MDPI Books Publisher, 2018.

Course designed by: Dr Manju Antony

SBU24BT5DSE304: IMMUNOLOGY

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the fundamental aspects of innate and adaptive immunity; organization and the role of the various cells and organs of the immune system.	U
CO2	Discuss the molecular and cellular mechanisms involved in initiation of specific immune responses.	U
CO3	Explain the principles of immunology, applications in human life and analyze the results of an immunological test.	U
CO4	Outline the immunological mechanisms underlying immunodeficiency, autoimmunity, hypersensitivity, and transplant rejection.	U
CO5	Discuss the types of vaccines now in use and the approaches used to create future vaccinations.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	1	2	2	-	-	2
CO2	2	-	1	-	1	2	2	-	-	2
CO3	2	-	1	1	1	2	1	-	-	1
CO4	2	-	1	-	1	2	1	-	-	1
CO5	2	-	1	-	1	2	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Oral presentations	Exam 1	Exam 2	
CO1	x	-	x	x	x	x
CO2	x	-	x	x	x	x
CO3	-	-	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Immunology (7 Hrs)				
History and scope of immunology. Types of immunity – Innate and acquired immunity.	1.1	1	1	Lecture

Innate immune cells and functions; phagocytosis-pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); cytokines, complement and inflammatory responses.	1.2	1	3	Lecture
Cells and organs of the immune system.	1.3	1	3	Lecture
Module 2: Humoral and Cell Mediated Immunity (18 Hrs)				
Antigens: Antigenicity, Epitopes.	2.1	2	2	Lecture
Antibodies: Immunoglobulin – structure, classes and functions. Genetic basis of antibody diversity. Organization and Expression of Immunoglobulin Genes, V(D)J rearrangements	2.2	2	5	Lecture
Humoral and cell mediated immune response: Primary and secondary immune modulation, Clonal selection theory.	2.3	2	2	Lecture
Activation of T cells: MHC, receptors on T and B cells. T-cell function, Cell mediated immune response; CTL mediated, NK cells, ADCC.	2.4	2	3	Lecture
B-cell and T-cell maturation and differentiation.	2.5	2	6	Lecture
Module 3: Antigen Antibody Interactions (15 Hrs)				
Antigen Antibody reactions and types: Agglutination and Precipitation and complement mediated immune reactions.	3.1	3	4	Lecture
Advanced immunological techniques - RIA, ELISA, ELISPOT assay, Complement fixation, Western blotting immunofluorescence, flow cytometry and immunoelectron microscopy	3.2	3	8	Lecture
Immunodiffusion, Immunoelectrophoresis	3.3	3	3	Lecture
Module 4: Immunological Disorders (12 Hrs)				
Hypersensitivity	4.1	4	2	Lecture
Transplantation immunology, immunohematology	4.2	4	4	Lecture
Tumour immunology	4.3	4	2	Lecture
Autoimmunity and autoimmune diseases.	4.4	4	2	Lecture
Immunodeficiency diseases.	4.5	4	2	Lecture
Module 5: Applications of immunology (8 Hrs)				
Vaccines-Live, Attenuated vaccines, “Inactivated” or “killed” vaccines, Subunit vaccines, Conjugate vaccines, DNA vaccines.	5.1	5	2	Lecture
Recent trends in vaccine preparation	5.2	5	2	Lecture
Polyclonal and monoclonal antibody production – Hybridoma technology. Antibody engineering.	5.3	5	4	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Ananthanarayanan.R and Jayaram Panicker C.K, Text book of Microbiology, Second Edition, Orient Longman, 2008.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K and Walter, P. Molecular Biology of the Cell ,4th ed, Garland Science, 2003.

3. Michael J. Pelczar ECS, Chan and Noel R, Kreig, Microbiology 5th edition, Tata McGraw Hill,1996.
4. Park, K., Parks, Text Book of Preventive and Social Medicine, 17th Edition. Banarasidass Bhenot Publications,2002.
5. Sharma, K, Manual of Microbiology: Tools and Techniques. 2nd Edition. Anes Book's Pvt. Ltd., New Delhi, 2009.

Reference

1. Kindt, T. J., Goldsby, R. A. And Osborne, B. A Kuby Immunology,6th ed, W.H. Freeman and Company, 2007.
2. Frank, S. A, Immunology and Evolution of Infectious Disease. Princeton University Press.,2002.
3. Male, D., Brostoff, J., Roth, D. B and Roitt, I, Roitt's Essential Immunology 13th ed. Wiley,2016.
4. Murphy, K., Travers, P., and Walport, M, Janeway's Immunobiology ,8th ed, Garland Science, 2012.
5. Tortora, Funk and Case, Microbiology: An Introduction, Benjamin Cummings Publishing Company, 1998.
6. Tizard I.R., Immunology, 4th edition, W.B. Saunders Publisher. Philadelphia,1995.

Course designed by: Tessmol P. George

SBU24BT5SEC300: IPR AND PATENTING

Type of Course	SEC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the concept and importance of IPR (Intellectual Property Rights)	U
CO2	Discuss the concepts and procedure of copyright and trademark	U
CO3	Distinguish the basics and concepts of trade secrets, industrial designs and geographical indications.	U
CO4	Demonstrate the basic concepts of patent, patent laws in India, Rights and obligations of a Patentee and infer the procedure of patenting	U
CO5	Enlist the criteria and modes of infringement and enforcement infringement	R

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	1	1	2	-	-	-	-
CO2	2	-	-	1	1	2	-	-	-	-
CO3	2	-	-	1	1	2	-	-	-	-
CO4	2	-	-	2	1	2	-	-	-	-
CO5	2	-	-	-	1	2	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Poster	Viva	Exam 1	Exam 2	
CO1	-	-	x	x	-	x
CO2	-	-	x	x	-	x
CO3	-	-	x	x	x	x
CO4	-	x	x	-	x	x
CO5	-	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to IPR (Intellectual Property Rights) (9Hrs)				
Origin and Development of IPR – historical and theoretical basis for protection of IPR	1.1	1	2	Lecture
Types of intellectual property- industrial property, artistic and literary property, sui generis systems	1.2	1	1	Lecture
Need for protecting IP, IPR laws	1.3	1	2	Lecture

IPR in India- genesis and development	1.4	1	2	Lecture
International organizations, agencies, treaties, important examples of IPR.	1.5	1	2	Lecture
Module 2: Copyright and Trademark (8Hrs)				
Copyright- registration procedure and copyright authorities	2.1	1,2	2	Lecture
Right and protection covered by copyright	2.2	1,2	1	Lecture
Fundamental of copyright law, copyright infringement	2.3	1,2	1	Lecture
An intellectual theft: academic integrity or plagiarism	2.4	1,2	1	Lecture
Trademark – rights of trademark- kind of signs used as trademarks	2.5	1,2	1	Lecture
Types, purpose and functions of trademarks, trademark registration process.	2.6	1,2	2	Lecture
Module 3: Industrial designs, Geographical Indications and trade secrets (6Hrs)				
Industrial Designs – protection, kind of protection is provided by industrial designs	3.1	1,3	2	Lecture
Trade Secrets – trade secrets law, determination of trade secret status, liability for misappropriations of trade secrets.	3.2	1,3	2	Lecture
Geographical Indications of goods- types, Why and How GI need protection and GI laws, Indian GI act.	3.3	1,3	2	Lecture
Module 4: Introduction to Patent and patenting (14Hrs)				
Concept of Patent – historical view of patent system in India and International scenario	4.1	1,4	2	Lecture
Evolution of Patent Laws in India – Indian Patent Act 1970 and TRIPS, Biotechnology patents in India	4.2	1,4	2	Lecture
Patentable inventions - Process and product (Biotechnology / Pharmaceutical Products), inventions NOT patentable. Indian and International agencies involved in patenting, GATT	4.3	1,4	2	Lecture
Procedure of patenting- process of obtaining a patent – application- examination – acceptance - opposition – sealing of patents – preservation of Patents- documentation – register of patents.	4.4	1,4	4	Lecture
Rights and obligations of a patentee- duration of patents – rights of patentee – limitation of rights - use and exercise of rights – right to secrecy – compulsory licenses – special categories	4.5	1,4	4	Lecture
Module 5: Infringement and Enforcement Infringement (8Hrs)				
Criteria of infringement	5.1	5	2	Lecture
Modes of infringement (doctrine of colourable variation)	5.2	5	2	Lecture
Onus of proof – defences in suits of infringement	5.3	5	2	Lecture
Injunctions and related remedies	5.4	5	2	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. N.Subbaram, Patents, Pharma Book Syndicate, Hyderabad,2003.
2. WIPO, Hand book on Intellectual Property

3. P. Narayanan (Eastern Law House), Intellectual Property Law,2001
4. Deepa Goel and Shomini Parashar, IPR, Biosafety and Bioethics, Pearson Education India, 2013

Reference

1. International Encyclopaedia of Laws: Intellectual Property (Kluwer Law International, 1997) (looseleaf), vols. 1-5, 1997
2. V.K.Ahuja, Law relating to Intellectual Property rights, 2nd Edition, LexisNexis, 2013
3. Barrett, Margreth, Intellectual Property, 3rd edition, New York Aspen publishers, 2009
4. Nard, Craig Allen, Law of Intellectual Property, 2nd edition, New York Aspen publishers, 2008
5. Fisher, Matthew (ed.), Fundamentals of Patent Law: Interpretation and Scope of Protection, New Delhi, Mohan law House, 2010
6. Miller, Joseph Scott (ed.), Patents, UK, Edward Elgar, 2010

Course designed by: Shija Jacob

SEMESTER VI

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BT6DSC300	Major/Minor	Recombinant DNA Technology	5	75	4
SBU24BT6DSC301	Major/Minor	Bioinformatics	5	75	4
SBU24BT6DSC302	Major/Minor	Industrial and Environmental Biotechnology	5	75	4
SBU24BT6DSE300	Elective	Cancer Biology and Cell Signalling	4	60	4
SBU24BT6DSE301	Elective	Proteomics	4	60	4
SBU24BT6SEC300	SEC	Scientific Communication in Research	3	45	3
SBU24BT6VAC300	VAC	Environmental Science and Human Rights	3	45	3

SBU24BT6DSC300: RECOMBINANT DNA TECHNOLOGY

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline the concept of gene cloning and various tools/techniques used in molecular biology.	U
CO2	Describe various enzymes and cloning vectors used in genetic engineering.	U
CO3	Explain different gene transfer techniques in prokaryotes and eukaryotes.	U
CO4	Discuss steps involved in the construction of genomic DNA and cDNA library and methods used for the screening of recombinants.	U
CO5	Apply the learned protocols for nucleic acid isolation, electrophoretic separation and gain skills needed for various routine laboratory procedures.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	-	2	2	-	-	1	-
CO2	2	1	1	-	2	2	-	-	1	-
CO3	2	2	1	-	2	2	-	-	1	-
CO4	2	1	1	-	2	2	-	-	1	-
CO5	2	2	1	2	2	2	-	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Oral presentations	Assignment	Viva	Exam 1	Exam 2	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	-	-	x	x	x	x
CO4	x	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical assignment	Viva	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Tools in Recombinant DNA technology (4 Hrs)				
History. Introduction to gene cloning, Enzymes used in Genetic Engineering: Restriction enzymes, Phosphatase, polynucleotide kinase, single strand specific nucleases; DNA polymerases, RNA Polymerases, Reverse Transcriptase Ligases (T4 DNA ligase, *E.coli* DNA ligase)	1.1	1,2	3	Lecture
Modification of Ends -Adapters, Linkers, Homopolymer Tailing. TOPO cloning (Vaccinia topoisomerase I)	1.2	2	1	Lecture
Module 2: Cloning Vectors and Gene Transfer Methods (20 Hrs)				
Cloning vectors; essential features of a cloning vector, Cloning vectors for *E.coli*, Plasmid based vectors, pBR 322, pUC vector.	2.1	1, 2	2	Lecture
Biology of Lambda phage (lytic and lysogenic cycle), λ bacteriophage-based vectors (insertional and replacement), in vitro packaging; Biology of M13 bacteriophage, M13 phage based vectors	2.2	1, 2	3	Lecture
Hybrid vectors Cosmids, phagemids	2.3	1, 2	2	Lecture
High capacity vectors: P1 phage based vectors, PACs, bacterial artificial chromosomes, yeast artificial chromosomes. Advantages of each vector.	2.4	1, 2	3	Lecture
Vectors for bacteria other than *E. coli*, vectors for yeast and other fungi	2.5	1, 2	2	Lecture
Bacmid, Cloning vectors for eukaryotes	2.6	1, 2	2	Lecture
Agrobacterium tumefaciens and the biology of crown gall formation, *Agrobacterium* Ti plasmid-based vectors	2.7	1, 2	2	Lecture
Shuttle vectors, Expression vectors.	2.8	1, 2	2	Lecture
Gene transfer in prokaryotes and eukaryotes, Chemical transfection: Calcium phosphate mediated, Liposomes and lipoplexes mediated, Electroporation, Biolistic, Microinjection	2.9	1, 2,3	2	Lecture
Module 3: Generation of Genomic and cDNA Libraries (3 Hrs)				
Genomic library, definition and procedure of construction, cDNA library, definition, advantages and procedure of construction, different methods of first strand and second strand of cDNA synthesis	3.1	4	3	Lecture
Module 4: Selection and Screening of Recombinant Clones (3 Hrs)				
Insertional inactivation, alpha complementation and blue white selection, colony and plaque hybridization, immunological screening. Use of reporter genes, GUS, luciferase and GFP genes.	4.1	4	3	Lecture
Module 5: Methods in Molecular Biology (15 Hrs)				
Blotting techniques; Southern, Northern and Western blotting and south-western blotting, hybridization, FISH	5.1	1	2	Lecture

Probe preparation via nick translation, random priming, end labelling, radioactive and non radioactive probes.	5.2	1	2	Lecture
DNA sequencing; Sanger's dideoxy method, automated DNA sequencer, Whole genome sequencing, Next generation sequencing (NGS) - illumina sequencing, ABI/SOLID, Ion Torrent (Thermo Fisher),454 Sequencing (Roche)	5.3	1	3	Lecture
Polymerase chain reaction; Components, Step, Primer Design, Symmetric PCR, Asymmetric PCR, Inverse PCR, Anchored PCR, Quantitative real time PCR, SYBR Green and TaqMan chemistries, Applications of PCR.	5.4	1	3	Lecture
Molecular markers RAPD, RFLP, AFLP	5.5	1	2	Lecture
DNA finger printing, DNA foot printing	5.6	1	2	Lecture
Site directed Mutagenesis	5.7	1	1	Lecture
Module 6: Teacher Specific Content. *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Primrose, S.B.P, Twyman R.M, Principles of gene manipulation and Genomics, 7th edn, Blackwell Scientific publishers, 2006.
2. Glick, B.J., Pasternak, J.J. and Patten, C.L. Molecular biotechnology, Principles and Applications of Recombinant DNA, 4th edition, Wiley International Publishers,2010.

Reference

1. Brown, T. A, Gene Cloning and DNA Analysis: An Introduction, 7th edn, Wiley-Blackwell,2016
2. Watson, J.D, Recombinant DNA: Genes and genomes; a short course,3rd edn, WH Freeman &Co, 2006
3. Old, R.W. and Primrose, S.B.P. Principles of Gene Manipulation: An Introduction to Genetic Engineering, 6th edn, Blackwel Scientific, 2006.
4. Jeromy W Dale and Malcom von Shantz, From gene to genomes – Concepts and applications of DNA technology, John Wiley and sons Ltd,2002.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 7: Isolation of Chromosomal and Plasmid DNA (15 Hrs)				
Isolation of plant genomic DNA	7.1	5	5	Lab Practice
Isolation of genomic DNA from bacteria	7.2	5	5	Lab Practice
Isolation of plasmid DNA from bacterium	7.3	5	5	Lab Practice
Module 8: PCR amplification (8 Hrs)				
PCR amplification of the gene	8.1	5	4	Lab Practice
Primer designing	8.2	5	4	Lab Practice Demonstration
Module 9: Molecular Marker (4 Hrs)				
RAPD analysis	9.1	5	4	Lab Practice
Module 10: Restriction Digestion (3 Hrs)				
Restriction digestion of DNA sample	10.1	5	3	Lab Practice

Textbook

1. Sambrook J, Russel D W & Maniatis T, Molecular Cloning: A Laboratory Manual, Cold Spring Harbour Laboratory Press, 2001.

Course designed by: Dr. Reshma John

SBU24BT6DSC301: BIOINFORMATICS

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Interpret the basic concepts of genomics and benefits of genome analysis.	U
CO2	Describe the importance of different biological databases for information retrieval and data analysis.	U
CO3	Investigate the alignment and evolutionary relationship.	A
CO4	Explain the key concepts for protein structure prediction and understand energy simulation methods and its importance in drug designing.	U
CO5	Utilize bioinformatics tools and databases to retrieve and analyze biological data and to apply the basic principles of molecular docking in drug designing.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	-	2	2	2	-	-	2
CO2	2	1	2	-	2	2	2	-	-	2
CO3	2	-	2	-	2	1	1	-	-	1
CO4	2	-	1	-	1	1	1	-	1	1
CO5	2	-	1	1	1	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Oral presentations	Exam 1	Exam 2	
CO1	x	-	-	x	x	x
CO2	x	x	x	x	x	x
CO3	-	-	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva	Record	Lab Test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Bioinformatics Introduction (4 Hrs)				
Introduction to bioinformatics: connections to genes and genomes -Human Genome Project, Next Generation Sequencing methods. SNPs.	1.1	1	1	Lecture
Introduction to Programming Languages in Bioinformatics.	1.2	1	1	Lecture
Fundamentals of computer programming– Python and R.	1.3	1	2	Lecture
Module 2: Biological databases (12 Hrs)				
Data mining and data formats (FASTA, PDB).	2.1	2	2	Lecture
Biological database: Nucleic acid databases – Genbank, NCBI, ENA, DDBJ Protein databases – PIR, SWISSPROT, TrEMBL; Protein structure database (PDB)	2.2	2	6	Lecture
Secondary protein databases – PROSITE, PROFILES; Structural classification databases – SCOP, CATH	2.3	2	2	Lecture
Literature databases – PubMed, Genome databases (Ensembl, TIGR)	2.4	2	1	Lecture
Specialized databases (OMIM, GEO, KEGG, ZINC).	2.5	2	1	Lecture
Module 3: Sequence Alignment Methods (14 hrs)				
Similarity searching: Amino acid substitution matrices PAM and BLOSUM	3.1	3	1	Lecture
Pair-wise sequence alignment-Global and local alignment,	3.2	3	1	Lecture
Use of Dot plot, dynamic programming and database similarity searching- BLAST	3.3	3	6	Lecture
Multiple sequence alignment: tools and applications; CLUSTAL.	3.4	3	2	Lecture
Phylogenetic analysis: connection between MSA and phylogenies (neighbor joining method), Use of PHYLIP, MEGA	3.5	3	4	Lecture
Module 4: Structural Bioinformatics (15 Hrs)				
Molecular structure viewers: RasMol, SWISS-PDB Viewer.	4.1	4	1	Lecture
Predicting protein structure and function from sequence. Principles of homology modelling.	4.2	4	3	Lecture
Drug design: Structure based drug design and computer aided drug design	4.3	4	1	Lecture
Pharmacophore identification and novel drug design; Molecular and chemical properties of drugs, Lipinski's rule of five. Databases: PubChem, DrugBank.	4.4	4	3	Lecture
Representation of Drugs: Smile notation, IUPAC name, Chemical formula, molecular descriptors, 2D representation, Formats: SDF, MOL, MOL2. Classical SAR and QSAR studies.	4.5	4	2	Lecture
Molecular Docking – Identification of ligands, active site prediction, docking and evaluation.	4.6	4	3	Lecture
Molecular Docking software – AutoDock.	4.7	4	2	Lecture

ADME; Overview of in-vitro & in vivo clinical trials, and approval IP issues related to drugs IdMOC for drug testing.				
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Arthur Lesk, Introduction to Bioinformatics, 3rd edition, Oxford University Press,2008.
2. O. Bosu and S.K. Thukral, Bioinformatics: Databases, Tools and Algorithms, Oxford University Press, 2007.
3. S.C. Rastogy, N. Mendiratta and P. Rastogi, Bioinformatics Methods and Applications-Genomics, Proteomics and Drug Discovery, Prentice Hall of India Pvt.Ltd., New Delhi, 2013.
4. S Ignasimuthu,. Basic Bioinformatics. Narosa Publications, 2009.

Reference

1. CR Cantor and CL Smith, Genomics: The Science and Technology Behind the Human Genome Project, John Wiley and Sons, 1971.
2. David W. Mount, Bioinformatics: Sequence and Genome Analysis,2nd edition, CSHL Press, 2004.
3. Higgins, D and Taylor, W, Bioinformatics: sequence, structure, and databanks: a practical approach. Oxford University Press, Inc, 2000.
4. Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, 3rd edition, Cambridge University Press, 2008.
5. G Robert, R programming in Bioinformatics, CRC press, Taylor and Francis Group, USA, 2008.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Bioinformatics Practical (30 Hrs)				
Retrieval and analysis of nucleotide sequence and protein sequences from NCBI	6.1	5	6	Lab practice
Retrieval of literature data using PubMed	6.2	5	2	Lab practice
Use of BLAST for searching a gene sequence	6.3	5	6	Lab practice
Multiple sequence alignment using Clustal W and construction of phylogenetic trees	6.4	5	6	Lab practice
Retrieval of structural data of a protein from PDB database	6.5	5	2	Lab practice
Analysis of structural features of proteins using Rasmol,	6.6	5	2	Lab practice
Homology modelling using Swiss Model and/or Modeller.	6.7	5	6	Lab practice

Reference

1. Andreas D. Baxevanis, Bioinformatics, A Practical Guide to the Analysis of Genes and Proteins, 3rd edition, Wiley-Interscience,2004.
2. Jean-Michel Claverie and Cedric Notredame, Bioinformatics For Dummies, Wiley Publication, 2nd Edition, 2007.

Course designed by Tessmol P. George

SBU24BT6DSC302: INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the methods of screening and strain improvement of industrially important microbes and their industrial applications.	U
CO2	Explain the principle, types of fermenters and illustrate the biotechnological aspects of fermentation process and large-scale production of commercially important microbial products	U
CO3	Discuss the concepts of Biotechnology in environmental management andidentify the components of environmental eco systems and effect of pollutant on environment.	U
CO4	Discuss various treatment strategies and types of biotechnological approach in agriculture and waste management	U
CO5	Apply techniques for assessing water quality, fermentative production methods, immobilization methods and assessing the quality of products obtained by fermentation	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	-	1	2	1	-	1	1
CO2	2	1	1	1	1	2	1	-	1	1
CO3	2	-	1	1	1	2	1	-	1	1
CO4	2	-	1	1	1	2	1	-	1	1
CO5	-	-	-	-	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	MCQ	Exam 1	Exam 2	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	-	x	x	x	x	x
CO4	-	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Industrial Biotechnology (9 Hrs)				
Introduction, scope and historical developments, importance of microbes in industry; microbial biomass, microbial enzymes, microbial metabolites and microbial recombinant products.	1.1	1	3	Lecture
Mode of Microbial culture: Batch, Continuous and Fed batch culture	1.2	1	3	Lecture
Isolation, screening and genetic improvement of industrially important organisms: Techniques for isolation and screening, primary and secondary screening, Methods of Strain Improvement: Mutation, protoplast fusion, and genetic engineering for enhancing microbial strains.	1.3	1	3	Lecture
Module2: Fermentation Production of Microbial Metabolites & Enzymes (16 Hrs)				
Fermentation: Definition, Submerged fermentation and solid state fermentation. Fermentation Media: Role of Fermentation Media: Defined and undefined media. Major components of fermentation media : water, carbon and nitrogen sources, minerals, chelators, oxygen requirement, rheology, foaming and antifoaming agents.	2.1	2	3	Lecture
Media Formulation and Sterilization: Techniques for formulating and sterilizing fermentation media.	2.2	2	3	Lecture
Fermenter: functions of a fermenter, Design of a fermenter, body construction, types of fermenters: Waldhof type, tower type, airlift type, packed bed type. sterilization of the fermenter, aeration: porous sparger, orifice sparger, nozzle sparger, probes. Recovery of fermentation products, foam separation, precipitation, filtration, centrifugation.	2.3	2	3	Lecture
Primary metabolism products, production of amino acids as case study. Secondary metabolites, bacterial antibiotics production. Metabolic pathway engineering of microbes for production of novel product for industry.	2.4	2	4	Lecture
Microbial enzymes, amylase, proteases, cellulases, role of enzymes in various industrial processes, Biotransformation with production of vitamin C as a case study. Production of an enzyme through solid state fermentation.	2.5	2	3	Lecture

Module 3: **Introduction to Environmental Biotechnology and Biological Monitoring of Environmental Pollution (10 Hrs)**				
An overview, concept, scope and market. Introduction to environmental pollutions,	3.1	3	2	Lecture
Bacterial examination of water for portability. Testing of water for physiochemical parameters including BOD & COD	3.2	3	2	Lecture
Biodegradation of Hydrocarbon, cellulose, lignin, pesticides. Monitoring pollution; Bio indicators; Biomarkers – biochemical indicators, immunochemistry, genetic indicators;	3.3	3	3	Lecture
Biotechnological methods of pollution detection: General bioassays in pollution monitoring, cell biology in environmental monitoring, molecular biology in environmental monitoring and biosensors in environmental analysis.	3.4	3	3	Lecture
Module 4: Biotechnological Approach in Agriculture and Waste Management (10 Hrs)				
Qualitative and quantitative analysis of soil and air, Removal of pollutions from air and soil. Solid waste: Sources and management (composting, vermicomposting and methane production).	4.1	4	5	Lecture
Green bio products-Biofertilizer: types and advantagesBioremediation: methods – insitu and exitu. Types of bioremediation, microbial bioremediation, phytoremediation, biostimulation, bioaugmentation, bioventing.	4.2	4	5	Video lecture
Module 5: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Foster C.F., John ware D.A, Environmental Biotechnology, Ellis Horwood Limited
2. Stanbury, P.F.A. Whitaker and S.J. Hall, Principles of fermentation technology, Pergamon Press, 1995.
3. U. Sathyanarayana, Biotechnology, 1 st edition, Books and Allied (p) Ltd, 2017

Reference

1. Howard S. Peavey, Donald R. Rowe, George Techobanolous, Environmental Engineering, McGraw-Hill International Editions.
2. Metcalf and Eddy, Inc. Wastewater Engineering – Treatment, Disposal and Reuse, 3rd Edition Tata McGraw-Hill Publishing Company Limited.
3. Foster C.F., John ware D.A, Environmental Biotechnology, Ellis Horwood Limited.
4. Indu Shekhar Thakur, Environmental Biotechnology, IK Publishers.
5. L.E. Casida, Industrial Microbiology, Willey Eastern Ltd.
6. Prescott & Dunn, Industrial Microbiology, CBS Publisher.
7. Cruger and Annilesse Cruger, A textbook of industrial microbiology, Sinaser Associates. Inc, 1990.
8. Chatterjee AK, Asoke K. Ghosh, Environmental Biotechnology, PHI Learning Private Limited, 2011.
9. Jogdand SN, Environmental Biotechnology, Himalayan publication, 2015.
10. Nuzhat Ahmed, Fouad M. Qureshi and Obaid Y. Khan, Industrial and Environmental Biotechnology, Horizon Press, 2006.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Analysis of water (15 Hrs)				
Isolation of bacteria through serial dilution and plating technique	6.1	5	6	Lecture, Lab Practice
MPN analysis of water samples.	6.2	5	6	Lab practice
Estimation of dissolved oxygen.	6.3	5	3	Lab practice
Module 7: Fermentation (10 Hrs)				
Production of wine	7.1	5	4	Lecture, Lab practice
Production of an enzyme through submerged fermentation.	7.2	5	3	Lab practice
Estimation of alcohol content in wine.	7.3	5	3	Lab practice
Module 8: Immobilization of enzyme (5 Hrs)				
Immobilization of enzymes using sodium alginate.	8.1	5	5	Lab practice

Textbooks

1. Pradipta Kumar Mohapatra, Textbook of environmental Biotechnology, International Publishing house Pvt.Ltd, 2006.
2. Wiley, Joanne, Sherwood, Linda, Woolverton, Christopher J, Prescott's microbiology, Mcgraw-Hill education, 2017.
3. Kun, L.Y, Microbial biotechnology: principles and applications, World Scientific Publishing Company,2003

Reference

1. T R Srinivas, Environmental Biotechnology, 1 st edition, New age International Pvt Ltd, 2008.
2. Gareth M Evans, Judith C Furlog, Environmental Biotechnology: Theory and Application, Wiley, 2002.
3. Stanbury, P.F.A. Whitaker and S.J. Hall, Principles of fermentation technology, Pergamon Press, 1995.
4. Tortota et al, Microbiology an introduction, Pearson education, 2008.

Course designed by: Mrs. Vigimol T. Varghese, Shobin Varghese

SBU24BT6DSE300: CANCER BIOLOGY AND CELL SIGNALLING

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the fundamental concepts of cancer biology	U
CO2	Understand the importance of the tumour microenvironment in cancer progression and cellular and molecular factors contributing to cancer development	U
CO3	Understand cell signalling pathways leading to cancer	U
CO4	Demonstrate relation of epigenetics and cancer	U
CO5	Extend knowledge of cancer biology to diagnosis and treatment strategies	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-		-	2	2	-	-	1	1
CO2	2	-	2	-	2	2	-	-	1	-
CO3	2	2	2	-	2	2	1	-	1	-
CO4	2	2	2	-	2	2	1	-	1	-
CO5	2	2	2	-	2	2	-	-	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Poster	Assignment	MCQ	Exam 1	Exam 2	
CO1	x	-	x	x	x	x
CO2	-	x	x	x	x	x
CO3	-	-	x	-	x	x
CO4	x	-	x	-	x	x
CO5	-	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Cancer Biology (8 Hrs)				
Understanding cancer as a disease: Definition, prevalence, and impact; Historical perspectives on cancer research. Different forms of cancer	1.1	1	4	Lecture
Hallmarks of cancer: Overview of cancer characteristics and properties	1.2	1	2	Lecture

Causes of cancer: Genetic, environmental, and lifestyle factors	1.3	1	2	Video presentation
Module 2: Cellular Basis of Cancer and Tumour Microenvironment (15 Hrs)				
Theory of carcinogenesis, Cell cycle regulation and checkpoints, Mutations and genomic instability in cancer, Oncogenes and tumour suppressor genes, Apoptosis and its role in cancer.	2.1	2	7	Lecture
The role of the extracellular matrix Immune system and cancer: Tumour immunology, Angiogenesis and its importance in tumour growth, Cancer cell interactions with neighbouring cells	2.2	2	8	Lecture
Module 3: Cell Signalling Basics & Signal Transduction in Cancer (17 Hrs)				
Overview of cell signalling pathways, Types of signalling molecules: Autocrine, paracrine, endocrine, Cell surface receptors and intracellular signalling cascades	3.1	3	7	Lecture
Signal Transduction in Cancer: Aberrant cell signalling in cancer Receptor tyrosine kinase and cancer; Wnt, Notch, and Hedgehog pathways in cancer, PI3K/Akt/mTOR signalling in cancer progression	3.2	3	10	Lecture
Module 4: Epigenetics and Cancer (7 Hrs)				
DNA methylation and histone modifications in cancer, MicroRNAs and their role in cancer	4.1	4	5	Lecture
Epigenetic therapies in cancer treatment	4.2	4	2	Lecture
Module 5: Cancer Diagnosis and Treatment (13 Hrs)				
Diagnostic methods: Imaging, biopsies, molecular techniques, Traditional cancer therapies: Surgery, chemotherapy, radiotherapy,hormone therapy, Targeted therapies and immunotherapy, Emerging trends in cancer treatment	5.1	5	13	Lecture
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Robert A. Weinberg, The Biology of Cancer, Garland Science, New York, 2013
2. Vincent T. DeVita Jr, Theodore S. Lawrence, and Steven A. Rosenberg, Cancer: Principles & Practice of Oncology, Wolters Kluwer, Philadelphia, 2018
3. David M. Terrian, Cancer Cell Signaling: Methods and Protocols, First edition, Humana Press, New York, 2014

Reference

1. Douglas Hanahan, Robert A. Weinberg, Hallmarks of Cancer: The Next Generation, Cell Press, Cambridge, 2011.
2. Lauren Pecorino, Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics, First Edition, Oxford University Press, New York, 2012
3. Robert C. Rees, William H. Carson, Tumor Immunology and Immunotherapy. First edition, Oxford University Press, New York, 2015

Course designed by: Shobin Varghese

SBU24BT6DSE301: PROTEOMICS

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline the basic concept of proteomics and explain its significance in the field of biotechnology	U
CO2	Explain experimental techniques for analysing proteomes, protein separation and quantification.	U
CO3	Outline various strategies for protein identification, structural and functional analysis.	U
CO4	Explain various proteome databases for protein identification, characterization, and functional annotation.	U
CO5	Describe applications of proteomics in biotechnology, biomarker discovery, drug development, and personalized medicine.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	-	-	1	-
CO2	2	-	2	-	2	2	-	-	1	-
CO3	2	2	2	-	2	2	-	-	1	-
CO4	2	2	2	-	2	2	1	-	1	-
CO5	2	2	2	-	2	2	1	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Oral presentation	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	x	x
CO2	-	x	x	x	x	x
CO3	-	x	x	x	x	x
CO4	-	-	x	-	x	x
CO5	x	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Proteomics (10 Hrs)				
Introduction and scope of proteomics; Proteome, Areas of proteomics-quantitative proteomics; functional proteomics, structural proteomics, Aims, strategies and challenges in proteomics.	1.1	1	4	Lecture

Overview of protein structure-primary, secondary, tertiary and quaternary structure, Chemical properties of proteins, Physical interactions that determine the property of proteins. Protein isolation; detection and quantitation of proteins. Interpretation and Visualization.	1.2	1	6	Lecture
Module 2: Analysis of Proteomes (10 Hrs)				
Analysis of proteomes, Sample Preparation, Solubilization, Reduction, Resolution, Reproducibility of 2-DE Gels.	2.1	2	3	Lecture
Separation of proteins by two-dimensional polyacrylamide gel electrophoresis, Isoelectric focusing (IEF), protein microarrays	2.2	2	3	Lecture
MALDI- TOF mass spectrometry, peptide mass fingerprinting, Determination of 3D structure of protein by NMR spectroscopy, X-ray crystallography. Shot gun proteomics	2.3	2	4	Lecture
Module 3: Strategies for Protein Identification (13 Hrs)				
Protein sequencing, Sanger and Edman sequencing,	3.1	3	3	Lecture
Protein quantification based on isotope labelling and MS. Analysis of post-translational modifications.	3.2	3	3	Lecture
Analysis of protein interactions using affinity chromatography, DNA-Protein interaction: Electrophoresis mobility shift assay (EMSA),Chromatin Immunoprecipitation (ChIP), Protein-protein interactions: Surfaceomes and Secretomes, Solid-phase ELISA, pull-down assays (using GST-tagged protein) tandem affinity purification for western analysis, by surface plasmon resonance technique; Chemically induced dimerization, Yeast two-hybrid system, Phage display, Protein interaction maps, Protein arrays-definition; applications- diagnostics, expression profiling	3.3	3	7	Lecture
Module 4: Proteome Databases and Servers (15 Hrs)				
Proteome database: Chip-seq, Amino acid sequencing Protein Databases: UniProt, NCBI Protein Protein Data Bank (PDB), InterPro, STRING, PhosphoSitePlus, PRIDE.	4.1	4	5	Lecture
Proteomic analysis software (protein pilot, Mascot)	4.2	4	5	Lecture
Introduction to quantitative proteomics and techniques (i-TRAQ and SILAC).	4.3	4	5	Lecture
Module 5: Potentials of Proteomics in Biotechnology (12 Hrs)				
Case studies related to Clinical and biomedical application of proteomics; drug discovery and personalised medicine, Target identification and validation.	5.1	1, 5	3	Lecture
Biomarker discovery in drug development, Stem Cell Research, Protein Engineering	5.2	1, 5	3	Lecture
Monitoring Agricultural Contaminants, Bioindication and Biotic Response	5.3	1, 5	3	Lecture
Metaproteomics. Human Proteome Atlas	5.4	1, 5	3	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Twyman R M, Principles of Proteomics, Second Edition, Garland Science Taylor & Francis Group New York and London,2013.
2. Liebler D C, Introduction to Proteomics, Humana Press, New York, USA,2002.
3. Keith Wilson & John Walker, Principles and Techniques of Biochemistry and Molecular Biology, ed., Cambridge Univ. Press,2010.
4. Stryer, Biochemistry, W. H. Freeman and Co., New York, 2007.
5. R. D. Appel and D.F. Hochstrasser, Proteome Research: New Frontiers in Functional Genomics, Springer, 1997.

Reference

1. Rehm H, Protein Biochemistry and Proteomics, 4th Edition, Academic Press,2006.
2. Daniel C. Liebler, Introduction to Proteomics: Tools for the New Biology, Humana Press Inc, 2002.

Course designed by: Dr. Reshma John

SBU24BT6SEC300: SCIENTIFIC COMMUNICATION IN RESEARCH

Type of Course	SEC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the conventions of formal academic writing.	R
CO2	Explain how to comprehend and apply a range of scientific information resources	U
CO3	Demonstrate the ability to generate original literary works while employing strategies to prevent plagiarism.	U
CO4	Explain the planning and writing of various types of academic assignments	R
CO5	Demonstrate how to manage references and usage of bibliographic management software.	R

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	1	-	1	-	-	-	1
CO2	-	-	-	1	-	1	-	-	-	1
CO3	-	-	-	1	-	1	-	-	-	1
CO4	-	-	-	1	-	1	-	-	-	1
CO5	-	-	-	2	-	1	-	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Oral Presentation	Viva	Exam 1	Exam 2	
CO1	x	-	x	-	x	x
CO2	x	x	x	-	x	x
CO3	x	x	x	x	x	x
CO4	-	-	x	x	x	x
CO5	-	x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: The Fundamentals of Academic Writing (9 Hrs)				
The importance of scientific communication in research and academia, Word choice in scholarly writing	1.1	1	3	Lecture
Academic writing conventions: essay tone, essay style, and essay structure	1.2	1	3	Lecture

Evaluating the reliability of an information source by separating views from facts, Techniques and resources for taking notes in a class	1.3	1	3	Lecture
Module 2: How to Avoid Plagiarism (11 Hrs)				
Plagiarism – definition and types, Self-plagiarism	2.1	2,3	3	Lecture
Strategies to avoid plagiarism: Writing summary, Paraphrasing, Quotations and Citations	2.2	2,3	3	Lecture
Software for detecting plagiarism and similarities – TURNITIN, VIPER, GRAMMARLY	2.3	2,3	5	Lecture
Module 3: Categories of Scientific Literature (10 Hrs)				
Modes of scientific communication – Written forms: news article, editorial, scientific report, review article, original research article, thesis, Artistic forms: poster, Oral Forms: oral presentations in a conference, Technological forms: educational technologies, including computer games, simulations, and social media	3.1	2,4	5	Lecture
Primary and Secondary Literature – Definition, distinguishing features and examples Format and Organization of Particular Examples – news article, review article, research paper, thesis, poster	3.2	2,4	2	Lecture
How to Conduct a Literature Search: Use of PUBMED, Google Scholar, and other modern tools to conduct a literature search	3.3	2,4	3	Lecture
Module 4: Preparing and Composing Academic Assignments (5 Hrs)				
Writing an experiment for a laboratory notebook, Project Report, Writing an essay/assignment. Constructing Statement of Purpose	4.1	4	5	Lecture
Module 5: Bibliography and References (10 Hrs)				
In-text citations, Reference writing in APA style: Textbook/book chapter as source, Research paper/Journal article as a source, Websites and Citations, Constructing a bibliography	5.1	5	5	Lecture
Reference management tools – ZOTERO, ENDNOTE	5.2	5	5	Lecture
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Day RA, Gastel B, How to Write & Publish a Scientific Paper,7th Edition, Cambridge University Press,2012.
2. Booth V, Communicating in Science: Writing a Scientific Paper and Speaking at Scientific Meetings, 2nd Edition Reprinted, Cambridge University Press, 2006.

Reference

1. Matthews JR., Matthews RW, Successful Scientific Writing: A Step-by-step Guide for the Biological and Medical Sciences, 3rd Edition, Cambridge University Press, 2008
2. Yousuf A, Sidiq M, Acharya S, Publish and Cherish – The Art and Craft of Publishing Scientific Research, 1st Edition, Sara Book Publication, 2018.

Couse designed by Sreeja Raj

SBU24BT6VAC300: ENVIRONMENTAL SCIENCE AND HUMAN RIGHTS

Type of Course	VAC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Recognize the structure and function ecosystem and compare its nature with different ecosystems and explain the ecological interconnections of life on Earth.	U
CO2	Indicate various environmental problems and ways of addressing them, including interactions across local to global scales.	R
CO3	Identify suitable measures for the protection of nature and natural resources.	R
CO4	Appraise the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.	R
CO5	Critically examine the problems and successes of defending human rights for various communities in India and around the world.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	2	2	1	-	1
CO2	1	-	-	-	-	2	2	1	-	1
CO3	1	-	-	-	-	2	2	1	-	1
CO4	1	-	-	-	-	1	2	1	-	
CO5	1	-	-	-	-	1	2	1	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ	Quiz	Viva	Written Test	
CO1	x	-	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	-	x
CO5	x	x	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: General Introduction (3 Hrs)				
Introduction to Ecology & Environmental Sciences; Principles and Scope of Ecology. Branches of ecology; Interdisciplinary nature of Ecology and Environmental sciences	1.1	1	3	Lecture
Module 2: Population and Community Ecology (7 Hrs)				
Population characteristics: Metapopulations, growth form and carrying capacity, Ecotypes and Ecads.	2.1	1	2	Lecture
Community characteristics: Quantitative (e.g., frequency, density and abundance), Qualitative (e.g., physiognomy and phenology), Synthetic (e.g., dominance).	2.2	1	3	Lecture
Ecotone and edge effect, Habitat, ecological niche and microclimate.	2.3	1	2	Lecture
Module 3: Plants and Environment (5 Hrs)				
Adaptations of plants to environment - xerophytes, hydrophytes, epiphytes, halophytes and mangroves. Interactions between species: positive and negative - competition, parasitism, predation, commensalism, mutualism, neutralism.	3.1	4	3	Lecture
Ecological succession: types of succession, the process of succession, climax community, Hydrosere, and xerosere	3.2	4	2	Lecture
Module 4: Environmental Issues (10 Hrs)				
Global and local environmental issues: global warming and climate change (use case studies to illustrate the points); ozone depletion; greenhouse effect; acid rain; carbon trading, carbon credit; carbon sequestration; IPCC/UNFCC; nuclear accidents and nuclear holocaust, sand mining; wetland reclamation; landscape changes; deforestation; soil erosion. Flood and drought, desertification, overexploitation, threats to freshwater resources of Kerala; tourism, and its impact on the environment.	4.1	2,3	5	Lecture
Pollution: air pollution; water pollution; soil pollution; noise pollution; pesticide pollution, solid waste management: causes, effects and control measures of urban and industrial waste biodegradable and non-degradable	4.2	2,3	3	Lecture
Disaster management: introduction to hazards; hazards classification; natural and anthropogenic, disaster management - earthquakes; cyclone; tsunami; floods; landslides; droughts	4.3	2,3	2	Lecture
Module 5: Human Rights (20 Hrs)				
National and International Perspectives: Definitions of Human Right, Relevance of Human Rights in India-Social Aspects-Economic Aspects-Political Aspects, Human Rights International Norms, UDHR-Civil and political rights- Economic, social and cultural rights- Rights against	5.1	5	10	Lecture

torture, Discrimination and forced labour-Rights of the child, Human Rights and duties in India- Preamble to the Indian Constitution-Human Rights and Duties in Indian Constitution				
Deprivation of Human Rights-The core issues: Poverty-Overpopulation- Illiteracy- Unsustainable Development, Disadvantageous Groups (Women, Children, SC/ST, Homeless and slum dwellers, physically and mentally handicapped, refugees and internally displaced persons.	5.2	5	5	Lecture
Redressal Mechanisms against Human Rights Violation: Judiciary - Government systems for Redressal - NHRC and other Statutory Commissions- Media Advocacy-Creation of Human Rights Literacy and Awareness	5.3	5	5	Lecture
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Agarwal, D.K. Environment and Ecology,10th Edition, Scientific Publishers, Jodhpur,2022.
2. Chapman J L, Reiss M J Ecology: Principles and Applications, Cambridge University Press, 2005.

Reference

1. Desai, A., The Scheduled Castes and Tribes: Human Rights Issues and Challenges, Oxford University Press, New Delhi, 2018.
2. Fox C W, Roff D A, Fairbairn D, Evolutionary Ecology: Concepts and Studies. Oxford University Press, 2001
3. Ganguly, S.R. Human Rights: History, Philosophy and Jurisprudence, Eastern Book Company, Lucknow,2020
4. H.D Kumar, Modern Concepts of Ecology, Vikas Publishing House, New Delhi,2000

Couse designed by: Sreeja Raj

SEMESTER VII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BT7DSC400	Major/Minor	Genomics, Metagenomics and Transcriptomics	4	60	4
SBU24BT7DSC401	Major/Minor	Advanced cell and Molecular Biology	5	75	4
SBU24BT7DSC402	Major/Minor	Research Methodology and Biostatistics	4	60	4
SBU24BT7DSC403	Major/Minor	Biopharmaceutics and Drug Designing	4	60	4
SBU24BT7DSC404	Major/Minor	Medical Biotechnology and Molecular Diagnostics	4	60	4
SBU24BT7DSC405	Major/Minor	Tissue Engineering and Regenerative Medicines	4	60	4

SBU24BT7DSC400: GENOMICS, METAGENOMICS AND TRANSCRIPTOMICS

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Comprehend the fundamentals of the structure of the genome and its organelles	U
CO2	Connect the important techniques used for genomic and metagenomic study.	U
CO3	Apply gene expression technique using Next Generation Sequencing	A
CO4	Analyze the *in silco* tools used for metagenomic study	An
CO5	Compile the importance of RNA sequence analysis in genomic study	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	2	-	-	2
CO2	2	-	2	-	1	2	2	-	-	2
CO3	2	1	1	-	1	2	2	-	1	1
CO4	2	1	1	-	1	2	2	-	-	1
CO5	2	-	1	-	1	2	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Oral presentations	Exam 1	Exam 2	
CO1	-	-	x	x	x	x
CO2	x	-	x	x	x	x
CO3	x	x	x	x	x	x
CO4	-	x	x	-	x	x
CO5	-	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Genomics (10 Hrs)				
Structure and organization of genomes; genome mapping and sequencing methods; assembly of DNA sequences-methods	1.1	1	1	Lecture
Genome sequencing projects for microbes, plants and animals; Human Genome Project (HGP).	1.2	1	4	Lecture

Concept of genome assembly, contigs, scaffolds, complete genome, draft genome, chromosomal level assembly	1.3	1	3	Lecture
Genome assembly tools: ABySS, SOAPdeneno, Flye, Supernova	1.4	1	1	Lecture
Introduction to genomes and packages for genomic analysis such as EMBOSS.	1.5	1	1	Lecture
Module 2: Basic Techniques Used for Genomic and Metagenomic Study (15 Hrs)				
Genome sequencing studies	2.1	2	1	Lecture
Expression system studies: DNA Barcoding and meta barcoding, 16sr RNA, Cytochrome c oxidase.	2.2	2	4	Lecture
Molecular Finger printing techniques: RFLP, tRFLP, DGGE, FISH.	2.3	2	4	Lecture
Differential expression analysis.	2.4	2	2	Lecture
Next-generation sequencing–Roche/454 pyrosequencing, Illumina (Solexa), SOLiD, Ion Torrent; Next Generation Sequencing: Whole genome annotation of small genome: Preprocessing, Repeat masking.	2.5	2	4	Lecture
Module 3: Analysis of Genomic Data (10 Hrs)				
Genome information and special features	3.1	3	2	Lecture
Coding sequences, (CDS), Untranslated regions (UTR'S)	3.2	3	2	Lecture
cDNA library, Expressed sequence Tags (EST)	3.3	3	2	Lecture
Standard genomic pipeline	3.4	3	2	Lecture
Servers involved: Galaxy, RAST, Meta data	3.5	3	2	Lecture
Module 4: Analysis of Metagenomic Data (5 Hrs)				
Identifying the genes, gene annotation, metabolic pathway analysis	4.1	4	3	Lecture
Gene prediction – Augustus, BUSCO Evaluation - Genes /Genome	4.2	4	2	Lecture
Module 5: RNA Sequence Analysis for Genomic Study and Applications (20 Hrs)				
Transcriptomics- Types and functions of coding and non-coding RNAs- mRNAs, rRNA, tRNA, lncRNAs, miRNAs, piRNAs, siRNAs, ceRNAs; Basic introduction to Transcriptomic techniques- EST, SAGE/CAGE.	5.1	5	8	Lecture
Processing, Alignment, quality control check points, Expression quantification.	5.2	5	6	Lecture
Tools used: Single cell RNA seq, poly (A) RNA seq, Applications of Transcriptomics.	5.3	5	6	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Rastogi S. C., Mendiratta N.and Rastogi P, Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery). PHI Learning Pvt. Ltd, 2013.
2. Mandoiu I., and Zelikovsky A, Computational methods for next generation sequencing data analysis, John Wiley & Sons, 2016.
3. W. R. Streit and R. Daniel, Metagenomics: Methods and Protocols, 1st Edn., Humana Press, 2010.

4. K. E. Nelson, Metagenomics of the Human Body, 1st Edn, Springer, 2010.
5. D. Marco, Metagenomics: Current Innovations and Future Trends,1st Edn, Caister Academic Press, 2011.

Reference

1. Green MR and Sambrook J, Molecular Cloning, A Laboratory Manual,4th Ed, Cold Spring Harbor Laboratory Press,2012.
2. Jonathan P, Bioinformatics and Functional Genomics, John Wiley & Sons, 2nd Ed, 2009.
3. Mount, D. W, Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, 2004.
4. Korpelainen E., Tuimala J., Somervuo P., Huss M., & Wong G., RNA-seq data analysis: a practical approach, CRC press, 2014.
5. Marco.D, Metagenomics: Theory, Methods and Applications,1st Edn., Caister Academic Press, 2010.
6. Primrose, S. B. and Twyman R. M, Principle of Genome Analysis and Genomics, 7th Ed, Blackwell Publishing Company, Malden, USA, 2006.

Course designed by: Tessmol P. George

SBU24BT7DSC401: ADVANCED CELL AND MOLECULAR BIOLOGY

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the principles of cell signalling and communication	U
CO2	Explain cytoskeleton, cellular motility, organellar dynamics and intracellular trafficking	U
CO3	Describe cell cycle regulation and cell fate determination	U
CO4	Describe in detail about components and mechanisms involved in transcription and translation as well as gene regulatory mechanisms	U
CO5	Summarize advanced techniques in cell biology and molecular biology	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	-	-	2	1	-	1	-
CO2	2	-	-	-	-	2	1	-	1	-
CO3	2	-	-	-	-	2	1	-	1	-
CO4	2	2	-	-	-	2	-	-	1	1
CO5	2	-	2	2	-	2	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Oral presentation	Exam 1	Exam 2	
CO1	-	x	-	x	x	x
CO2	x	x	-	x	x	x
CO3	-	x	x	x	x	x
CO4	-	x	x	-	x	x
CO5	-	-	-	-	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Cellular Signalling and Communication (6 Hrs)				
Overview of Cell Signalling: Autocrine, paracrine, endocrine signalling, Cell Surface Receptors: Types, activation mechanisms,	1.1	1	2	Lecture
Intracellular Signal Transduction: Second messengers, signal amplification pathways, Protein Kinases and Phosphorylation Cascades	1.2	1	2	Lecture
Regulation of Cell Signaling: Feedback mechanisms, signal termination, cellular communication in development and disease	1.3	1	2	Lecture
Module 2: Cytoskeleton Dynamics and Cellular Motility (7 Hrs)				
Cytoskeletal Components: Microtubules, microfilaments, intermediate filaments, Cytoskeletal Organization and Dynamics: Assembly, disassembly, motor proteins	2.1	2	3	Lecture
Cell Migration: Mechanisms, roles in development and wound healing, Intracellular Transport: Motor proteins, vesicle trafficking pathways	2.2	2	3	Lecture
Cytoskeleton and Disease: Implications in cancer metastasis, neurodegenerative disorders	2.3	2	1	Lecture
Module 3: Cell Cycle Regulation and Cell Fate Determination (6 Hrs)				
Cell Cycle Phases: G1, S, G2, M phases	3.1	3	2	Lecture
Cell Cycle Checkpoints: Control mechanisms, DNA damage response, cell cycle regulation by cyclins and cyclin-dependent kinases (CDKs)	3.2	3	2	Lecture
Cell Fate Determination: Stem cell niche, differentiation pathways, cell cycle dysregulation in disease: cancer, developmental disorders	3.3	3	2	Lecture
Module 4: Organelle Dynamics and Intracellular Trafficking (8 Hrs)				
Endoplasmic Reticulum: Protein folding, quality control mechanisms, Golgi Apparatus: Protein modification, sorting, trafficking, Endocytic Pathways: Clathrin-mediated endocytosis, phagocytosis, receptor recycling, Mitochondrial Dynamics: Fission, fusion, quality control mechanisms.	4.1	2	6	Lecture
Organelle Dysfunction in Disease: ER stress, mitochondrial disorders, lysosomal storage diseases	4.2	2	2	Lecture
Module 5: Transcription& Translation (5 Hrs)				
Prokaryotic transcription, initiation, elongation and termination, promoters, Structure and function of eukaryotic RNAs and ribosomal proteins. Eukaryotic transcription – RNA polymerase I, II and III, Elongation and Termination, Eukaryotic promoters and enhancers, Transcription factors, Post transcriptional processing, Splicing: Catalytic RNAs, RNA stability and transport, RNA editing.	5.1	4	3	Lecture

Prokaryotic and eukaryotic translation, Co- and Post-translational modifications of proteins; Translational control; Protein stability - Protein turnover and degradation	5.2	4	2	Lecture
Module 6: Gene regulation (13 Hrs)				
Gene regulation in prokaryotes, Constitutive and Inducible expression, small molecule regulators; Operon concept: *lac* and *trp* operons, attenuation, anti-termination, stringent control.	6.1	4	5	Lecture
Gene regulation in eukaryotes– regulatory RNA and RNA interference mechanisms, Silencers, insulators, enhancers, mechanism of silencing and activation;	6.2	4	5	Lecture
Families of DNA binding transcription factors: Helix-turn-helix, helix-loop-helix etc.	6.3	4	3	Lecture
Module 7: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. G. Karp, Cell and Molecular Biology: Concepts and Experiments, 6th Edition, John Wiley & Sons. Inc 2009.
2. Becker, W. M. and Klein smith, L. J, World of the Cell ,6th Edition, Benjamin Cummings, 2005.

Reference

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P, Molecular Biology of the Cell, 4th Edition, Garland Science, New York, 2002
2. Harvey, Arnold, B., Lawrence, S., Zipursky, Paul, M., David, B., and James, D, Molecular Cell Biology ,4th Edition, W. H. Freeman, New York, 2000
3. Lodish, H., Berk, A., Kaiser, C., Reiger, M., Bretscher, A., Ploegh, H., Angelika Amon A., Matthew P. Scott M.P., Molecular Cell Biology. 7th Edition, W.H. Freeman and Co., USA, 2012

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 8: Cell fractionation and membrane studies (10 Hrs)				
Cell fractionation	8.1	5	5	Lab Practice
Biomembrane and ion trapping	8.2	5	5	Lab Practice
Module 9: Molecular Biology Practicals (10 Hrs)				
Plasmid Analysis	9.1	5	5	Lab Practice
DNA fingerprinting using PCR	9.2	5	5	Lab Practice
Module 10: Transformation Studies (10 Hrs)				
Bacterial Transformation	10.1	5	10	Lab Practice

Textbook

1. K.V. Chaitanya, Cell and Molecular Biology: A Lab Manual, PHI Learning Private Limited, 2013.

Reference

1. G. Shanmugam, Cell Biology: A Laboratory Manual, Macmillan,1988.
2. Benjamin A Pierce, Genetics: A Conceptual Approach, 6th edition, WH Freeman, 2017
3. D.Peter Snustad, Michael J Simmons, Principles of Genetics, 6th Ed, Wiley, 2011

Course designed by: Shobin Varghese

SBU24BT7DSC402: RESEARCH METHODOLOGY AND BIOSTATISTICS

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline the basic methods of Research	R
CO2	Demonstrate the methodology of science in solving scientific problems	U
CO3	Describe various methods for collecting experimental data, disentangling the data collected, and making valid inferences	U
CO4	Explain the writing of a coherent thesis using suitable software tools	U
CO5	Identify the appropriate statistical techniques for the measurement scale and design	U

Cognitive Levels
R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	1	1	1	1	-	-	1
CO2	-	-	-	1	1	1	1	-	-	2
CO3	-	-	-	1	1	1	1	-	-	-
CO4	-	-	-	1	1	1	1	-	-	2
CO5	-	-	-	1	1	1	1	-	-	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ	Viva	Quiz	Written Test	
CO1	x	x	x	-	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	-	x
CO5	x	x	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basic Concepts of Research (8 Hrs)				
Research- Meaning, purpose of research, and Qualities of a good research. Types of research - Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical	1.1	1	3	Lecture
Research process – An overview of the process of research, Identification of problem, literature survey, Identification of	1.2	1	3	Lecture

variables. Hypothesis, Formation of hypothesis, Testing of hypothesis. Report writing - Components of research thesis				
Characteristics of research: Empirical. Systematic and rigorous, Logic and validity, Control, public scrutiny, reproducibility Epistemology: induction deduction abduction, Introduction to copyright-academic misconduct/plagiarism	1.3	1	2	Lecture
Module 2: Proposal Writing and Literature Review (8 Hrs)				
Framing Proposal for acquiring grants: The question to be addressed – Rationale and importance of the question being addressed – Empirical and theoretical framework – Presenting pilot study/data or background information - Research proposal and time frame – Specificity of methodology – Organization of different phases of study – Expected outcome of the study and its implications – Budgeting - Available infra-structure and resources - Executive summary	2.1	4	5	Lecture
Review of related literature and originality in writing; Citation formats: in medical sciences, social sciences; Issues of academic fraud and plagiarism, conflicts of interest, authorship, and publication	2.2	4	3	Lecture
Module 3: Sampling (4 Hrs)				
Sampling & Tools - Role of sampling in research; Types of sampling - random and non-random sampling.	3.1	2	2	Lecture
Research Tools and Techniques Validity and reliability; Interviewing and observational methods	3.2	2	2	Lecture
Module 4: Data Representation (10 Hrs)				
Representation of Data - Graphical and Diagrammatic Presentation of Data (Bar diagrams, Pie-diagram, Histogram, Frequency Polygon, Smoothed frequency curve and Ogives).	4.1	3	5	Lecture
Tabulation and Classification. Frequency Distribution.	4.2	3	5	Lecture
Module 5: Biostatistics (30 Hrs)				
Data collection, data; grouped, ungrouped. Variable, Quantitative Variable: Discrete and Continuous Variable, Qualitative Variable.	5.1	5	5	Lecture
Measures of central tendency: Arithmetic mean, mode, median Measures of dispersion: Range, mean deviation, variation, standard deviation, coefficient of variation, standard error. Chi-square test for goodness of fit and student 't' test.	5.2	5	10	Lecture
Application of statistics in research. Uses of software in biostatistics: R-program, SPSS	5.3	5	15	Lecture
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Kothari C R, Research Methodology: Methods and Techniques, 2nd ed., New Age International Publishers, New Delhi, India. Ltd., Ramnagar, Delhi, 2008.
2. Copper, H.M., Integrating research: A guide for literature reviews, 2nd Edition, Sage Publications, California, 2002.

Reference

1. Mishra, Dr. Shanti Bhushan & Alok, Dr. Shashi, Handbook of Research Methodology, New Age International Publishers, New Delhi, India. Ltd., Ramnagar, Delhi, 2017

Couse designed by: Sreeja Raj

SBU24BT7DSC403: BIOPHARMACEUTICS AND DRUG DESIGNING

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe natural sources of drugs and the pharmcodynamic and pharmacokinetic properties	U
CO2	Identify various biopharmaceuticals and systems for the production	R
CO3	Explain the drug discovery and development process	U
CO4	Outline various methods used in drug designing	U
CO5	Identify various drug delivery mechanisms	R

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1	2	1	2	1	-	1	-
CO2	1	-	1	1	-	2	1	-	1	-
CO3	2	1	1	-	-	2	1	-	1	-
CO4	2	1	2	-	1	2	1	-	1	-
CO5	1	-	1	1	2	2	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Quiz	Written test	MCQ	
CO1	-	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	-	x	x	x	x	x
CO4	-	x	x	-	x	x
CO5	-	x	x	-	x	x

Course Content &Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Biopharmaceuticals (10 Hrs)				
Biopharmaceuticals- History and features Source of drugs – plant, animals, microbes and minerals.	1.1	1	3	Lecture
Drug metabolism – Pharmacokinetics – Absorption, Distribution, Metabolism and Excretion (ADME).	1.2	1	4	Lecture
Pharmacodynamics – Mechanism of drug action. Physico – chemical properties of the drugs. Drug receptors	1.3	1	3	Lecture
Module 2: Biopharmaceutical Products (10 Hrs)				
Hormones, vitamins, enzymes and antibiotics	2.1	2	2	Lecture

Blood products and nucleic acids of therapeutic interest	2.2	2	2	Lecture
Biological therapeutics-Adoptive cell transfer, cancer vaccines, cytokine therapy, oncolytic virus therapy, adjuvant from biological organisms	2.3	2	4	Lecture
Systems for the production of Biopharmaceuticals	2.4	2	2	Lecture
Module 3: Overview of Drug Discovery and Development Process (15 Hrs)				
Steps in drug discovery- Target selection, Target validation, Lead compound identification, Lead Optimization, Pharmacological profiling	3.1	3	5	Lecture
Steps in drug development-Preclinical studies, Therapeutic index/Efficacy and potency study, Toxicity studies – reproductive toxicity and teratogenicity, mutagenicity, and carcinogenicity tests	3.2	3	3	Lecture
Clinical trials, clinical trial design, trial size design and study population.	3.3	3	3	Lecture
Good Manufacturing Practice (GMP), Manufacturing principles - Quality control	3.4	3	2	Lecture
Regulatory authorities –Central drug standards control organisation, food and drug administration, pharmacopeia	3.5	3	2	Lecture
Module 4: Drug designing (15 Hrs)				
Basic principle behind the drug designing–Drug-receptor interactions.Types of drug design (ligand based and structure based)Role of X-ray crystallography, NMR spectroscopy in drug designing	4.1	4	5	Lecture
Modern methods in drug designing: Computer-aided Drug design (CADD); Molecular docking, pharmacophore modelling, Homology (comparative) modelling, Molecular dynamics (MD) simulations, Binding pocket identification, Structure-based virtual screening.	4.2	4	5	Lecture
Quantitative Structure Activity Relationship (QSAR) models, *insilico* ADME/T prediction	4.3	4	5	Lecture
Module 5: Drug delivery systems (10 Hrs)				
Delivery of biopharmaceuticals – oral delivery systems, pulmonary delivery, nasal, transmucosal and transdermal delivery system.	5.1	5	5	Lecture
Targeted approaches: Applications of Nano-biotechnology in drug development and delivery. Polymeric and metallic nanoparticles for drug delivery.	5.2	5	5	Lecture
Module 6: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Gary Walsh (Ed), Pharmaceutical Biotechnology – Concepts and Application,2011.
2. Vyas SP, Dixit VK, Pharmaceutical Biotechnology,2019.
3. Kolkate, Jalapure, Hurakadle, Text book of Pharmaceutical Biotechnology, 2011.
4. Graham P Bunn, Good Manufacturing Practices for Pharmaceuticals ,7th Edition, 2019.

Reference

1. Crommelin DJA, Sindelar RD, Meibohm B. Pharmaceutical Biotechnology Fundamentals and Applications. 5th Edition, 2019.
2. Orlilcki R, Cienciala C, Krylova LP, Pielichowski J, Zaikov GQ, Pharmaceutical And Medical Biotechnology New Perspectives, 2013
3. Antoine Al-Achi, Mali Ram Gupta, William Craig Stagner, Integrated Pharmaceutics Applied Preformulation, Product Design, and Regulatory Science, 2013.
4. Shyam S Mohaptra, Shivendu Ranjan, Nandita Dasgupta, Raghavendra kumar Mishra, Sabu Thomas, Applications of targeted Nano drugs and Delivery systems, 2018.

Course designed by: Mrs. Vigimol T. Varghese

SBU24BT7DSC404: MEDICAL BIOTECHNOLOGY AND MOLECULAR DIAGNOSTICS

Type of Course	Major/Minor		
Course Level	400 – 499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the foundational concepts in clinical biotechnology and its role in disease diagnosis and treatment.	U
CO2	Explain the underlying principles of drug discovery, drug development and target identification.	U
CO3	Summarise modern therapeutic approaches, such as stem cell therapy and vaccine technology and its beneficial impact in public health.	U
CO4	Demonstrate the applications of various diagnostics techniques and interpret the results.	U
CO5	Explain the applications of molecular diagnostic methods used in the monitoring of genetic disorders, oncology and infectious diseases.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	-	-	1	-
CO2	2	-	2	-	2	2	-	-	1	-
CO3	2	-	2	-	2	2	-	-	1	-
CO4	2	2	2	1	2	2	-	-	1	-
CO5	2	2	2	1	2	2	-	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Oral presentation	Assignment	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	x	x
CO2		-	x	x	x	x
CO3	x	-	x	x	x	x
CO4	-	x	x	-	x	x
CO5	-	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Drug discovery and Development (6 Hrs)				
Introduction, worldwide market in medical biotechnology, Role of Biotechnology in medicine, revolution in diagnosis, changing approaches of therapy	1.1	1, 2	2	Lecture

Drug discovery: Overview, rational drug design, combinatorial chemistry in drug development, computer assisted drug design, role of bioinformatics in genome – based therapy, antisense DNA technology for drug designing.	1.2	1, 2	4	Lecture
Module 2: Modern Therapeutics (14 Hrs)				
Stem cells in therapy, Gene therapy	2.1	1, 3	2	Lecture
Therapeutic proteins, interleukins, interferons – principle, production and applications.	2.2	1, 3	2	Lecture
Biotechnological approaches to obtain blood products: Tissue plasminogen activator and erythropoietin, Streptokinase and urokinase in thrombosis	2.3	1, 3	2	Lecture
Insulin analogs and its role in diabetes; Recombinant human growth hormone	2.4	1, 3	2	Lecture
Immunotherapy; Monoclonal antibodies and their role in cancer	2.5	1, 3	2	Lecture
Nutraceuticals- Food derived bioactive peptides.	2.6	1, 3	1	Lecture
Bioartificial organs-liver-kidney-skin-pancreas-Urinary bladder bone-Challenges and advantages	2.7	1, 3	3	Lecture
Module 3: Vaccine Technologies (8 Hrs)				
History of vaccines, Conventional vaccines: Bacterial and Viral vaccine. impact of genetic engineering on vaccine production	3.1	1, 3	2	Lecture
New Vaccine Technologies - Rationally designed vaccines, DNA vaccination, Mucosal vaccination, new approaches for vaccine delivery, Engineering virus vectors for vaccination, Vaccines for targeted delivery systems	3.2	1, 3	4	Lecture
Disease specific vaccines: Tuberculosis vaccine, Malaria vaccine, Covid Vaccine, HIV/AIDS vaccine. New Emerging diseases and vaccine needs –Ebola, Zika	3.3	1, 3	2	Lecture
Module 4: Techniques for Diagnosis (13 Hrs)				
PCR based assays: Real-time PCR, ARMS, allele specific, multiplex, methylation analysis, MLPA, SSCP, heteroduplex analysis, competitive oligonucleotide priming, DHPLC, DGGE, CSCE. Mutation screening panels (xTAG, Luminex) Micro arrays: SNP chromosomal microarrays, EST, SAGE	4.1	1, 4	5	Lecture
Proteomic and Metabolomics Assays for Diagnostic, Isotope coated affinity tag (ICAT), SILAC, i-TRAQ	4.2	1, 4	3	Lecture
Protein microarray, Metabolite profile for biomarker detection in the body fluids/tissues under various metabolic disorders using LCMS & NMR	4.3	1, 4	5	Lecture
Module 5: Applications of Molecular Diagnostics (19 Hrs)				
Major Histocompatibility Complex (MHC), HLA typing RFLP, PCR based methods, SSO, SSP and SBT methods. Role of Molecular diagnostics in bone marrow transplantation and organ transplantation. Bone marrow transplant engraftment analysis	5.1	1,5	5	Lecture

Genetic tests for following disorders- Thalassemia, Sickle Cell anaemia, Fragile-X syndrome, Alzheimer's disease, Duchenne Muscular Dystrophy/ Becker's Muscular Dystrophy, Huntington's disease, Down syndrome.	5.2	1,5	5	Lecture
Applications of Molecular diagnostics in malignant disease- Acute and Chronic leukaemia's, Melanoma, colon, lung and breast cancers. Molecular testing of BRCA1 and BRCA2, Circulating tumour cell testing (CTC).	5.3	1,5	4	Lecture
Molecular diagnosis of various viral diseases: Dengue, SARS, Hepatitis virus, HPV, PCR based microbial typing; 16s rRNA typing, Diagnosis of fungal pathogens based on 18S rRNA sequences.	5.4	1,5	5	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Carl Burtis, Edward Ashwood, David Bruns, Tietz textbook of clinical chemistry and molecular diagnostics, 5th Edition, Elsevier Press, 2012.
2. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, 2010
3. Lela Buckingham and Maribeth L. Flaws, Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, F. A. Davis Company, 2019
4. Pongracz J, Keen M, Medical Biotechnology. First Edition, Churchill Livingstone, Elsevier Publication, UK, 2009.
5. Trivedi PC, Medical Biotechnology, First Edition, Aavishkar Publisher. Jaipur, India, 2008.

Reference

1. Albert Sasson, Medical Biotechnology: Achievements, Prospects and Perceptions. United Nations University Press, 2005.
2. Kun LY, Microbial Biotechnology – Principles and applications. World Science publications, 2004
3. Glick BR & Patten CL, Molecular Biotechnology: Principles and applications of Recombinant DNA, Fifth Edition, ASM press, 2017.

Course designed by: Dr. Reshma John

SBU24BT7DSC405: TISSUE ENGINEERING AND REGENERATIVE MEDICINES

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate the fundamental knowledge in stem cell technology and tissue engineering.	U
CO2	Describe the basics of stem cell culturing techniques and the importance of stem cell therapy in treating various diseases and infer the ethical and moral issues in stem cell research.	U
CO3	Discuss the basic requirements and conditions of tissue engineering	U
CO4	Describe the applications of tissue engineering in regenerative medicines and other fields.	U
CO5	Understand the basics, types, applications and ethical issues of bioprinting	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	1	1	2	1	-	-	-
CO2	2	2	-	1	1	2	1	-	-	-
CO3	2	2	-	1	1	2	1	-	-	-
CO4	2	2	-	1	1	2	1	-	-	-
CO5	2	2	-	1	1	2	1	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Seminar	Viva	Exam 1	Exam 2	
CO1	-	-	x	x	-	x
CO2	-	-	x	x	-	x
CO3	-	-	x	x	x	x
CO4	x	-	x	-	x	x
CO5	-	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hour	Transaction Mechanism
Module 1: Basics of Stem Cell Technology (10Hrs)				
Cell diversification in early animal embryo: process of fertilization & stages of development in eukaryotes with special attention to mammals, pluripotency & formation of three germ layers	1.1	1	2	Lecture

Differentiation, dedifferentiation and transdifferentiation, cellular signalling and maintenance of stem cells	1.2	1	2	Lecture
Stem cells & their unique properties	1.3	1	1	Lecture
Types of Stem Cells- embryonic stem cells, adult stem cells, induced pluripotent stem cells, hemopoietic Stem Cells, neural stem cells, muscle and cardiac stem cells, umbilical cord blood stem cells, cancer stem cells, mesenchymal stem cells	1.4	1	3	Lecture
Epidermal stem cells & their applications, hepatic stem cells & their role in liver regeneration	1.5	1	2	Lecture
Module 2: Stem Cell Culture and Therapy (11Hrs)				
Basics of stem cell culture- isolation, expansion, genetic manipulation, genetic reprogramming and cloning of stem cells.	2.1	1, 2	2	Lecture
Stem cell markers, role of feeder layer in stem cell culture. stem cells cryopreservation.	2.2	1, 2	2	Lecture
Stem cell therapy- potential of stem cell therapy for various diseases, eg. AIDS/HIV, Alzhemier's disease, Parkinson disease, anaemia, cancer, anti-ageing, Multiple sclerosis, Rheumatoid arthritis, diabetes, kidney & liver failure	2.3	1, 2	3	Lecture
Stem cell banking	2.4	1, 2	1	Lecture
Use of genetically modified stem cells in experimental gene therapy	2.5	1, 2	2	Lecture
Ethical and moral considerations in stem cell research	2.6	1, 2	1	Lecture
Module 3: Introduction to Tissue Engineering (13Hrs)				
Principles of tissue engineering – history, importance and scope, basics/fundamentals of tissue engineering, tissue dynamics/homeostasis	3.1	1, 3	3	Lecture
Triads of tissue engineering	3.2	1, 3	2	Lecture
Biomaterials and scaffolds in tissue engineering, properties and types of scaffolds	3.3	1, 3	3	Lecture
Tissue specific scaffolds; immune response to scaffolds, methods of scaffold design/preparation	3.4	1, 3	2	Lecture
Cell-ECM/Scaffold interactions, tissue engineering bioreactors.	3.5	1, 3	3	Lecture
Module 4: Applications of Tissue Engineering (11Hrs)				
Tissue and organ regeneration- Design of implants and prostheses based on control of biomaterials-tissue interactions, comparative analysis of intact, biodegradable and bio replaceable implants by reference to case studies	4.1	1, 4	5	Lecture
Bio-artificial organs: skin tissue engineering, liver tissue engineering, bladder reconstruction, kidney tissue engineering, muscle tissue engineering, neural tissue engineering, bone and cartilage tissue engineering, cardiovascular tissue engineering.	4.2	1, 4	5	Lecture
Ethical issues in tissue engineering.	4.3	1, 4	1	Lecture
Module 5: Introduction to Bioprinting (15Hrs)				
Definition of bioprinting; different types of bioprinting techniques	5.1	5	3	Lecture
Introduction to bioinks; properties and formulation of bioink	5.2	5	3	Lecture
3D bioprinting- invitro, in vivo and ex vivo research models and techniques	5.3	5	4	Lecture
In situ bioprinting	5.4	5	1	Lecture
4D bioprinting with examples	5.5	5	3	Lecture

Ethical issues related to bioprinting	5.6	5	1	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. R.M.Twyman, Developmental Biology, Viva Books Pvt. Ltd., 2001
2. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Kieth Roberts and Jamnes D. Watson, Essential Cell Biology, Garland Science, 2nd Edition, Taylor and Francis Group, 2003.
3. Bernhard O. Palsson, Sangeetha N. Bhatia, Tissue Engineering, Pearson, 2004

Reference

1. Marshak, Stem Cell Biology, Cold Spring Harbar Symposium Publication, 2001.
2. Bruce Alberts, Dennis Bray, Alexander Johnson, Julian Lewis, Martin Raff, Kieth Roberts and Peter Walter, Molecular Biology of the Cell, Garland Science, 4th Edition, Taylor and Francis Group, 2003.
3. Willam D. Stansfield, Jaime S.Colorne and Raul J. Cano, Molecular and Cell Biology-Schaum's Outline of Theory and Problems, Tata McGraw Hill Publisher, 2004.
4. Robert A Brown, Extreme Tissue Engineering: Concepts and Strategies for Tissue Fabrication, Wiley Blackwell, 2013
5. W Mark Saltzman, Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues, Oxford University Press, 2004
6. John P Fisher, Antonios G Mikos, Joseph D Bronzino, Tissue Engineering, CRC Press, 2006
7. Robert Lanza, Robert Langer, Joseph Vacanti, Principles of Tissue Engineering, Third Edition, Elsevier Academic Press, 2007
8. Derby B, printing and prototyping of tissues and scaffolds, Science, 2012.
9. Murphy SV, Atala A, 3D bioprinting of tissues and organs, Nature Biotechnology, 2014.

Course designed by: Shija Jacob

SEMESTER VIII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BT8DSC400	Major	Advanced Instrumentation Techniques	5	75	4
SBU24BT8DSC401	Major	Enzyme Technology	5	75	4
SBU24BT8DSC402	Major	Advances in Genetic Engineering	5	75	4
SBU24BT8PRJ400	Major	Project			12

SBU24BT8DSC400: ADVANCED INSTRUMENTATION TECHNIQUES

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the working, principle, and instrumentation of analytical techniques.	U
CO2	Distinguish the principle, instrumentation and applications of centrifugation and chromatography	U
CO3	Discuss various electrophoresis and bioimaging techniques and its uses in detection and identification different compounds	U
CO4	Describe the principle, instrumentation and applications of various spectroscopic, radioactive and diffraction techniques in the analysis of various compounds	U
CO5	Apply the principle of chromatography, electrophoresis and spectroscopy for the separation and quantification of different compounds.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	-	1	2	1	-	-	-
CO2	2	2	-	-	1	2	1	-	-	-
CO3	2	2	-	-	1	2	1	-	-	-
CO4	2	2	-	-	1	2	1	-	-	-
CO5	2	2	-	2	1	2	1	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Seminar	Viva	Exam 1	Exam 2	
CO1	-	-	x	x	-	x
CO2	-	-	x	x	-	x
CO3	-	-	x	x	x	x
CO4	-	-	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Lab involvement	Viva	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Centrifugation and Chromatographic Techniques (12 Hrs)				
Centrifugation: basic principle, types of centrifuges and rotors,preparative and analytical centrifugation.	1.1	1, 2	3	Lecture
Chromatography techniques: theory and application of column chromatography- gel filtration chromatography, ion exchange chromatography, affinity chromatography, GLC	1.2	1, 2	3	Lecture
Liquid chromatography- super critical fluid chromatography	1.3	1, 2	1.5	Lecture
HPLC, NanoLC and HPTLC	1.4	1, 2	2	Lecture
Hyphenated techniques-LC-MS/MS, GC-MS/MS	1.5	1, 2	2.5	Lecture
Module 2: Electrophoresis and Bioimaging Techniques (11 Hrs)				
Theory and application of PAGE, SDS PAGE, agarose gel electrophoresis	2.1	1, 3	2	Lecture
2DE, iso-electric focusing, isotachophoresis	2.2	1, 3	2	Lecture
Pulse field gel electrophoresis, capillary electrophoresis	2.3	1, 3	2	Lecture
Principles and applications of fluorescence microscopy, scanning electron microscopy, transmission electron microscopy	2.4	1, 3	3	Lecture
Atomic force microscopy and electron cryo microscopy	2.5	1, 3	2	Lecture
Module 3: Spectroscopy and Radioactive Techniques (14 Hrs)				
Spectroscopy- basic concepts and nature of electromagnetic radiation, electromagnetic spectrum	3.1	1, 4	1	Lecture
UV–Visible spectroscopy, IR and Raman spectroscopy	3.2	1, 4	2	Lecture
Fluorescence spectroscopy, luminometry, inductively coupled plasma atomic emission spectrophotometry	3.3	1, 4	2	Lecture
NMR spectroscopy- principles of H-NMR and C-NMR	3.4	1, 4	1	Lecture
Mass spectroscopy- MALDI TOF	3.5	1, 4	2	Lecture
Surface plasmon resonance (SPR) spectroscopy, FTIR spectroscopy, spark or arc emission spectroscopy.	3.6	1, 4	2	Lecture
Principles of fluorescence, tracer technology, Dose response relationship	3.7	1, 4	1	Lecture
Radioisotopes in diagnostics and biotechnology	3.8	1, 4	1	Lecture
Geiger-Mueller counter, scintillation counters.	3.9	1, 4	1	Lecture
Non-radioactive tracer technology	3.10	1, 4	1	Lecture
Module 4: Optical and Diffraction Techniques (8 Hrs)				
Principle, instrument design and applications of polarimetry, refractometry	4.1	1, 4	1	Lecture
Principle, instrument design and applications of Circular dichroism (CD) and optical rotatory dispersion (ORD)	4.2	1, 4	2	Lecture
Principle, instrument design and applications of X- ray crystallography	4.3	1, 4	1	Lecture
Manipulation of biomolecules using optical tweezers (optical trapping)	4.4	1, 4	1	Lecture
Flow Cytometry, FACS, MACS	4.5	1, 4	2	Lecture
Thermogravimetry	4.6	1, 4	1	Lecture

Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**

Textbooks

1. Skoog, D.A. F. James Holler, and Stanky, R.Crouch "Instrumental Methods of Analysis", Cengage Learning , 2007.
2. Willard, Hobart, et al., "Instrumental Methods of Analysis",7 th Edition, CBS, 1986.
3. Braun, Robert D. "Introduction to Instrumental Analysis". Pharma Book Syndicate, 1987.
4. Ewing,G.W. "Instrumental Methods of Chemical Analysis", 5 th Edition, McGrawHill, 1985
5. Keith Wilson, John Walker: Principles and Techniques of Biochemistry & Molecular Biology, 7 th edition, Cambridge University Press, 2010.

Reference

1. Sharma, B.K. "Instrumental Methods of Chemical Analysis: Analytical Chemistry" Goel Publishing House, 1972.
2. Haven, Mary C., et al., "Laboratory Instrumentation ", 4th Edition, John Wiley, 1995.
3. Karp, G., Cell and Molecular Biology: Concepts and Experiments, 6th Edition, John Wiley& Sons. Inc., 2010.
4. Prakash M and Arora CK, Laboratory instrumentation, Anmol Publications.
5. Jay Nadeau, Introduction to Experimental Biophysics (Set): Textbook and Lab Manual by CRC Press; 2015.
6. Alexander P, Lundgren HP: A Laboratory Manual of Analytical Methods of Protein Chemistry, Pergamon Press, Oxford, 2014.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Separation Techniques: Chromatography (PC, TLC and Column) (13 Hrs)				
Separation of amino acids by paper chromatography	6.1	5	3	Lab Practice
Separation of amino acids by TLC	6.2	5	5	Lab Practice
Separation of plant pigments by column chromatography	6.3	5	5	Lab Practice
Module 7: Separation Techniques: Electrophoresis (15 Hrs)				
Separation of DNA by AGE	7.1	5	5	Lab Practice
Separation of protein by PAGE	7.2	5	10	Lab Practice
Module 8: Spectrophotometric quantification (2 Hrs)				
Spectrophotometric quantification of DNA	8.1	5	2	Lab Practice

Textbooks

1. Keith Wilson, John Walker, Principles and Techniques of Biochemistry & Molecular Biology, 7 th edition, Cambridge University Press: 2010.

Reference

1. Jay Nadeau, Introduction to Experimental Biophysics (Set): Textbook and Lab Manual by CRC Press, 2015.
2. Alexander P, Lundgren HP, A Laboratory Manual of Analytical Methods of Protein Chemistry, Pergamon Press, Oxford, 2014.

Course designed by: Shija Jacob

SBU24BT8DSC401: ENZYME TECHNOLOGY

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline fundamental properties of enzymes, enzyme kinetics and applications in various fields of Biotechnology	U
CO2	Explain techniques employed in enzymes purification and characterization as well as applications of enzyme technology in food, medical, pharmaceutical and other industries.	U
CO3	Describe various enzyme immobilisation techniques	U
CO4	Discuss the applications of enzyme technology and engineering and to explain the regulatory and ethical aspects of enzyme technology and its implications of enzyme use.	U
CO5	Discuss the isolation and purification of enzymes from its source and identify the effect of substrate concentration, enzyme concentration, temperature and pH on enzyme activity	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	-	1	2	-	-	-	-
CO2	2	2	-	-	1	2	-	-	-	1
CO3	2	2	-	-	1	2	-	-	-	-
CO4	2	2	-	-	1	2	-	-	-	-
CO5	2	2	-	-	1	2	-	-	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	MCQ	Assignment	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	-	x
CO2	x	-	x	x	-	x
CO3	-	-	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	-	x	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Lab involvement	Viva	Record	Lab Test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Enzyme Technology (10 Hrs)				
Introduction to enzymes: definition, properties and classification of enzymes	1.1	1	3	Lecture
Enzyme kinetics: M-M equation and factors affecting enzyme activity	1.2	1	3	Lecture
Purification and characterization of enzymes	1.3	1	4	Lecture
Module 2: Applications of Enzymes in Industry and Research (12 Hrs)				
Enzymes in food industry: use of enzymes in food production, processing and quality control	2.1	1,2	2	Lecture
Enzymes in detergent industry: application of enzymes in detergent production	2.2	1, 2	2	Lecture
Enzymes in biofuel industry: use of enzymes in production of renewable energy.	2.3	1,2	2	Lecture
Enzymes in clinical medicine: role of enzymes in diagnosis and therapy	2.4	1,2	2	Lecture
Enzymes in pharmaceutical industry: application of enzymes in drug discovery, synthesis and formulation	2.5	1,2	2	Lecture
Enzymes in genetic engineering: application of enzymes as tools in gene manipulation	2.6	1, 2	2	Lecture
Module 3: Enzyme Engineering (15 Hrs)				
Immobilisation of enzymes: techniques and applications	3.1	3	3	Lecture
Enzyme engineering: site directed mutagenesis, directed evolution and rational design	3.2	4	3	Lecture
Enzyme stability and methods for storage	3.3	4	1	Lecture
Designer enzymes, Enzyme nanotechnology	3.4	4	4	Lecture
Enzyme inhibitors and drug design Enzymes as biosensors	3.5	4	4	Lecture
Module 4: Regulatory and Ethical Aspects of Enzyme Technology (8 Hrs)				
Regulation of enzymes: overview of regulatory requirements for enzyme use in various industries	4.1	4	2.5	Lecture
Ethical considerations: ethical issues related to use of enzymes in biotechnology	4.2	4	3	Lecture
Future prospects: emerging trends and future applications of enzyme technology	4.3	4	2.5	Lecture
Module 5: Teacher specific content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Nicholas Price & Lewis Stevens, Fundamentals of Enzymology, Oxford University Press, 2009.
2. Trevor Palmer, Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, East west, 2008

3. Murray, Darryl K. Granner, Peter A. Mayes, Harper's Illustrated Biochemistry, Tata Mc Graw hill, 2009.

Reference

1. Holum, J, Elements of General and Biological Chemistry, 2nd edition, Wiley, NY ,1968.
2. Cornish Bowde and Mc Cleland, Principles of Enzyme Technology, Elsevier, 2012.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Enzyme Technology Practicals (30 Hrs)				
Extraction of enzyme from a natural source	6.1	5	4	Lab Practice
Dialysis and chromatographic methods for purification of enzyme from crude extract	6.2	5	6	Lab Practice
Effect of substrate concentration on enzyme activity	6.3	5	5	Lab Practice
Effect of enzyme concentration on enzyme activity	6.4	5	5	Lab Practice
Effect of temperature on enzyme activity	6.5	5	5	Lab Practice
Effect of pH on enzyme activity	6.6	5	5	Lab Practice

Reference

1. Martinek R, Practical Clinical Enzymology: J. Am. Med. Tech., 1969.
2. Holum J. Elements of General and Biological Chemistry, 2nd ed., Wiley, NY, 1968.

Course designed by: Dr. Lijy Jacob

SBU24BT8DSC402: ADVANCES IN GENETIC ENGINEERING

Type of Course	Major		
Course Level	400 – 499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Outline various tools in genetic engineering such as, gene cloning, gene targeting and genome editing technologies.	U
CO2	Explain the strategies for maximizing protein expression in host using inducible expression systems.	U
CO3	Explain the applications of recombinant DNA technology and its potential impact on various fields, including medicine and agriculture.	U
CO4	Describe various techniques used in genetic engineering and develop comprehensive knowledge about latest technologies in DNA sequencing and PCR.	U
CO5	Apply the learned protocols to isolate and purify nucleic acids, conduct PCR analysis and gain hands-on experience to perform routine laboratory procedures.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	-	2	2	-	-	1	-
CO2	2	-	2	-	2	2	-	-	1	-
CO3	2	-	2	-	2	2	1	-	1	-
CO4	2	2	2	-	2	2	1	-	1	-
CO5	2	2	2	-	2	2	-	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Oral presentation	Viva	Exam 1	Exam 2	
CO1	x	-	x	x	x	x
CO2		-	x	x	x	x
CO3	x	x	x	x	x	x
CO4	-	x	x	-	x	x
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Assignment	Viva	Record	Lab test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Tools and Techniques in Genetic Engineering (8 Hrs)				
Introduction to transgenic technology, Enzymes for *in vitro* DNA manipulation	1.1	1	2	Lecture
Expression vectors, vectors amenable for protein purification and export. Shuttle vectors with special emphasis on GateWay ® system.	1.2	1	2	Lecture
Artificial chromosomes, Vectors for bacteria other than *E. coli*, vectors for yeast and other fungi	1.3	1	2	Lecture
Vectors for animal cell lines	1.4	1	2	Lecture
Module 2: Expression Strategies for Heterologous Genes (11 Hrs)				
Principles for maximizing gene expression in vectors - Vector engineering, codon optimization and Host engineering.	2.1	2	2	Lecture
Maximizing protein expression in Bacteria, fungi and animal cells – Promoters- Ca MV promoter, Maize actin 1 gene. Reporter systems	2.2	2	2	Lecture
Expression vectors, Fusion tagged expression system, affinity tag. Studying the translation product- hybrid arrest and hybrid release translations	2.3	2	2	Lecture
Inducible expression system and control of transgene expression through naturally inducible promoters – lac and tet. Steroid hormones as heterologous Inducers. Chemically induced dimerization (CID) as inducible transgene regulation.	2.4	2	3	Lecture
Site specific recombination for efficient gene targeting	2.5	2	2	Lecture
Module 3: Gene Silencing and Genome Editing Technologies (8 Hrs)				
Introduction to gene silencing technology - siRNA, miRNA, and antisense RNA. Principle and application of gene silencing. Gene silencing by homologous recombination. Epigenetic gene silencing.	3.1	1,3	4	Lecture
Introduction to genome editing – TALEN and Zinc-Finger-Nucleases. Genome editing by CRISPR-Cas9 - in vitro synthesis of single guide RNA (sgRNA), Cloning genomic targets into CRISPR/ Cas9 plasmids, evaluation of Cas9 gene editing, applications of CRISPR-Cas9 technology.	3.2	1,3	4	Lecture
Module 4: Applications of Recombinant DNA Technology (8 Hrs)				
Production and purification of recombinant proteins- insulin and somatostatin.	4.1	1, 3	2	Lecture
Gene therapy, Gene Knockout, Animal pharming	4.2	1, 3	2	Lecture
Metabolite engineering, imparting new agronomic traits to plants to improve quality and quantity	4.3	1, 3	2	Lecture
Nanoparticles for labelling, delivery of drugs, DNA and RNA, Bioethics: laws, possible hazards and merits to society or nature	4.4	1, 3	2	Lecture

Module 5: Techniques in Molecular Biology (10 Hrs)				
Serial Analysis of Gene Expression (SAGE), Differential Display. Electrophoretic Methods for mutation detection: SSCP, Heteroduplex analysis, DGGE	5.1	4	2	Lecture
Modifications of PCR: Gene amplification and Analysis-PCR, Multiplex PCR, Allele-Specific PCR, Real-Time PCR, Quantitative fluorescent PCR, ARMS-PCR (Amplification-Refractory Mutation System-PCR)	5.2	4	4	Lecture
Next-Generation Sequencing: Massively Parallel Sequencing Platforms: 454/Roche GS FLX: Illumina Genome Analyzer II: Library Preparation, Cluster Creation, Data Analysis, Paired-End Sequencing. SOLiD 3 System: SOLiD, PacBio SMRT technology and Oxford Nanopore sequencing.	5.3	4	4	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Primrose, S.B.P, Twyman R.M. Principles of gene manipulation and Genomics, 7th Edn, Blackwell Scientific publishers, 2006.
2. Glick, B.J., Pasternak, J.J. and Patten, C.L. Molecular biotechnology, Principles and Applications of Recombinant DNA, 4th edition, Wiley International Publishers,2010.

Reference

1. Brown, T. A, Gene Cloning and DNA Analysis: An Introduction, 7th edn, Wiley-Blackwell,2016
2. Watson, J.D, Recombinant DNA: Genes and genomes; a short course. 3rd edn, WH Freeman &Co, 2006
3. Old, R.W. and Primrose, S.B.P. Principles of Gene Manipulation: An Introduction to Genetic Engineering, 6th edition, Blackwel Scientific, 2006.
4. Jeromy W Dale and Malcom von Shantz, From gene to genomes – Concepts and applications of DNA technology, John Wiley and sons Ltd,2002.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 7: Advances In Genetic Engineering practical's (30 Hrs)				
Isolation of Genomic DNA from Plant / Animal / Bacterial Cells	7.1	5	5	Lab practice
Isolation of Total RNA	7.2	5	5	Lab practice
Isolation of Plasmid DNA	7.3	5	5	Lab practice
Polymerase Chain Reaction	7.4	5	3	Lab practice
Restriction digestion of Bacterial Genomic and Plasmid DNA.	7.5	5	3	Lab practice
Ligation of DNA	7.6	5	3	Lab practice
Preparation of Competent Cells.	7.7	5	2	Lab practice

Transformation in *E. coli*.	7.8	5	2	Lab practice
Screening and selection of Recombinants and Confirmation of Insert DNA in Plasmid	7.9	5	2	Lab practice

Textbooks

1. Sambrook J, Russel D W & Maniatis T. Molecular Cloning: A Laboratory Manual, Cold Spring Harbour Laboratory Press, 2001.

Course designed by: Dr. Reshma John

SBU24BT8PRJ400: PROJECT

Type of Course	Major		
Course Level	400-499		
Credit	12		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Identify a relevant research area and design experiments in the disciplinary or interdisciplinary fields of biotechnology.	A
CO2	Understand methods to collect and manage scientific literature from relevant information sources.	U
CO3	Understand good laboratory practices and attain hands-on training experience on various techniques in biotechnology.	U
CO4	Collect and interpret experimental data to reach valid conclusions.	A
CO5	Develop written and oral scientific communication skills to present experimental procedures and results with valid conclusions	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	2	2	1	-	1	-
CO2	2	-	2	2	2	2	-	-	1	-
CO3	2	2	2	2	2	2	-	-	1	-
CO4	2	-	1	2	2	2	-	-	1	-
CO5	2	-	1	2	2	2	-	-	1	-

Rubrics for Assessment Tools

Each course contains specific assessment tools. However, the faculty teaching the course has the freedom to alter these tools according to the course requirements, with prior permission from the respective Board of Studies.

Rubrics for Assignment

Criteria	Level 1	Level 2	Level 3
Level of Content	Many relevant aspects regarding the topic are missing	Some aspects are missing	All aspects regarding the topic are covered
Organization	Writing lacks logical organization. It shows some coherence but ideas lack unity.	Writing is impartially coherent and medium level of logical organization.	Writing is coherent and logically organized. Overall unity of ideas is present.
Reference	Lack clarity of sources and are unauthentic	Sources are listed properly but many are unauthentic	Enough reference and all the sources are authentic

Rubrics for Poster Presentation

Criteria	Level 1	Level 2	Level 3
Clarity	Script is confusing and hard to follow	Script is relevant and easy to follow	Script is purposeful and easy to follow
Quality of content	Content is undeveloped and does little to sustain the attention of the reader	Provides relevant content that engages the reader	Provides pertinent content that captivates the reader
Visual support	No visuals that support the assigned content	Visuals included that support the assigned content. Some visuals that do not support the assigned content or distracting from main ideas	more visuals that support the assigned content

Rubrics for Viva

Criteria	Level 1	Level 2	Level 3
Clarity in the understanding concepts	Only superficial knowledge in most of the topics	Adequate understanding in most of the topics, but fails to elaborate	Good understanding with explanation ability
Communication skills	Struggle to communicate the concepts	Limitations in concept clarity, proper vocabulary and articulation	Concept clarity, proper vocabulary and perfect articulation

Rubrics for Record

Criteria	Level 1	Level 2	Level 3
Presentation and punctuality	Not Punctual and submit incomplete record Poor presentation	Punctual in submission of record in a satisfied manner, Fair presentation	Punctual in submission of record work in an exemplary manner Neat and excellent presentation

Writing and Organization	No headings and diagrams. Not labelled or labelled incorrectly	Good documentation of record with some unlabelled diagrams and headings	Excellent documentation of record with index, title, labelled diagrams

Rubrics for oral presentation

Criteria	Level 1	Level 2	Level 3
Organization & Style	Lack of organization or coherence, not adequate information, Missing introduction or conclusion	Mostly clear organization Sufficient coverage of topic, Weak introduction or conclusion	Clear, well-organized structure, Information presented is accurate, well-researched, and relevant to the topic,Strong introduction and conclusion
Presentation Skills	Significant hesitancy or lack of confidence	Generally confident delivery	Confident, engaging delivery
Time Management	Presentation significantly exceeds time limit, fails to engage audience	Significant deviation from time limit, Limited audience engagement	Presentation fits within allotted time, Engages audience through interaction

Rubrics for lab involvement

Criteria	Level 1	Level 2	Level 3
Preparation	student frequently comes to lab unprepared, and demonstrates a poor understanding of the experiment's objectives and procedures.	Student usually comes to lab prepared demonstrates a satisfactory understanding of the experiment's objectives and procedures.	Student consistently comes to lab well-prepared, and demonstrates a clear understanding of the experiment's objectives and procedures.
Participation	Rarely participates in lab activities, group work, or hands-on experimentation.	Generally, participates in lab activities, and need encouragement to participate fully.	Actively engages in all aspects of the lab, asks relevant questions, and collaborates effectively.
Laboratory Skills	Shows poor technique and proficiency in lab procedures, frequently making errors that compromise the accuracy or safety of experiments.	Generally, demonstrates competent technique in performing lab procedures with occasional errors.	Demonstrates excellent technique and proficiency in executing lab procedures accurately and safely.

Rubrics for Case study report

Criteria	Level 1	Level 2	Level 3
Identification of Main Issues Problems	Unable to identify issues in the case study	understanding in identification of issues in the case study	Excellent understanding in identification of issues. in the case study
Analysis of the Issues	No analysis on the issues	Adequate analysis of the issues	Excellent analysis of the issues.
Provide suggestions on appropriate solutions	No suggestion for solutions to the issues in the case study	Adequate suggestion and appropriate solutions to the issues in the case study	Excellent and very appropriate suggestion on solutions to the issues in the case study
Writing Style	Not using proper grammar, spelling and writing effective sentences that make logical sentences.	Adequate use of proper grammar, spelling and writing effective sentences that make logical sentences	Exceptional use of proper grammar, spelling and writing effective sentences that make logical sentences.

Rubrics for Quiz

Criteria	Level 1	Level 2	Level 3
General approach	Doesn't really address the question. States few relevant answers. Reveals some misconceptions. Is not clearly or logically organized. Errors in grammar and style.	Doesn't address the questions explicitly, although does so tangentially. States a relevant and justifiable answer. Presents arguments in a logical order. Uses acceptable style and grammar (1-2 errors).	Addresses the question. States a relevant, justifiable answer. Presents arguments in a logical order. Uses acceptable style and grammar (no errors).
Comprehension	Doesn't demonstrate accurate understanding of question but makes an effort. No evidence to support response to question.	Demonstrates an accurate but only adequate understanding of the question. Doesn't back conclusions with data. Uses only one idea to support the answer. Less thorough than above.	Demonstrates an accurate and complete understanding of the question. Backs conclusions with data and justifications. Uses 2 or more ideas, examples and/or arguments that support the answer.

Rubrics for Industry visit

Criteria	Level 1	Level 2	Level 3
Level of engagement in industry visit	Unable to attend the industry visit and never contribute to visit by ideas and questions	Attend the visit and rarely Contribute to the visit by offering ideas and asking questions	Attend the visit and proactively contribute to visit by offering ideas and frequently asking questions
Collection of data during industry visit	Not collecting proper data from industry	Collecting data from each department of the treatment plant by interactions with experts in there	Collecting data from each department of the treatment plant by interactions with experts with supporting photographs.
Analysis Of the data	No analysis on the data	Decent analysis on the data	Adequate analysis of the data
Writing Style of industry visit report	Not using proper grammar, spelling and writing effective sentences that make logical sentences.	Inadequate use of proper grammar, spelling and writing effective sentences that make logical sentences.	Adequate use of proper grammar, spelling and writing effective sentences that make logical sentences and report with supporting photographs.

Appendix

SHORT TERM COURSES

The main objective of the short term courses offered by the college is to supplement the students with various skills and technical know-how outside the structured academic curriculum, to produce quality citizens who are academically proficient, self-reliant and socially committed. The courses have compulsory components and optional components that equip the students to attain various programme objectives envisaged by the Vision and Mission statements of the college.

All Short-Term Courses (STCs) are coordinated by the Department of Short Term Courses, headed by a Director and is supervised by a Vice Principal nominated by the Principal. Each component of the STC is coordinated and managed by a Faculty Convener. The Advisory Board of the Department consists of the Vice-Principals, Director of the Short Term Courses and the various Conveners.

In case of any grievances, students can approach the Grievance Redressal Cell of the STC which consists of the Vice-Principal in Charge, Director and the concerned Convener. If the student feels that the issue was not adequately addressed, he/she can approach the Grievance Redressal Cell of the college. The grading pattern for all courses will be the same as in the UG regulations 2024. The courses offered by the department are given in the following table.

	Name	Semesters	Type	Credit
1	Value Education	I to VI	Compulsory	3
2	Basic Life Support System and Disaster Management (BLS & DM)	I	Compulsory	1
3	Social Awareness Course (SAC)	I and II	Compulsory	2
4	Skill Development Courses (SDC)	II and III	Optional	2
5	Finishing School	III and IV	Compulsory	1
6	Virtual Lab Experiments	V	Optional	1

REGULATIONS FOR SHORT TERM COURSES

VALUE EDUCATION

Value Education is a compulsory extra credit course with three (3) credits for all the students admitted to the undergraduate programmes.

Duration

The duration of the course shall be three academic years (six semesters). There shall be minimum 60 hours spread over three years with 20 hours every academic year.

Evaluation

The evaluation of each course shall contain two parts.

i. Continuous evaluation (every year)
ii. Final evaluation (every year)

There shall be a maximum of 50 marks comprising of forty (40) marks for final evaluation and ten (10) marks for continuous evaluation.

Continuous Evaluation

Component	Marks
Assignment	5
Attendance	5
Total	10

1. **Assignment**

   The students shall submit at least one assignment in every year. The marks for assignment is five (5).

2. **Attendance**

   The minimum requirement of aggregate attendance during a year for appearing the final examination shall be 75%.

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Final evaluation

Final evaluation shall be conducted by the course coordinator at the end of every year.

There shall be an annual written examination of one and a half hours (1½) duration with a maximum forty marks (40), every year.

The question paper shall be strictly on the basis of model question paper set by the Expert Committee.

A question paper consists of short answer type, short essay type and long essay type questions.

The total marks of the course (three years combined) shall be one hundred and fifty (150).

Award of certificate

A separate minimum 30% marks each for continuous evaluation and final evaluation and an aggregate minimum of 35% are required for a pass in the course.

If a student does not acquire minimum marks in first and second years, he/she can continue the course.

The student shall be eligible to get certificate only after completing the course with D Grade. On successful completion of the course, the grade awarded will be indicated in the Mark cum Grade Card.

The grading pattern will be the same as in UG Regulations 2024.

The course shall be completed during the tenure of the programme.

BASIC LIFE SUPPORT SYSTEM AND DISASTER MANAGEMENT (BLS & DM)

- The main objective of this course is to provide intensive training on Basic Life Support System and Disaster Management with the help of professional trainers and adequate numbers of mannequins and kits for imparting the training to students.
- This course is compulsory for all the undergraduate students of this college and has one (1) credit.
- The course on BLS & DM shall be conducted by a nodal centre created in the College.
- Each student shall undergo five (5) hours of hands-on training in BLS & DM organised by the Centre for BLS & DM.
- After the completion of the training, the skills acquired shall be evaluated using an offline/online test and grades shall be awarded.
- Nodal Centre for BLS & DM shall conduct an online test and publish the results.
- Students who could not complete the requirements of the BLS & DM training shall appear for the same along with the next batch.
- The grading of the course is as per the grading pattern in UG Regulations 2024.

SOCIAL AWARENESS COURSE (SAC)

- The aim of SAC is to make students aware of the problems that different societies and communities face on a day-to-day basis and to be conscious of the difficulties and hardships of society.
- This is a compulsory course with two (2) credits.
- Social Awareness Course shall be conducted by a nodal centre consisting of the convenor, other faculty members nominated by the Principal.
- The centre shall identify the areas where the students can serve the society through the course.
- During the first semester itself, the centre shall organise activities to sensitize the students about the significance and relevance of Social Awareness and publish a list of different areas where they can work as volunteers.
- The centre shall allot students to various areas based on their preference.
- Students shall carry out the voluntary work allotted to them after the regular class hours/weekends/holidays falling in the first and second semesters and the summer vacation following the second semester.
- Evaluation of the SAC activity shall be based on the hours of work put in by a student. A minimum of 50 hours of social work (corresponding to 50 marks) is required for the successful completion of the course. Every additional work beyond the minimum 50 hours shall fetch five (5) marks per hour. Maximum marks shall be 100.
- Students who donate blood during the first year shall be given 10 marks on production of the certificate from the medical officer. However, marks earned through blood donation shall not be counted for a pass in the course. Mark for blood donation shall be awarded only once during the SAC.
- Two credits shall be awarded to students who complete the requirements of SAC.
- The grading will be as per the grading pattern in the UG Regulations 2024.
- Students who could not complete the requirements of the SAC shall appear for the same with the next batch.
- The Director of Short-Term Courses and Convenor of SAC has the right to exclude students who are physically challenged from SAC, if requested.

SKILL DEVELOPMENT COURSES (SDC)

- This is a compulsory component of STC with two (2) credits.
- SDC's shall be completed within the first four semesters of the programme.
- Depending on the nature of the course, there will be a theory component and a skill development component.
- The credit will be awarded only if the student gets a D grade (35% marks) and above.
- A student can do a maximum of three skill Development Courses according to his/her choice, but pass in at least one course is compulsory.
- The Convenor of SDC will coordinate the course.
- The Head of the Department concerned in consultation with the faculty members may prepare a syllabus for the SDC, which will be approved by the Board of Studies concerned.

Evaluation of SDC

The evaluation the course shall be done internally and contain two parts.

i. Continuous evaluation
ii. Final evaluation

Both continuous evaluation and final evaluation shall be carried out using indirect grading. The marks for continuous evaluation is twenty (20) and that of the final evaluation is eighty (80).

Continuous evaluation

The components of the continuous evaluation and their marks are as below.

For all courses, without practical

There are two components for continuous evaluation, which include attendance and assignment. All the components of the continuous evaluation are mandatory.

Component	Marks
Attendance	5
Assignments	15
Total	**20**

Marks for attendance

Minimum 75% attendance is compulsory for attending the final examination.

% of Attendance	Marks
90 and above	5
85 - 89	4
80 – 84	3
76 – 79	2
75	1

(Decimals shall be rounded mathematically to the nearest whole number)

For all courses with practical

The components for continuous evaluation of courses with practical are given below.

Component	Marks
Attendance	5
Lab/skill work involvement	15
Total	**20**

Assignments

At least one assignment shall be submitted for the course.

Final evaluation

The final evaluation of theory and practical courses shall be conducted by the office of the Controller of Examinations. It can be in the form of 80 marks written examination or 80 marks project/practical examination or 80 marks written and project/practical examination combined, as decided by the Board of Studies concerned.

FINISHING SCHOOL

- It is a compulsory course with one (1) credit.
- The course provides compulsory training for all under graduate students of this college.
- The training is to help students develop their soft skills and interview skills.
- The training shall impart soft skills comprising of language skills, personal presentation and grooming, table manners, resume preparation, group discussion techniques, and interview skills among the undergraduate students.
- This course shall be conducted during the third and fourth semesters for all the undergraduate students.
- There will be a total of 20 contact hours which shall be handled by a team of professional members/faculty. In addition, a one-day outbound training session by a team of professional trainers that touches on the aspects of creativity, problem solving and team building shall also be organized.
- The students shall be assessed on the basis of the components given below.

Component	Marks
Attendance	5
Aptitude Test	10
Assignments	10
Group discussion	10
Interview	15
Total	**50**

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

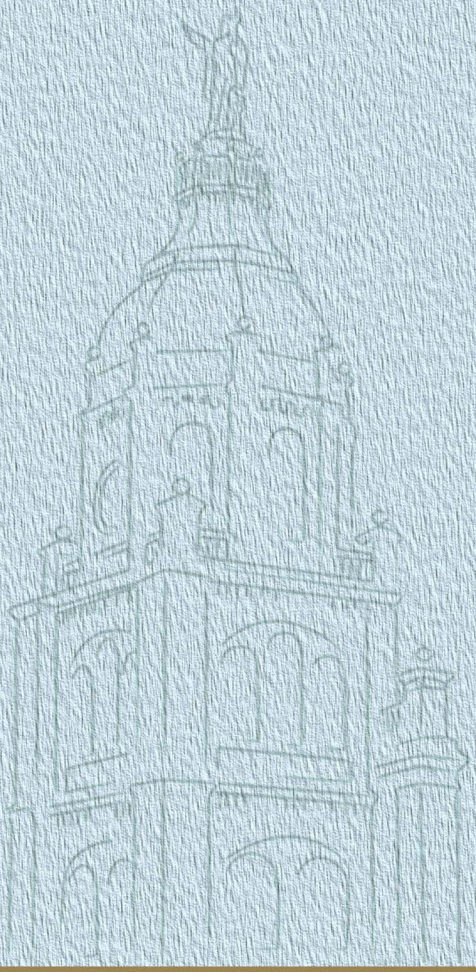
% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Grades will be awarded as per grading pattern in UG Regulations 2024.

VIRTUAL LAB EXPERIMENTS

- This is an optional course with one (1) credit.
- The main aim of the Virtual Lab Experiments is to provide remote-access to simulation-based Labs in various disciplines of Sciences which enthuse students to conduct experiments by arousing their curiosity.
- The Convenor will coordinate the Virtual Lab component and he may use the services available in different virtual lab platforms after the approval of the advisory body.
- Students have to do at least 36 hours of experiments and they get a maximum of one credit for this.
- Convenor and the mentor of the student shall oversee the progress and assign grades as per the grading pattern in UG Regulations 2024 after the completion of the programme.



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