THE MAHATMA GANDHI UNIVERSITY UNDERGRADUATE PROGRAMMES (HONOURS) SYLLABUS

MGU-UGP (Honours)

(2024 Admission Onwards)

Faculty:Science

BoS:Biotechnology (UG)

Subject: Bachelor of Science (Honours)

Biotechnology

Mahatma Gandhi University
Priyadarshini Hills
Kottayam – 686560, Kerala, India

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Preface

We are very happy to present the new curriculum and syllabus for the **BSc (Honours) Biotechnology** Programme for favour of approval by the Faculty of Science and Academic Council of Mahatma Gandhi University, Kottayam, Kerala, India.

We are delighted to present the FYUGP syllabus for the B.Sc. Biotechnology (Honours) programme, an undergraduate programme focusing on applied biosciences. This program delves into the utilization of living organisms and their properties across various sectors such as bioprocess technology, pharmaceuticals, industries, agriculture, and food sciences, catering to a multitude of societal needs. The formulation of this syllabus is the culmination of dedicated efforts by a group of educators who meticulously crafted it, considering terms like Outcome Based Education, Academic Bank of Credit, and Skill Based Subjects.

The syllabus prioritizes skill-based education, meticulously designed to cultivate graduate attributes and learning outcomes in a systematic manner. Acknowledging the practical nature of biotechnology, substantial efforts were made to incorporate hands-on experiences. The curriculum framework is structured to provide a robust foundation, enabling students to pursue further studies and research while acquiring essential skills.

Incorporating cutting-edge technology and online resources like MOOCs has been a key focus to enhance the learning process. By emphasizing cognitive abilities and practical skills, the syllabus aims to prepare students for diverse professional careers in our rapidly evolving, knowledge-driven society. Additionally, it underscores the importance of maintaining globally competitive standards while fostering scientific curiosity, critical thinking, and ethical values among students.

The programme aims to deliver a high-quality curriculum with strong vocational elements, nurturing intellectual growth and manpower development in key areas of modern biotechnology. From molecular biology to bioinformatics, the program offers a wide range of opportunities spanning classical to applied aspects of biotechnology.

Furthermore, the syllabus aims to instil a deep understanding of the interdisciplinary nature of biotechnology and its significance in addressing global challenges. Through a combination of theoretical knowledge and practical application, students are equipped with the necessary tools to tackle real-world problems effectively.

The curriculum also emphasizes the importance of research and innovation, encouraging students to explore new ideas and contribute to advancements in the field. By fostering a spirit of inquiry and problem-solving skills, the programme prepares students to become leaders in biotechnology and allied industries.

Moreover, the syllabus is designed to promote inclusivity and diversity, ensuring that all students have equal opportunities to succeed. By creating a supportive and collaborative learning environment, the programme aims to inspire students to reach their full potential and make meaningful contributions to society.

Mahatma Gandhi University has taken tremendous effort to stay in tune with the directions from the Government and UGC for implementing the programme in time. As a part many training programmes have been conducted. The BoS of Biotechnology (UG) conducted a five-day workshop on the curriculum at CMS College, Kottayam. During this workshop, the new curricula and syllabus have been designed and representative teachers from all colleges running the B.Sc Course have participated and suggestions were taken. Dr. Jinu John, the head and Assistant Professor, Department of Biotechnology, C M S College, Kottayam was the subject expert and Dr. Shibin Mohanan, Assistant Professor in Botany, Nirmala College, Moovattupuzha was the Master Trainer.

With dedicated efforts, wholehearted support and involvement of all the members of the Board of Studies, the task of preparing the curricula and syllabi and bringing it out in the present form was made possible. I sincerely express my whole-hearted gratitude to all the fellow members of the BoS for their endless help, cooperation and encouragement showered on me for the completion of this great task. I am also thankful to all teacher representatives from Biotechnology departments of various colleges, external and internal experts for their active participation and fruitful suggestions during the syllabus design process.

I would like to express our deep sense of gratitude to Dr. Sajeshkumar, N. K, Assistant Professor and Head, Department of Biotechnology, M A College, Ramapuram, Pala, Dr. Seema Panicker, Assistant Professor and Head, Department of Biotechnology, St. Mary's College, Thiruvalla and Ms. Jyothi C Nair, Assistant Professor and Head, Department of Biotechnology, Indira Gandhi College of Arts and Science, Nellikkuzhi, Kothamangalam for their valuable inputs and help.

The objectives of the B.Sc. Biotechnology programme are to empower the students from the basics of interdisciplinary life-sciences to the recent trends in Biotechnology and its applications for the benefit of the community. The course empowers the students with conceptual and practical skills of biotechnology and introduces the students to the latest developments in biotechnology. It is fast emerging as a top course providing distinct advantages to students as it finds applications in various aspects of life sciences. The learning outcomes-based curriculum framework for a degree in B.Sc. (Honours) Biotechnology is intended to provide a comprehensive foundation for the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with the required skills at various stages. This course serves a plethora of opportunities in different fields right from classical to applied aspects in Biotechnology.

Board of Studies & External Experts

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   Assistant Professor
   Department of Zoology
   St. Thomas College, Palai. Kottayam.

Subject Experts

1. **Dr. Sajesh Kumar, N.K**. Assistant Professor and Head. Mar Augusthinose College Ramapuram, Pala, Kottayam.

2. **Dr. Seema Panicker**, Assistant Professor, St.Mary's College, Thiruvalla.

3. **Smt. Jyothi C Nair**, Assistant Professor, Indira Gandhi College of Arts and Science, Nellikkuzhi, Kothamangalam.

4. **Smt. Resiya Karim**, Assistant Professor, Department of Biotechnology, MES College, Marampally, Aluva.

5. **Dr. Jayesh Kuriakose**, Assistant Professor, Department of Biotechnology, The Cochin College, Cochi.

6. **Dr. Jinu John,** Assistant Professor and Head, Department of Biotechnology, CMS College (Autonomous) Kottayam.

7. **Dr. Shibin Mohan,** Assistant Professor, Department of Botany, Nirmala College, Moovattupuzha.

Syllabus Index

Name of the Major: Biotechnology

Semester: 1

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG1DSCBTG100	Fundamentals for Biotechnology	DSC A	4	5	3	0	2	0
MG1MDCBTG100	Ecology and Environmental Science	MDC	3	4	2	0	2	0

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

Semester: 2

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG2DSCBTG100	Applied Biotechnology	DSC A	4	5	3	0	2	0
MG2MDCBTG100	Tools and Techniques in Biotechnology	MDC	3	4	2	0	2	0

Semester: 3

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG3DSCBTG200	Biophysics and Instrumentation	DSC A	4	5	3	0	2	0
MG3DSCBTG201	Cell Biology and Genetics	DSC A	4	5	3	0	2	0
MG3DSCBTG202	Fundamentals of Molecular Biology	DSC B	4	5	3	0	2	0
MG3DSEBTG200	Developmental Biology and Assisted Reproduction Technology	DSE	4	4	4	0	0	0
MG3DSEBTG201	Plant and Animal Physiology							
MG3MDCBTG200	Nutritional Biotechnology	MDC	3	3	3	0	0	0
MG3VACBTG200	Environmental Biotechnology and Human Rights	VAC	3	3	3	0	0	0

Semester: 4

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG4DSCBTG200	Molecular Biology	DSC A	4	5	3	0	2	0
MG4DSCBTG201	Immunology	DSC A	4	5	3	0	2	0
MG4DSEBTG200	Biosafety and Bioethics	DSE	4	4	4	0	0	0
MG4DSEBTG201	Biostatistics							
MG4DSCBTG202	Tissue Culture Techniques	DSC B	4	5	3	0	2	0
MG4SECBTG200	Quality Control in Biology	SEC	3	3	3	0	0	0
MG4VACBTG200	Human Resource Management in Biotechnology	VAC	3	3	3	0	0	0

MG4INTBTG200	INTERNSHIP	INT	2 Credits

Semester: 5

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours / week	Hour Distribution /week			
					L	T	P	O
MG5DSCBTG300	Recombinant DNA Technology	DSC A	4	5	3	0	2	0
MG5DSCBTG301	Enzyme Technology	DSC A	4	5	3	0	2	0
MG5DSEBTG300	Biotechnology and Entrepreneurship	DSE	4	4	4	0	0	0
MG5DSEBTG301	Basic Bioinformatics	DSE	4	4	4	0	0	0
MG5DSEBTG302	Bioprocess Technology	DSE	4	4	4	0	0	0
MG5DSEBTG303	Marine Biotechnology							
MG5SECBTG300	Scientific communication in research	SEC	3	3	3	0	0	0

Semester: 6

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG6DSCBTG300	Plant and Animal Biotechnology	DSC A	4	5	3	0	2	0
MG6DSCBTG301	Cancer biology and Cell signalling	DSC A	4	4	4	0	0	0
MG6DSEBTG300	Industrial Biotechnology	DSE	4	5	3	0	2	0
MG6DSEBTG301	Food Biotechnology							
MG6DSEBTG302	Sustainable Biotechnology	DSE	4	4	4	0	0	0
MG6DSEBTG303	Intellectual Property Rights and Patenting							
MG6SECBTG300	Skills in Biotechnology	SEC	3	4	2	0	2	0
MG6VACBTG300	Biotechnology for Nourishing Health	VAC	3	3	3	0	0	0

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Semester: 7

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG7DCCBTG400	Genomics and Transcriptomics	DCC	4	4	4	0	0	0
MG7DCCBTG401	Advanced cell and Molecular Biology	DCC	4	5	3	0	2	0
MG7DCCBTG402	Research Methodology and Scientific Writing	DCC	4	4	4	0	0	0
MG7DCEBTG400	Advanced Bioinformatics	DCE	4	4	4	0	0	0
MG7DCEBTG401	Disease and Diagnostic Biotechnology	DCE	4	4	4	0	0	0
MG7DCEBTG402	Immunoengineering	DCE	4	4	4	0	0	0
MG7DSEBTG400	Agricultural Biotechnology *	DSE	4	4	4	0	0	0
MG7DSEBTG401	Proteomics*	DSE						
MG7DSEBTG402	Genetic Engineering*	DSE						

* for those who are opting Biotechnology as minor.

Semester: 8

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
MG8DCCBTG400	Advanced Instrumentation technique	DCC	4	5	3	0	2	0
MG8DCCBTG401	Analytical & Molecular Techniques	DCC	4	8	0	0	8	0
MG8DCEBTG400	Molecular Mechanism of learning and Memory	DCE	4	4	4	0	0	0
MG8DCEBTG401	Biopharmaceuticals and Nanotechnology	DCE	4	4	4	0	0	0
MG8DCEBTG402	Forensic Biotechnology	DCE	4	4	4	0	0	0
MG8DCEBTG403	Stem Cell & Tissue Engineering	DCE	4	4	4	0	0	0
MG8PRJBTG400	Project	PRJ	12					

Any three DCE

SEMESTER-1

Mahatma Gandhi University
Kottayam

Programme	**BSc (Hons) Biotechnology**				
Course Name	**Fundamentals for Biotechnology**				
Type of Course	**DSC A**				
Course Code	**MG1DSCBTG100**				
Course Level	**100-199**				
Course Summary	Fundamentals of Biotechnology covers essential concepts related to various fields of Biotechnology. Module 1 gives basic ideas about the historical background on the field cell biology Biotechnology. Module 2 covers basics of Genetics, Immunology and Microbiology. Module 3 deals with the structure and function of biomolecule and rDNA Technology and its applications. Module 4 covers various aspects of Good laboratory practices.				
Semester	1	Credits		4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others
		3	0	1	0	75
Pre-requisites, if any	NA				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	On completion of the course students will be able to identify the scope of biotechnology, tracing its historical development from ancient to modern times.	K	2, 3, 6,10
2	Students will be able to discuss the various applications of biotechnology in medicine, agriculture, and industry.	U	1, 10
3	Students could apply their knowledge to solve problems like monohybrid and dihybrid crosses in genetics.	An	2, 5, 9,10
4	Students gain the knowledge of good laboratory practices.	U	1,2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs.	CO No.
1 Introduction to Biotechnology and the Cell.	1.1	**History of Biotechnology** Biotechnology - Definition, History and scope of Biotechnology, Conventional Biotechnology and Modern Biotechnology, Milestones in the development of Biotechnology. Career aspects and applications of biotechnology.	4	1, 2
	1.2	Cell theory, Cell as a tool for biotechnology. Prokaryotic and Eukaryotic cell structure.	4	1, 2
2 Overview of Genetics, Microbiology and Immunology	2.1	Introduction to Mendelian genetics; Mendelian laws; Monohybrid and Dihybrid experiments.	4	1, 2
	2.2	Introduction to Microbiology, microbial diversity – General characteristic of bacteria, fungi, virus microscopic algae and protozoa.	6	1, 2
	2.3	An overview to immunology- antigen, antibody; Cells of immune system.	6	3
3 Biomolecules-Structure and Function	3.1	General classification of Carbohydrates, Proteins, Lipids and Nucleic acids. General structure and characteristic of Carbohydrates, Proteins, Lipids and Nucleic acids.	6	1, 2
	3.2	Structure and function of nucleic acids; An outline to DNA replication, transcription and translation.	8	2
	3.3	An introduction to Recombinant DNA technology, Basic steps in rDNA technology. Applications of rDNA technology–Vaccine-Hepatitis, Covid; Hormones- Humulin, Growth hormone.	8	2
4 Practical	4.1	Overview of laboratory safety rules and regulations, Maintenance of aseptic conditions and personal hygiene.	5	4
	4.2	Introduction to the laboratory layout and equipments. Cleanliness of laboratory wares and workspace.	6	4
	4.3	Biological safety measures and maintenance of live cells, Maintenance of Sterility.	6	4
	4.4	Sources of spillage and contamination, Methods of decontamination, Waste management practices in laboratory.	8	4
	4.5	Documentation and record keeping in laboratory.	5	4
5		**Teacher specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks 5 hrs.	Major expt./ procedure/ case study analysis – 15 Minor expts./ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

Reference

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2. Campbell, N. A., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Reece, J. B. (2017). Biology (11th ed.). Pearson.
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4. Mader, S. S., & Windelspecht, M. (2018). Biology (13th ed.). McGraw-Hill Education.
5. Solomon, E. P., Berg, L. R., Martin, D. W., & Villee, C. A. (2017). Biology (10th ed.). Cengage Learning.
6. Brooker, R. J., Widmaier, E. P., Graham, L. E., & Stiling, P. D. (2018). Biology (5th ed.). McGraw-Hill Education.

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Programme						
Course Name	**Ecology and Environmental Science**					
Type of Course	MDC					
Course Code	**MG1MDCBTG100**					
Course Level	**100-199**					
Course Summary	Course enlightens with the importance of conserving and maintaining the ecosystem, appraise the impact of restoration of ecosystems around the globe					
Semester	1	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		2	0	1	0	60
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome On completion of the course the student will able to	Learning Domains *	PO No
1	Identify the basic components of ecosystem	U	1,2,3
2	Evaluate the different conservation strategies and technologies.	A	2,3
3	Compare various restoration projects happened globally	A	2,3
4	Justify the restoration policies in India	E	1,2,3
5	Compare the restored ecosystem and policies	E	1,2,3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Ecosystem and Biodiversity	1.1	**Ecosystem features and significance** Definition and characteristics of ecosystems. Biotic and abiotic components. Ecosystem services and their significance. Ecosystem Processes- Food chain, Food web	4	1
	1.2	**Energy flow and Nutrient cycling.**	4	1

		Outline of Energy flow and nutrient cycling (Nitrogen and Carbon).		
	1.3	**Biodiversity** Ecosystem Dynamics and Conservation: Ecological Succession. Threats to ecosystems.	4	2
	1.4	**Biodiversity conservation.** Conservation strategies- National Park, Wildlife Sanctuaries and restoration ecology, Germplasm conservation strategies.	4	2
2 Ecosystem Restoration	2.1	**Ecosystem restoration globally:** Various ecosystem restoration projects around the globe: Arabian Oryx Reintroduction (Oman).	4	3
	2.2	**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.	10	3
3 Practicals	3.1	**Environmental protection Movements and mission in India.** **Case study report**:- Bishnoi movement, Chipko movement, Save Silent Valley movement, Jungle Bachao movement, Save the Western Ghats Movement, Swachh Bharat Abhiyan.	12	4
	3.2	**Ecosystem Restoration Projects.** **Case study report** : Ecological rehabilitation of the Aravalli hills, Chambal River Conservation-Madhya Pradesh and Rajasthan.	8	4
	3.3	**Field study:** Visit to any National Park or wild life sanctuary and prepare the study report.	10	2
4		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Class room lecture, ICT enabled classes, Discussions, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 15 marks Practical – CCA : 15 marks

	B. End Semester Examination – 1.0 hr. Theory : 35 marks Practical : 35 marks
Pattern of questions	Total marks: 35 marks (1.0 hr.) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :3 out of 5 3x3= 9 marks Short essay (6 marks) :1 out of 2 1x6= 6 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical (35 marks) 5 hrs	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References:

1. Allison, S. K (2014). Ecological restoration and environmental change: Renewing damaged ecosystems. Routledge
2. Singh, J.S., S.P & Gupta, S.R (2006). Ecology, Environment and Resource conservation. Anamaya Publ., New Delhi
3. Chapman, J.L.& M.J. Reiss (1998). Ecology: Principles and Applications. Cambridge Univ. press. 2 nd edition.
4. Peter Stiling (2015). Ecology: Global Insights & Investigations 2nd Edition. McGraw-Hill international edition
5. Krishnamurthy KV (2003) An Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.
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SEMESTER-2

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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Applied Biotechnology**					
Type of Course	**DSC A**					
Course Code	**MG2DSCBTG100**					
Course Level	**100-199**					
Course Summary	The course covers a broad range of topics related to the application of biological systems, organisms, or derivatives to develop or create new products or processes beneficial to the society.					
Semester	2	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	After completing this course, the students will		
1	Understand the past, present, and future of Biotechnology, enable to critically analyze and contribute to the field's ongoing advancements.	U	1,10
2	Ability to differentiate between the diverse domains of biotechnology.	U	1,2,3,10
3	Capable of evaluating the highlighting methods in biotechnology.	E	1,2,3,8,10
4	Able to comprehend the opportunities in various biotechnological institutes and companies.	U	1,2,5,6
5	Evaluate the recent advancements and products in biotechnology and its impacts on society	E	1,2,6,8,10
6	Able to handle laboratory wares and chemicals, prepare solutions and reagents and verify the quality of reagents.	A	1,2,3,5

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Biotechnology	1	**Scope of Biotechnology** Multidisciplinary nature of Biotechnology, Trends and emerging technologies in Biotechnology- Personalized medicine, 3D-bioprinting.	3	1
2 Applied Biotechnology	2.1	**Colours of Biotechnology** Colours of Biotechnology: Green, blue, white, red, grey, gold, dark.	3	2
	2.2	**Industrial (White)Biotechnology** Enzymes for textile industry, breweries, food supplements-SCP, Vitamins, food processing-cheese, yogurt, biodegradable plastics, biofuels.	5	2
	2.3	**Environment (Grey) Biotechnology** Waste management, Biodegradation of heavy metals, water cleaning, removing oil spills, air and soil pollution, bioremediation, biomining.	4	2
	2.4	**Medical (Red) Biotechnology** Antibiotic production, molecular diagnostics, vaccines and vaccine delivery, recombinant therapeutics, insulin, forensics.	5	5
	2.5	Overview of Recombinant DNA Technology and its applications, Human Genome Project – Objectives and Features, Ethical Legal and Social Issues (ELSI), Its implications	5	5
3 Biotechnology in Human Welfare	3.1	Genetically Modified Organisms- Methodology, Merits and Demerits. Transgenic animals: Features, merits and demerits of - Polly, Rosie the cow, Glo fish, GFP animals. Golden rice, Flavr Savr Tomato.	5	4
	3.2	Animal Vaccine production, Improvement of livestock-increased milk production, artificial insemination, poultry and fisheries.	4	4
	3.3	**Recent advances in Biotechnology** CRISPR-Cas9, Synthetic biology - Artificial Cell-Types and its applications. Bio printing, Xenografts; AI and Bio-robotics, Fundamental concepts	4	5
	3.4	**Nanobiotechnology** Nanobiotechnology- Definition, Applications in health and environment.	3	5
	4.5	**Bio-startups and Industries:** An introduction to bio-entrepreneurship and bio-startups, Marketing of biotechnology products, Major Biotechnology institutes and companies in India.	4	5
	4.1	Introduction to Solutes and Solutions: Basic concepts of measuring solutes, solvents and solutions.	4	6

4 Practicals	4.2	**Calculations on unit conversions:** Weight, Volume, and Concentration; Calculations on Molarity, Molality, Normality, Percentage solutions and dilution series.	7	6
	4.3	Preparation of buffer solutions of specific pH values and strength. Preparation of laboratory reagents. Accuracy, Precision and Purity.	7	6
	4.4	Preparation of standard solutions and standard curve. Verification of prepared solutions through pH measurements, titration and Colorimetry/Spectrophotometry.	6	6
	4.5	Methods for identifying and rectifying errors during solution preparation, titration and analysis. Verification of quality of reagents and chemicals.	6	6
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs. Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs.) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical- 35 marks 5 hrs.	Major expt./ procedure/ case study analysis – 15 Minor expts./ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References:

1. Biotechnology and ethics: A blueprint for the future. (1996). North western University, Center for Biotechnology.
2. Dubey, R. C. (2022). Textbook of Biotechnology. S. Chand and Co.

3. Lodish, H. F. (2022). Molecular cell biology. Macmillan International Higher Education.
4. Nanotechnology in catalysis. (2017). Wiley-VCH Verlag GmbH & Co. KGaA.
5. Niemeyer, C. M., & Mirkin, C. A. (2007). Nanobiotechnology: Concepts, applications, and perspectives. Wiley-VCH.
6. Poole, C. P., & Owens, F. J. (2010). Introduction to nanotechnology. Wiley India.
7. Singh, B. D. (2016). Biotechnology. Kalyani Publishers.
8. Willey, J. M., Prescott, L. M., Sandman, K. M., & Wood, D. H. (2023). Prescott's microbiology. McGraw-Hill.

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Programme						
Course Name	**Tools and Techniques in Biotechnology**					
Type of Course	**MDC**					
Course Code	**MG2MDCBTG100**					
Course Level	**100-199**					
Course Summary	This course introduces students to the exciting world of biotechnology tools and techniques with a focus on accessibility and ease of understanding.					
Semester	2	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	
		2	0	1	0	60
Pre-requisites, if any	NA					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome After completion of the course, the student will	Learning Domains *	PO No
1	Understand the fundamentals of molecular biology and its practical applications.	U	2,3,6
2	Explain basic gene manipulation techniques and their significance.	U	2,3
3	Describe various bioinformatics tools	U	2,3
4	Identify the concept of advanced biotechnological tools and their applications.	U	2,3,6
5	Able to isolate and quantify DNA, protein and retrieve DNA and protein sequences from databases.	S	2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	1.1	Basics of DNA and RNA structure and types.	2	1

Basics of Molecular Biology:Unravelling the Secrets of DNA and RNA	1.2	Basic outline of Central dogma of molecular biology: Replication, Transcription and Translation – steps.	5	1
	1.3	Fundamentals of PCR and its types (Reverse Transcriptase PCR, Nested PCR, QPCR, RT PCR).	3	1,4
	1.4	Principle and applications of electrophoresis: AGE, PAGE.	2	3
2 **Recombinant DNA technology: The Art of Gene Manipulations**	2.1	An outline of Cloning vectors: Features and types.	2	2
	2.2	Introduction to Restriction enzymes-Properties and types.	2	2
	2.3	Basics steps of Gene cloning and expression.	2	2
	2.4	Overview of Site-directed mutagenesis.	2	3
3 **Play with Proteins and Bioinformatics**	3.1	Protein isolation and purification: Precipitation of proteins, Basic steps of SDS-PAGE and Western blotting.	2	3
	3.2	Introduction to Mass spectrometry-Principles and Applications	2	4
	3.3	Getting started with bioinformatics: Definition, Introduction and applications.	2	3
	3.4	Important databases: NCBI, GenBank, DDBJ, EMBL, PDB viewer.	4	3
4 **Practicals**	4.1	Isolation and electrophoresis of DNA	6	5
	4.2	Quantitative estimation of DNA	5	5
	4.3	Purification of protein by precipitation method	6	5
	4.4	Quantitative estimation of Protein	5	5
	4.5	Introduction to NCBI, GenBank, DDBJ, EMBL and retrieval of DNA and Protein sequence in FASTA format.	8	5
Module 5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Class room lecture, ICT enabled classes, Discussions, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 15 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.0 hr. Theory : 35 marks Practical : 35 marks
Pattern of questions	Total marks: 35 marks (1.0 hr.) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :3 out of 5 3x3= 9 marks Short essay (6 marks) :1 out of 2 1x6= 6 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical- 35 marks 5 hrs.	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References

1. Molecular Biology of the Gene by James D. Watson
2. Essential Cell Biology by Bruce Alberts et al.
3. PCR (The Basics) by Tom Strachan and Andrew P. Read
4. Electrophoresis: Theory, Techniques, and Biochemical and Clinical Applications by G. Pasquali
5. Molecular Cloning: A Laboratory Manual by Michael R. Green and Joseph Sambrook
6. Recombinant DNA Technology and Molecular Cloning by Robert A. Meyers
7. Introduction to Genetic Analysis by Anthony J.F. Griffiths et al.
8. Site-Directed Mutagenesis: Methods and Protocols by Bimal D. Mepani
9. Protein Bioinformatics: An Algorithmic Approach to Sequence and Structure Analysis by Ingvar Eidhammer
10. Mass Spectrometry for the Novice by John Greaves and Andrew P. Jones

Suggested Readings

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount
2. Principles of Proteomics by Richard M. Twyman
3. CRISPR-Cas: A Laboratory Manual by Jennifer Doudna and Prashant Mali
4. Next-Generation DNA Sequencing Informatics by Stuart M. Brown
5. Microarray Technology and Its Applications by Uwe R. Müller
6. Nanobiotechnology: Concepts, Applications, and Perspectives by Christof M. Niemeyer
7. Molecular Biology Techniques: An Intensive Laboratory Course by Heather Miller
8. Introduction to Bioinformatics by Arthur M. Lesk
9. NCBI Handbook by National Center for Biotechnology Information (NCBI)
10. Biotechnology: Science for the New Millennium by Ellyn Daugherty

SEMESTER-3

Mahatma Gandhi University
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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Biophysics and Instrumentation**					
Type of Course	**DSC A**					
Course Code	**MG3DSCBTG200**					
Course Level	**200-299**					
Course Summary	The course covers the fundamentals of biophysics and various instruments used for different experiments in a laboratory					
Semester	3	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To remember and recall fundamental principles of biophysics, including thermodynamics, biomolecular structures, and analytical techniques.	K	1,2,3
2	Demonstrate comprehension by explaining the concepts of biophysics and instrumentation.	U	2,3,10
3	Employ principles of analytical and separation instruments in medical and industrial applications	A	2,3,6
4	Analyse experimental data obtained through various techniques in biophysics.	An	1,2,10
5	Apply comprehensive experimental approaches integrating diverse biophysical and instrumentational techniques	A	1,2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to biophysics	1.1	**Thermodynamics:** Laws of thermodynamics, the concept of enthalpy, entropy, free energy and thermodynamic equilibrium.	2	1,4
	1.2	**Role of Water and its significance:** Role of water in living organisms. Basic principles and biological significance of osmosis,diffusion, adsorption and surface tension.	2	1,4
	1.3	**Principles of light:** Electromagnetic spectrum, Reflection, Refraction, Absorption, Transmittance, Scattering, Dispersion, Interference, Polarization of light.	3	1,4
2 Protein and DNA	2.1	**Proteins: P**roteins - primary, secondary, tertiary and quaternary structure. Peptide bond. Ramachandran plot.	4	1,2
	2.2	**DNA:** Structural DNA polymorphism – A, B, Z and other structural forms. GC content and denaturation kinetics, Melting temperature and cot curve.	5	1,2
3 Analytical and Separation techniques	3.1	**Radiation biology:** Radioactivity, Radioisotopes and its applications. Principle and instrumentation of GM counter and Scintillation counter. Autoradiography.	4	2,3,5
	3.2	**Microscopy and Micrometry:** Microscopy-Principle and instrumentation of Light microscope, Principle and instrumentation of Micrometry. SEM andTEM and AFM.	4	2,3,5
	3.3	**Analytical methods:** Principle (Beer-Lambert's Law) and instrumentation of Colorimetry and Spectrophotometry – UV visible and IR. Principle and instrumentation of pH meter. Principle and instrumentation of Biosensors.	6	2,3,5
	3.4	**Chromatography:** Chromatography–Principle, Instrumentation and application of paper-, column-, gel permeation-, ionexchange chromatography, TLC, HPLC & GC.	5	2,3,5
	3.5	**Centrifugation:** Principle, instrumentation and application of Centrifugation and Ultracentrifugation.	3	2,3,5
	3.6	**Dialysis: P**rinciple, instrumentation and application of Dialysis and Ultra filtration.	2	2,3,5
	3.7	**Electrophoresis:** Electrophoresis – Principle, instrumentation and applications of AGE, PAGE and SDS-PAGE.	5	2,3,5
4 Practical	4.1	Determination of pH using pH meter.	2	1,2,5
	4.1	Colorimetry – Quantitative estimation of biomolecules.	8	1,2,5
	4.3	Micrometry of plant animal and microbial cell.	6	1,2,5
	4.4	Chromatography – PC and TLC.	6	1,2,5

	4.5	Electrophoresis of DNA	4	1,2,5
	4.6	Purification of protein by dialysis.	4	1,2,5
5		Teacher Specific Content		

References

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical -35 marks **5 hrs.**	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

1. Boyer, R., & Boyer, R. (2005). Modern Experimental Biochemistry. Pearson Education(Singapore) Pvt. Ltd.
2. Chatwal, G. R., & Arora, M. (2007). Biophysics. Himalaya Pub. House.Roy, R. N. (2005). *A textbook of biophysics*. New Central Book Agency.
3. Upadhyay, A., Upadhyay, K., & Nath, N. (2009). *Biophysical Chemistry (principles andtechniques)*. Himalaya Pub. House.
4. Voet, D., & Voet, J. G. (2021). *Biochemistry*. John Wiley & Sons.
5. Wilson, K., & Walker, J. M. (2007). *Principles and techniques of Biochemistry and MolecularBiology*. Cambridge University Press.

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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Cell biology and Genetics**					
Type of Course	**DSC A**					
Course Code	**MG3DSCBTG201**					
Course Level	**200-299**					
Course Summary	The course covers a broad range of topics related to Cell structure, functions, cell cycle, Mendelian genetics, linkage, crossing over, sex determination, genetic disorders, gene mutation and population genetics.					
Semester	3	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practicum	Others	
		3	0	1	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome Upon completion of the course the student will be able	Learning Domains *	PO No
1	Recall the salient features of living cells.	K	1,2,4
2	Explain the structure of the cell organelles	U	1,2,3
3	Identify the stages of mitosis and meiosis	U	2,3,9
4	Explain the fundamentals of Mendelian laws and Population genetics.	U	2,8,10
5	Evaluate the genetic disorder and aim to improve the genetic quality for human welfare	E	5,6,7

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.

1 **Overview of cell**	1.1	**Cell structure and Cell diversity:** Introduction to cell structure, Prokaryotic and eukaryotic cell, Cell Architecture. Plant cell structure, Animal cell structure, Microbial cell structure.	4	1
	1.2	**Cell membrane and Extra cellular matrix:** Models of Cell membrane. Fluid Mosaic Model - structure and composition. Extracellular Matrix (ECM)	3	1, 2
	1.3	**Membrane Transport:** Overview of membrane transport, Passive transport, Active transport, Types of membrane transport (Uniport, Symport and Antiport)	4	1, 2
2 **Cellular world and Cell cycle**	2.1	**Cell organelles:** Structure and functions - Nucleus, Endoplasmic reticulum, Golgi Apparatus, Lysosomes, Peroxisomes, Mitochondria, Chloroplast.	4	1, 2
	2.2	**Cytoskeleton:** Overview of Cytoskeleton, Structure and functions - Microtubules, microfilaments, intermediate filaments.	3	1, 2
	2.3	**Cell cycle and Cell death:** Introduction to the cell cycle, Phases of cell cycle (G, S, G2, M), Mitosis and Meiosis, Cell cycle checkpoints, Overview of cell death process, Apoptosis, Necrosis and Autophagy	4	2, 3
3 **Hereditary wonders Genetic disorders and Advanced genetics**	3.1	**Introduction to Genetics:** Terminology and symbols in genetics. Mendelian laws with example- Testcross, Backcross Gene interactions: Co-dominance, Incomplete dominance, Epistasis, Multiple alleles-ABO blood typing, Polygenic inheritance, Pleiotropism, Lethel genes.	4	4
	3.2	**Linkage and crossing over:** Linkage types- Complete and Incomplete, crossing over- Types and Mechanism, Factors affecting crossing over.	3	4
	3.3	**Sex determination:** Sex determination - Autosomes and sex chromosomes, Chromosomal basis of sex determination (XX-XY, XX-XO, ZZ-ZW types) Mechanism of sex-linked inheritance, Sex influenced, Sex limited gene expression, Dosage compensation (Barr bodies, drum stick).	5	4
	3.4	**Extrachromosomal inheritance** - Mitochondria and Chloroplast.	2	4, 5
	3.5	**Gene Mutation:** Types. Chromosomal aberations – structural and neumerical. Chromosomal anomalies and human disorders - Down's syndrome, Edwards syndrome, Klinefelter's syndrome, Turners syndrome, Sickle cell anemia, Phenyl ketonuria.	5	4, 5
	3.6	**Population Genetics:** Human genetics- Karyotype study, Pedigree analysis. Population genetics- Genetic variation, Hardy Weinberg principle, Factors affecting Hardy Weinberg equilibrium.	4	4
4 **Practical**	4.1	Identification of Cell types	4	1,2,3
	4.2	Morphological comparison of living and dead cell.	4	1,2,3
	4.3	Mitosis – Onion Root Tip	4	1,2,3
	4.4	Meiosis – Rhoeo Flower Bud	5	1,2,3
	4.5	Staining of Mitochondria Staining of Barr body and Polytene Chromosome	10	1,2,3

	4.6	ABO Blood typing	3	1,2,3
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks 5 hrs.	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References

1. Cell and Molecular biology by Gerlad Karp, Academic Press
2.World of the Cell, Becker, Reece, Poenie, The Benjamin /Cumming's Pub
3.Cell Biology, Lodish et al, W H Freeman and Co., NewYork.
4.Cell Biology, Thomas D Pollard and W C Earnshaw, Saunder's Publishers
5.. Principles of genetics - E J Gardner John Wiley India llp Publication
6. Genetics –M W Strick Berger, Macmillan,
7. Fundamentals of Genetics - Peter. J. Russel, Harper Collins Pub.
8.Genetics, Principles and analysis- Daniel L. Hartin and Elisabeth W. John, Jones and Bartlett Pub. US.
9. Human Genetics, - 2nd& 3rd Edn. S. D. Gangane. Elsevier/ Paras publications.
10. Essentials of Human Genetics, - 4 th Edn. S. M. Bhatnagar, M. L. Kothari and L. A. Mehta.
11.Text book of genetics, - Veer Bala Rastogi, KNRN Pub
12. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, - P. S. Verma, V.K. Agarwal., S Chand pub
13. Genetics- - P. S. Verma, S Chand pub

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Programme						
Course Name	**Fundamentals of Molecular Biology**					
Type of Course	**DSC B**					
Course Code	**MG3DSCBTG202**					
Course Level	**200-299**					
Course Summary	Molecular biology is a multidisciplinary field that combines principles of molecular biology, genetics, biochemistry, and other related disciplines to manipulate biological systems at the molecular and cellular levels. This field has wide-ranging applications in medicine, agriculture, industry, and environmental management. A course in molecular biology typically covers a variety of topics to provide students with a comprehensive understanding of the field.					
Semester	3	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Able to describe fundamental molecular aspects of biology.	U	1.2.10
2	Compare the organization of DNA in viral, prokaryotic, and eukaryotic genomes.	An	1,2
3	Recall the concepts of central dogma of molecular biology.	K	2,3,10
4	Students can assess cellular functions, regulation, errors occurs during the cellular mechanisms and its repair.	U	1,3,10
5	Students can execute various molecular techniques including Isolation of genomic DNA and Plasmid, Centrifugation, Gel electrophoresis, Blotting techniques and PCR	A	1,2,10

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO. No:
1 Introduction to Molecular Biology	1.1	Milestones in Molecular Biology	1	1
	1.2	Experiments demonstrating DNA and RNA as the genetic material	2	1
	1.3	Structure and types of DNA and RNA	2	1
	1.4	Organization of DNA in viral, prokaryotes and eukaryotic genome and C-value paradox	2	2
	1.5	Gene structure- Structure of prokaryotic and eukaryotic genes, Central dogma of Molecular biology.	4	2
	1.6	Transposable elements in prokaryotes- Tn elements and eukaryotes- SINEs and LINEs.	2	2
2 DNA replication and repair.	2.1	DNA replication in prokaryotic and eukaryotic nuclear genome	4	3,4
	2.2	Mutation and DNA repair mechanisms.	8	3,4
3 Protein synthesis& Gene regulation	3.1	Transcription of mRNA in prokaryotes and eukaryotes and post transcriptional modifications. Reverse transcription.	4	3,4
	3.2	Genetic code and its properties. Translation - translation of prokaryotic and eukaryotic mRNA and Post translational modifications	6	3,4
	3.3	Gene regulation in prokaryotes- Operon concept, components of operon and Positive and negative regulation	6	3,4
	3.4	Molecular details of Lac operon.	4	3,4
4 Practical Molecular Techniques	4.1	Isolation of genomic DNA	10	5
	4.2	Gel electrophoresis	6	5
	4.3	PCR-Demonstration	6	5
	4.4	Western blotting – Demonstration only	8	5
5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks **5 hrs.**	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References

1. Russell, P. J. (1987). *Essential genetics*. Blackwell Scientific Publications.
2. Simmons, M. J., & Snustad, D. P. (2006). *Principles of genetics*. John Wiley & Sons. Watson, J. D. (2004). *Molecular biology of the gene*. Pearson Education India..
3. Karp, G. (2009). *Cell and molecular biology: concepts and experiments*. John Wiley & Sons.
4. Brooker, R. J. (1999). *Genetics: analysis & principles*. Reading, MA, USA:: Addison-Wesley.
5. Brown, T. A. (2020). *Gene cloning and DNA analysis: an introduction*. John Wiley & Sons.
6. Glick, B. R., & Patten, C. L. (2022). *Molecular biotechnology: principles and applications of recombinant DNA*. John Wiley & Sons.

Suggested Readings

1. Alberts, B. (2017). *Molecular biology of the cell*. Garland science.
2. Twyman, R. (2018). *Advanced molecular biology: a concise reference*. Garland Science.

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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Developmental Biology and Assisted Reproduction Technology**					
Type of Course	**DSE**					
Course Code	**MG3DSEBTG200**					
Course Level	**200-299**					
Course Summary	This course in Developmental Biology provides a comprehensive exploration of the scope, historical perspectives, and fundamental aspects of reproductive biology, including gonadal structure, hormones, reproductive cycles, gametogenesis, and the structure of gametes. It further delves into covering fertilization, parthenogenesis, and placenta, focusing on early embryonic development, morphogenetic movements, and germ layer formation. Finally, addresses human embryonic development stages, invitro fertilization, and offers insights into enzyme engineering and future perspectives in the field.					
Semester	3	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Able to recall the anatomy of human reproductive system and its structures.	K	1,2,4
2	Gain a comprehensive understanding of early embryonic development with its stages.	U	1,2,10
3	Gain knowledge about the Assisted Reproduction Technology	U	1,2,10
4	Equipped to comprehend genetic counselling along with an exploration of the ethical and future considerations in assisted reproductive technology.	An	1,2,3,4

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Developmental Biology	1.1	Stages of embryo development	1	1,2
	1.2	Gonads- Structure of Human testis and ovary.	3	1,2
	1.3	Gonadal hormones and their functions.	2	1,2
	1.4	Female reproductive cycle (menstrual cycle).	2	1,2
	1.5	Gametogenesis -spermatogenesis, oogenesis	4	1,2
	1.6	Structure of sperm and ovum. Different types of eggs on the basis of Yolk.	3	1,2
2 Fertilization, Parthenogenesis and Placenta	2.1	Fertilization-Mechanism and Significance.	4	2,3
	2.2	Pregnancy parturition and lactation	4	2,3
	2.3	Ectopic pregnancy. Polyspermy	2	2,3
	2.4	Parthenogenesis-Types	2	2,3
	2.5	Placenta and its hormones.	3	2,3
3 Early embryonic development	3.1	Cleavage definition types and patterns	3	3
	3.2	Blastula -Mechanism of Blastulation, Gastrulation.	3	3
	3.3	Morphogenetic movements-epiboly, extension, invagination, convergence, de-lamination	4	3
	3.4	Formation of germ layers	3	3
	3.5	Fate map (chick embryo)	2	3
4 Assisted Reproduction Technology and Future Perspectives	4.1	Introduction to Genetic counselling. Eugenics, Euthenics.	3	4
	4.2	Human embryonic development (Germinal, Embryonic and foetal stages)	5	4
	4.3	In vitro fertilization, Steps in IVF.	3	4
	4.4	Prenatal diagnosis – Amniocentesis, chorionic villi sampling (CVS), Fetoscopy.	4	4
5		Teacher specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

- Berril, N..J.; and Kars, G.; 1986. Developmental biology, Mc Graw Hills
- Majumdar N. N-1985 Vetebrate embryology; Tata McGraw-Hill, New Delhi
- Melissa A & Gibbs, 2006; A practical Guide to Developmental Biology, Oxford university press (Int. student edition)
- Scott F. Gilbert; 2003; Developmental biology; Sinauer Associates Inc., U.S.; 7th Revised edition.
- Vijayakumaran Nair, K. & George, P. V. 2002. A manual of developmental biology, Continental publications, Trivandrum
- Taylor DJ, Green NPO & G W Stout. (2008) Biological Science third edition. Cambridge university press. Ref pp 748 biology 755

Suggested Readings

- Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
- Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Plant and Animal Physiology**					
Type of Course	**DSE**					
Course Code	**MG3DSEBTG201**					
Course Level	**200-299**					
Course Summary	This physiology syllabus covers fundamental aspects of human and plant systems. Students study human digestion, blood components, circulatory and respiratory systems, as well as the nervous and endocrine systems. Renal physiology, diagnostic techniques, and clinical case studies are explored. In plant physiology, topics include water absorption, respiration, mineral nutrition, secondary metabolites, and plant growth regulators. Students also learn about plant movements, responses to stresses, and applications such as crop improvement and plant breeding. The syllabus emphasizes the practical applications of physiological principles in both human and plant contexts.					
Semester	3	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the importance of studying human physiology in the context of maintaining homeostasis	U	1.10
2	Analyze the factors influencing efficient digestion and absorption, considering both physiological and dietary aspects	K	2,3,6
3	Evaluate the factors influencing blood volume, such as hormones and kidney function	E	2,5,10
4	Diagnostic and treatment plans based on a deep understanding of human physiology	C	1,9,10
5	Develop new ideas for utilizing plant-associated microbes in biological control for enhanced plant health	C	4,6,10
6	Evaluate the impact of various factors on blood volume regulation and circulatory system function	E	2,5,10

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Human Physiology	1.1	Introduction to human physiology: Organ systems of human.	3	1,2
	1.2	Nutrition: Digestion and Absorption.	4	1,2
	1.3	Blood – Components of blood (plasma, red blood cells, white blood cells, platelets) Blood volume and its regulation.	5	1,2,3
	1.4	Circulatory system- Systemic circulation, Pulmonary circulation	4	1,2
2 Respiratory and Renal Physiology.	2.1	Respiratory system – exchange of gases, Respiratory disorders.	4	1,2
	2.2	Nervous system-Structure, Neuron structure & types, signal transduction, types of synapses and endocrine system.	5	1,2
	2.3	Renal physiology- kidney structure and function, glomerular filtration, Urine formation.	4	1,2
	2.4	Applications of human physiology: for Diagnosis and Treatment	3	1,2,6
3 Plant physiology	3.1	Introduction to plant physiology, Absorption and transport of water. Respiration in plants. Mineral nutrition in plants-Macro and Micro nutrients.	8	1,2,4
	3.2	Secondary Metabolites. Plant growth regulators-Auxins, Cytokinin, Gibberellins, Ethylene, Abscisic acid	8	2,4,5
4 Plant movement and responses.	4.1	Plant movements- trophic, tactic and nastic movements. Responses to biotic and abiotic stresses. Photoperiodism, Vernalisation.	6	4,5,6
	4.2	Applications of plant physiology-crop improvement, plant breeding. Defence mechanism in plants - plant-associated microbes for biological control of plant pathogens.	6	3,4,5
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References:

1. Tortora, G. J. Principles of Human Physiology (Edition number). Wiley.
2. Widmaier, E., Raff, H., & Strang, K. Vander's Human Physiology: The Mechanism of Body Function. McGraw Hill, New York.
3. Guyton, A. C., & Hall, J. E. Textbook of Medical Physiology. Elsevier Saunders, Pennsylvania.
4. Ganong, W. F. (Year). Review of Medical Physiology.
5. Sembulingam, K., & Sembulingam, P. Essentials of Medical Physiology. Jaypee Brothers Medical Publishers, New Delhi.
6. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). Plant Physiology (6th ed.). Sinauer Associates.
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8. Hopkins, W. G., & Hüner, N. P. A. (2008). Introduction to Plant Physiology (4th ed.). John Wiley & Sons.
9. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants (2nd ed.). Wiley-Blackwell.
10. Larcher, W. (2003). Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functional Groups (4th ed.). Springer.

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Programme						
Course Name	**Nutritional Biotechnology**					
Type of Course	**MDC**					
Course Code	**MG3MDCBTG200**					
Course Level	**200**					
Semester	3	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Prerequisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Student will be able to understand the role of nutrients for a healthy life.	U	1,6,8
2	Student will able to apply biotechnology for improving the nutritional quality of plants and animal foods and managing food adulterants.	A	1,6,10
3	Student is able to assess the use of bioprocess for increasing the functionality and nutraceutical properties of foods.	E	1,9,10
4	Students are able to understand the immobilization and encapsulation process.	U	1,6
5	Students are able to understand the production and use of enzymes in food processing.	U	1,10
6	Student will able to develop skills in creating well balanced and nutritious meal plans.	C	1,6
7	Students are able to assess the reason for particular lifestyle diseases.	E	1,6
8	Student will able to comprehend reasons, management and treatment of lifestyle diseases.	E	6,9,10

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

COURSE CONTENT
Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Nutrition and Life style	1.1	**Overview of nutrition**: Definition, importance of nutrition, nutrients-function, sources, types-macronutrients and micronutrients, principles of balanced diet.	3	1,2,3,4
	1.2	**Overview of lifestyle diseases**: Modern lifestyle and health impacts, protein energy malnutrition, RDA, diabetes, obesity, hypertension, stroke, cancer	3	1,2,3,4
2 **Food engineering**	2.1	**Food fortification**: Enriching with protein, vitamins and minerals.	2	1,2,3,4
	2.2	Organic food and GM food.	3	1,2,3,4
	2.3	Detection of food additives and pesticides.	2	1,2
	2.4	**Preservation and storage of food-** Freezing, Refrigeration, Thermal processing, Salting, Drying and irradiation, Pasteurization.	2	3
3 Food Science, Dietetics And Nutrition	3.1	**Bioprocess**: Fermentation technology, microorganism in food fermentation, antimicrobial ingredients, nutrients and Nutraceuticals production. Immobilization -basics and applications in food processing. Microencapsulation-basics and applications in food processing.	6	3
	3.2	**Enzymes in food processing:** Application of enzymes-amylases and proteases, in food industry. Enzymes for hydrolysate and bioactive peptides, maltodextrins and corn syrup solids.	5	3
	3.3	Role of enzymes in cheese making and whey processing, fruit juices, baking.	3	5
	3.4	Detection of food pathogens by plating techniques.	2	7
	3.5	**Overview of nutrition:** Definition and importance of nutrition, Nutrients and their functions, Sources of nutrients	2	1
	3.6	**Macronutrients and Micronutrients:** Understanding Macronutrients (carbohydrates, proteins, fats), Importance of micronutrients (vitamins and minerals), Balanced nutrition and dietary guidelines.	2	1

	3.7	**Nutrition in infancy:** Breast feeding vs Formula feeding, Introduction to solid foods, Nutritional needs during growth.	2	1,6
	3.8	**Nutrition in adulthood and Later years:** Age-related changes in Nutritional requirements, Common Nutritional challenges in adulthood, Healthy eating patterns for older adults.	2	1,6
	3.9	**Recommended Dietary Allowance (RDA):** Definition and purpose of RDA, Factors influencing RDA, Interpreting and applying RDA in diet planning.	2	1,6
	3.10	**Planning a healthy diet:** Principles of balanced diet, Meal planning and portion control, Dietary guidelines for different age groups.	2	1,6
	3.11	**Protein energy malnutrition:** Types and causes of protein energy malnutrition, Effects on health and development, prevention and treatment strategies.	2	7,8
4		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars
Assessment types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Class tests, Assignments, Viva Total marks : 75 CCA : 25
	B. End Semester examination – 1.5 hrs. Total marks : 50
Pattern of questions	Total marks: 50 marks (1.5 hrs.) One word answer question (1mark):10 out of 10 10x1= 10 marks Short answer questions (3marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

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1. Rutledge, Food and nutritional Biotechnology, Navyug publishers and distributors,2009
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3. Donald Bills and Shain -Dow Kung, Biotechnology and Nutrition, Proceedings of the Third international symposium, Butterworth - Heinemann, BotsoN
4. Ferguson, L.R. (2013). Nutrigenomics and Nutrigenetics in Functional Foods and Personalized Nutrition. Boca Raton, FL: CRC Press.

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6. Mahgoub, S.E.O. (2016). Genetically Modified Foods: Basics, Applications, and Controversy. Boca Raton, FL: CRC Press.
7. Pathak, Y.V., & Kim, S.-K. (Eds.). (2019). Handbook of Nutraceuticals Volume I: Ingredients, Formulations, and Applications. Boca Raton, FL: CRC Press
8. Jacob-Lopes, E., Maroneze, M.M., & Zepka, L.Q. (Eds.). (2020). Microalgae Biotechnology for Food, Health and High Value Products. Cham, Switzerland: Springer.

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Programme						
Course Name	**Environmental Biotechnology and Human Rights**					
Type of Course	**VAC**					
Course Code	**MG3VACBTG200**					
Course Level	**200-299**					
Course Summary	This interdisciplinary curriculum provides a comprehensive exploration of ecological, environmental, and human rights issues, fostering a holistic understanding of the interconnectedness between the natural world and societal well-being.					
Semester	3	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	*Need to complete 100 level courses*					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon completion of this course in Industrial & Bioprocess Technology, participants should be able to:		
1	Explain the concept, structure, components, and functions of ecosystem, energy resources, and environmental laws	K	1,2,4
2	Analyze the characteristics of wastewater and explore biodegradation processes.	An	1,2,3
3	Summarize wastewater treatment methods and solid waste management techniques	U	1,2,3
4	Gain insights into human rights, including their concept, history, and international dimensions.	U	1,2,3,6,10

5	Examine the role of the United Nations in promoting human rights and critically appraise its regime	An	1,2,3,6,10
6	Explore human rights from a national perspective, focusing on the Indian Constitution, fundamental rights, and specific issues related to women, children, minorities, and prisoners	An	1,2,3,6,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1. **Ecology and Environmental Science**	1.1	Ecosystem: Concept, Structure, Components, and Function	2	1
	1.2	Biotic Components and Abiotic Components: Ecological Succession	3	1
	1.3	Food Chains, and Food Webs, Energy flow in the ecosystem, Biogeochemical cycles- Nitrogen and Carbon.	4	1
	1.4	Energy Resources: Renewable and Nonrenewable energy resources.	3	1
2. Environmental Analysis, Biodegradation, Wastewater and Solid Waste Management	2.1	Characteristics of Wastewater:	3	2
	2.2	Bacteriological Analysis of Drinking Water:	3	2
	2.3	Biodegradation of Organic Compounds:	5	2
	2.4	Wastewater Treatment.	3	3
	2.5	Biological Treatment of Wastewater:	3	3
	2.6	Solid Waste Management	3	3
	2.7	Environmental laws	3	3
3. Human Rights and International Framework	3.1	Introduction to Human Rights	4	4
	3.2	Human Rights Coordination within the UN System	3	5
	3.3	Human Rights in the Indian Constitution	3	6

4		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars
Assessment types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Class tests, Assignments, Viva Total marks : 75 CCA : 25
	B. End Semester examination – 1.5 hrs. Total marks : 50
Pattern of questions	Total marks: 50 marks (1.5 hrs.) One word answer question (1mark):10 out of 10 10x1= 10 marks Short answer questions (3marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

Reference

1. Wackett, L. P., & Hershberger, D. (1997) Biocatalysts and Biodegradation. ASM Press, Washington
2. Kumar, A. (2007). Environmental Chemistry. New Age International publishers., New Delhi
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4. Moses, V., & Capes, R. E. (1991) Biotechnology: The Science and Business Harwood Academic (Medical, Reference and Social Sc,
5. Bottein, D. B., & Keller, E. A. (John Wiley Sons). Environmental Science: Earth as Living Planet.
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8. Sharma, R. A. (2016). Environmental Biotechnology. Pointer Publishers.
9. Dubey, R. C. 5 th ed (2014). Textbook of Biotechnology S Chand publishers.
10. Agarwal, S. K. (2015). Advanced Environmental Biotechnology, Ashish Publishing House.

Suggested Readings

1. Misra, S. P., Pande, S. N. (Ane Books Pvt. Ltd.). Essential Environmental Studies.
2. Sharma, P. D. Ecology and Environment.

SEMESTER-4

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Molecular Biology**					
Type of Course	**DSC A**					
Course Code	**MG4DSCBTG200**					
Course Level	**200-299**					
Course Summary	Molecular Biology covers essential concepts related to the study of biological molecules and their interactions within cells. Modules give basic ideas about the historical background, structure of nucleic acids and organization of genomes at various levels. It covers central dogma, reverse transcription, mutation and their repairing mechanisms and deals with regulation of gene expression and transposons and transposition.					
Semester	4	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Need to complete difficulty level 100-199 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe fundamental molecular aspects of biology.	U	1,2,10
2	Compare the organization of DNA in viral, prokaryotic, and eukaryotic genomes.	An	1,2,10
3	Illustrate the concepts of central dogma of molecular biology	U	1,2,3,10
4	Explain the cellular functions, regulation, errors occur during the cellular mechanisms and its repair.	U	1,2,3,10
5	Differentiate the role of enzymes involved in DNA replication, transcription and translation	An	1,2,3,10
6	Able to perform DNA isolation, electrophoresis of DNA and protein, estimation of DNA and RNA and restriction digestion.	A	2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO. No:
1 Fundamentals of DNA, RNA and Gene	1.1	Milestones in Molecular Biology	1	1
	1.2	Experiments demonstrating DNA and RNA as the genetic material	3	1
	1.3	Structure and types of DNA and RNA	2	1
	1.4	Physico - chemical properties of DNA	2	1
	1.5	Organization of DNA in viral, prokaryotes and eukaryotic genome and C-value paradox	3	2
	1.6	Gene structure- Structure of prokaryotic and eukaryotic genes	1	2
2 DNA Replication and Repair	2.1	Central dogma of Molecular Biology	1	3,4,5
	2.2	DNA replication – Different types. Conservative, Semiconservative, Dispersive, Theta, D-loop and Rolling circle model. Meselson and Stahl experiment	3	3,4,5
	2.3	Steps involved in DNA replication. - Initiation, Elongation and Termination.	5	3,4,5
	2.4	Structure and function of enzymes involved in DNA replication	1	3,4,5
	2.5	DNA repair mechanisms- Photo reactivation, NER, BER, SOS.	3	3,4
3 Transcription and Regulation of gene Expression	3.1	Transcription of mRNA in prokaryotes and eukaryotes, reverse transcription, post transcriptional modifications	5	1,3,4,5
	3.2	Genetic code and its properties	1	1,3,4,5
	3.3	Translation - Translation of prokaryotic and eukaryotic mRNA, post translational modifications	4	1,3,4,5
	3.4	Gene regulation in prokaryotes- Operon concept, components of operon	1	1,3,4
	3.5	Positive and negative regulation, Molecular details of Lac and Trp operon	5	1,3,4
	3.6	Transposable elements in prokaryotes and eukaryotes- Types and mechanism of transposition	4	1,3,4
4 Practicals	4.1	DNA Isolation and Agarose gel electrophoresis from *E. coli* Cells and plant cells	6	6
	4.2	Isolation of plasmid DNA from *E.coli* cells	4	6
	4.3	DNA estimation	3	6
	4.4	SDS PAGE	5	6
	4.5	Protein Gel Electrophoresis	4	6
	4.6	Restriction digestion	4	6

	4.7	RNA estimation	4	6
Module 5	Teacher specific Content			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical- 35 marks **5 hrs.**	Major expt./ procedure/ case study analysis – 15 Minor expts./ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References

1. Russell, P. J. (2021). Essential genetics. Blackwell Scientific Publications.
2. Simmons, M. J., & Snustad, D. P. (2006). Principles of genetics. John Wiley & Sons. Watson, J. D. (2021). Molecular biology of the gene. Pearson Education India.
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8. Sambrook, J., Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual. United States: Cold Spring Harbor laboratory Press.

Suggested Readings

1. Alberts, B. (2017). *Molecular biology of the cell*. Garland science.
2. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger Principles of Biochemistry. Macmillan.

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Programme	**BSc (Honours) Biotechnology**
Course Name	**Immunology**
Type of Course	**DSC A**
Course Code	**MG4DSCBTG201**
Course Level	**200-299**
Course Summary	Immunology delves into the history and mechanisms of the immune system, covering innate and acquired immunity, B and T cell processes, antigen-antibody reactions, and immune response types. It explores practical applications, including blood grouping, immunological techniques, and complement pathways. Immunological disorders like hypersensitivity and autoimmune diseases are discussed. The course concludes with applications in immunization, vaccine types, and antibody engineering, showcasing the practical implications of immunological insights.

Semester	4	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre- requisites, if any	Need to complete difficulty level 100-199 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Students will be able to identify and describe the major cells and organs involved in the immune system	R	1,3,4,10
2	Students will be able to communicate effectively about advanced immunological techniques and antigen-antibody reactions, both in written reports and oral presentations	U	1,4,10
3	Identify the cells and organs of Immune System	U	1,2,3
4	Students will express effectively about advanced immunological techniques and antigen-antibody reactions	E	1,2,3,10

5	Students will describe the Type I to Type IV hypersensitivity reactions	An	1,10
6	Students will evaluate therapeutic interventions.	E	1,2,10
7	They will evaluate the immune-techniques in therapeutic applications.	Ap	2, 10
8	Students will learn the steps involved in generating and characterizing hybridomas for the production of monoclonal antibodies	U	1, 2, 8, 10
9	Students will gain practical exposure to blood cell counting, blood grouping and typing and agglutination and antigen-antibody reactions.	U	1,2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to immunology	1.1	History and scope of immunology. Types of immunity – Innate and acquired immunity	3	1,2
	1.2	Cells and organs of the immune system. B Cell and T Cell maturation, activation and differentiation.	6	1,4
	1.3	Antigen – Haptens and adjuvants. Antibody – General features, Classification of immunoglobulin.	4	1,2,4
	1.4	Immune response – Humeral and cell mediated immunity. MHC – Classes and function	4	1,3
2 Antigen antibody interactions	2.1	Features of antigen antibody reactions – affinity, avidity, cross reactivity.	3	1,3
	2.2	Agglutination reaction – Blood grouping, Coombs test, WIDAL, precipitation reactions – ODD, RID	4	1,6,8
	2.3	Immunological techniques – EIA, FIA, RIA, Immuno-electrophoresis, Western blotting. Complement proteins – pathways and complement fixation test.	5	6,8
3 Immunological Disorders and Applications of Immunology	3.1	Hypersensitivity, Tumor immunology, Transplantation immunology, immunohematology.	7	1,2,4,7,8
	3.2	Autoimmunity and autoimmune diseases. Immunodeficiency diseases**.**	4	1,5,8
	3.3	Immunization – passive and active. Vaccines – types and applications, Polyclonal and monoclonal antibody production – Hybridoma technology. Antibody engineering	5	3,4,6,7,8

4 Practicals	4.1	Total count and Differential count of Blood cells	6	9
	4.2	Agglutination reactions- Blood grouping, Blood typing.	5	9
	4.3	WIDAL Test- qualitative	8	9
	4.4.	RPR	6	9
	4.5	Antigen Antibody reactions- Precipitation reaction- ODD	5	9
5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical- 35 marks 5 hrs.	Major expt./ procedure/ case study analysis – 15 Minor expts./ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References

1. Kindt, T. J., Goldsby, R. A., & Osborne, B. A. (2007). Kuby Immunology (6th ed.). W.H. Freeman and Company
2. Illustrated Immunology. (2022). India: New India Publishing.
3. Kumar, A. (2013). Textbook of Immunology. India: Energy and Resources Institute.
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5. Coico, R., Sunshine, G., Benjamini, E. (2003). Immunology: A Short Course. United Kingdom: Wiley.
6. Murphy, K., Travers, P., & Walport, M. (2012). Janeway's Immunobiology (8th ed.). Garland Science.
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9. Nigam, A. (2007). Lab Manual in Biochemistry, Immunology and Biotechnology. India: McGraw-Hill Education (India) Pvt Limited.
10. Speshock, J. (2019). Immunology Lab Manual. (n.p.): Kendall Hunt Publishing Company.

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Programme	**B Sc (Honours) Biotechnology**					
Course Name	**Biosafety and Bioethics**					
Type of Course	**DSE**					
Course Code	**MG4DSEBTG200**					
Course Level	**200**					
Course Summary	This course aims to provide students with a comprehensive understanding of the ethical considerations and safety measures involved in biological research, ensuring a well-rounded perspective on the responsible conduct of scientific work.					
Semester	4	Credits				Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Need to complete difficulty level 100-199 courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Define Biosafety and its importance	U	1,6
2	Demonstrate good lab procedures and practices	U	1
3	Classify different Biosafety levels and justify design of containment facilities at different Biosafety levels	A, Ap	1,10
4	Assess the hazards related to Biosafety	E	1,2,6
5	Estimate Bioethical principles of animal testing	E	1

6	Justify ethical principles in animal testing	E	1,6

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Biosafety Introduction and levels of containment	1.1	Introduction to Biosafety	2	1
	1.2	Procedures and good laboratory practices	3	2
	1.3	Standard operating procedures for research involving microbes and recombinant DNA	3	2
	1.4	Design of containment facilities, laboratories	3	4
	1.5	Levels of Biosafety containment	4	3
	1.6	National and international biosafety regulations and its importance	3	1
2 Risk Assessment and Management	2.1	Risk assessment and management	4	4
	2.2	Hazard identification and evaluation	4	4
	2.3	Personal Protective Equipment	2	3
	2.4	Biosafety cabinet	1	3
	2.5	Guidelines in biological research, Emergency response plans related to Biosafety	6	1
3 Introduction to Bioethics	3.1	Definition of Bioethics	2	5
	3.2	History of origin, scientific and legislative principles of Bioethics	4	5
	3.3	Institutional review boards and ethic committees	4	6
4 Legal aspects of Bioethics	4.1	Ethical, legal norms and requirements for conducting clinical and preclinical studies	5	5
	4.2	The rights of participants in clinical trials	5	5

	4.3	Ethical and legal aspects of working with experimental animals and plants	4	5
5 **Teacher Specific content**	Teacher Specific content			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **C. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	D. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References:

1. Singh, B. D. (2010). Biotechnology.
2. Dubey, R. C. (1993). A Textbook of Biotechnology. S. Chand Publishing.
3. Have, H. T., & Gordijn, B. (2014). Handbook of Global Bioethics. In Springer eBooks. https://doi.org/10.1007/978-94-007-2512-6
4. Lewis, M. A., Tamparo, C. D., & Tatro, B. M. (2007). Medical Law, Ethics, & Bioethics for the health professions. http://ci.nii.ac.jp/ncid/BB16082402
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Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Biostatistics**					
Type of Course	**DSE**					
Course Code	**MG4DSEBTG201**					
Course Level	**200-299**					
Course Summary	This course provides the knowledge and skills necessary to navigate the world of biostatistics. This aspire students to conduct research, work in healthcare, or pursue further studies; the practical insights gained from this course will serve as a solid foundation for the future endeavours.					
Semester	4	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Need to complete 100 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
	Upon completion of this course in Advanced Statistics and Data Analysis participants should be able to:		
1	Explain the significance, application, and limitations of statistics in life science .	U,A	2, 6
2	Apply various methods of sampling and demonstrate the application of methods for collecting and organizing primary and secondary data.	U,A	2,3
3	Apply methods of tabular, graphical, and diagrammatic data presentation and apply techniques for presenting and analyzing data.	U,A	2, 3, 10
4	Understand computer-oriented statistical techniques, and apply this for research analysis	U,A,C,S	2, 3, 10
5	Apply classification methods and data presentation techniques to real-world scenarios and utilize statistical packages for practical data analysis and interpretation.	C,A,S	2, 7, 6, 8

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Biostatistics	1.1	Introduction, definition, significance, application and limitation of statistics in life science. Statistical population and sample.	5	1
	1.2	Characteristics of sample, Methods of Sampling, Qualitative and quantitative data. Primary and Secondary data.	5	1
2 Collection and Classification of Data	2.1	Different methods of Tabular, Graphical and Diagrammatic presentation of data. Data collection methods	5	2,5
	2.2	Methods of classification of data: Geographical, Chronological, Qualitative, And Quantitative.	8	2
	3.2	Measures of Central tendency, Measures of dispersion, Correlation, Regression,	4	3
3 Presentation and Analysis of data	3.1	Different methods of Tabular, Graphical and Diagrammatic presentation of data.	7	2
	3.2	Probability theorems and distributions (Binomial, Poisson and Normal).	4	3
	3.3	Hypothesis testing, t-test, Chi square test, Basic principles of ANOVA technique.	7	3
4 Computer oriented Statistical methods	4.1	Introduction to Computer oriented statistical techniques.	4	4,5
	4.2	Introduction to MS excel software, Spread sheet and software. Statistical packages-Excel, SPSS.	5	4,5
	4.3	Frequency table of single discrete variable, Bubble sort, Computation of mean variance and Standard deviation.	6	4
5		Teacher Specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References:

1. Kothari, C. R. (2004). Research Methodology: Methods and Techniques. New Age International
2. Fundamentals of Biostatistics. Veer Bala Rastogi. (2008) Ane books .
3. Arora, P. N., Malhan, P. K. (2010). Biostatistics. India: Himalaya Publishing House.
4. Levin, R. I., & Rubin, D. S. (2012). Statistics for Management. Pearson Education.
5. Introduction to Biostatistics – Sokal & Rohif(1973) Toppan Co Japan
6. Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences. John Wiley & Sons.
7. Newbold, P., Carlson, W. L., & Thorne, B. (2012). Statistics for Business and Economics. Prentice Hall
8. Daniel, W. W. (2010). Biostatistics: Basic Concepts and Methodology for the Health Sciences. John Wiley & Sons.
9. Norman,T.J. Bailey (2007) Statistical methods in biology, 3rd edition.qqqq Cambridge university press
10. Rajaraman, V. (1969). Principles of Computer Programming. India: Prentice-Hall of India Private.

Mahatma Gandhi University

Kottayam

Programme	**BSc (Honours) Biotechnology**
Course Name	**Tissue Culture Techniques**
Type of Course	**DSC C**
Course Code	**MG4DSCBTG202**
Course Level	**200**
Course Summary	This comprehensive course explores the fundamental principles and applications of plant and animal cell culture, delving into the historical development, essential techniques, and diverse applications of these powerful technologies. Students will gain a thorough understanding of the cultivation and manipulation of plant and animal cells in vitro, from the preparation of culture media and sterilization procedures to the manipulation of growth hormones and the exploration of totipotency and cytodifferentiation. The course also examines the ethical and societal implications of these technologies and their potential impact on various fields, including agriculture, medicine, and Biotechnology.

Semester	4	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	2	0	75
Pre-requisites, if any	Need to complete difficulty level 100-199 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome Upon completion of this course in Tissue culture techniques students should be able to:	Learning Domains	PO No

1	Recognize the historical evolution of plant biotechnology and its key contributors	K	1,6
2	Demonstrate advanced proficiency in setting up and maintaining a plant tissue culture laboratory, showcasing comprehensive knowledge of its historical context and practical applications.	A	2,3,6
3	Apply precise techniques for media preparation, sterilization, and propagation of plants through totipotency stages, showcasing a comprehensive skill set in plant tissue culture methodologies.	A	2,3,10
4	Evaluate the advantages and applications of various plant tissue cultures, including organogenesis, somatic embryogenesis, somaclonal variation, and hybridization techniques.	E	2,3
5	Trace the historical development and milestones in animal cell culture	U	2,6
6	Demonstrate knowledge of basic requirements for successful animal cell culture, including laboratory setup and equipment.	U	2,3,6
7	Analyse the composition of culture media, including natural and synthetic media.	A	2,10
8	Differentiate between primary and secondary cell cultures, and maintain established/continuous cell lines	An	2,3,8
9.	Apply animal cell culture in the production of monoclonal antibodies, vaccines, specific metabolites, and transgenic animals	A	2,6,9
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Plant Biotechnology Basics	1.1	Historical development and Basic requirements. Overview of the historical development of plant biotechnology Evolution from selective breeding to modern genetic engineering , Key milestones and breakthroughs	2	1, 2
	1.2	Basic requirements and lab setup in plant tissue culture Importance of sterile conditions, Essential equipment and tools, Lab layout and safety considerations	3	3

	1.3	Media preparation, sterilization techniques, and role of growth hormones, Formation of plant tissue culture media, Various sterilization techniques, Role of growth hormones in regulating plant cell growth and development	5	3
	1.4	Totipotency and cytodifferenciation, Understanding the concepts of totipotency and cyto differenciation in plant cells Practical implications in tissue culture	3	4
2 **Plant Tissue Culture Techniques and Applications**	2.1	Callus culture, Suspension culture, and single cell techniques, Procedure and applications of callus culture, Principles and uses of suspension culture, Isolation and utilization of single cells in plant tissue culture	4	4
	2.2	Soma clonal variation, Exploring somaclonal variation, organogenesis, embryogenesis.	3	4
	2.3	Meristem culture, Techniques and applications of organogenesis Importance of meristem culture in disease - free plant propagation	3	4
	2.4	Haploid production and applications, Haploid production of ovary, ovule, anther, and pollen culture, Techniques for inducing haploid production in various plant organs.	3	5,6
	2.5	Applications in plant breeding and genetic studies, Applications of plant cell culture, Production of specific metabolites for pharmaceutical purposes.	3	5,6
3 **Animal Cell Culture**	3.1	History and basic requirements of animal cell culture, Evolution of animal cell culture, Laboratory requirements and aseptic techniques	4	6,7
	3.2	Cell culture media, types, preparation, and sterilization. Formulation of media for animal cell culture. Types and significance of different media. Sterilization methods in animal cell culture	3	6,7
	3.3	Primary and secondary cell culture, anchorage dependence Techniques and applications of primary cell culture, Understanding anchorage dependence in cell culture, Transformed and continuous cell lines, commonly used animal cell lines, their origin, and applications	5	8,9
	3.4	Applications of animal cell culture Role of animal cell culture in stem cell research, Production of monoclonal antibodies, vaccines, and specific metabolites	4	8,9

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **C. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	D. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks 5 hrs.	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

4 Practical	4.1	Sterilization Techniques	5	1,2,3
	4.2	Plant tissue culture Media preparation	5	1,2,3
	4.3	Callus culture	5	1,2,3
	4.4	Meristem culture	5	1,2,3
	4.5	Anther culture	5	1,2,3
	4.6	Organogenesis	5	1,2,3
5. Module		Teacher Specific Content		

References

1. Bhojwani, S. S., & Razdan, M. K. (1996). Plant tissue culture: Theory and practice. Elsevier.
2. Misra, S. P. (2009). Plant tissue culture. Ane Books India.
3. Singh, B. D. (2009). Plant breeding. Kalyani Publishers
4. Narayanaswamy, S. (1994). Plant cell and tissue culture. Tata McGraw-Hill Publishing Company
5. Ignacimuthu. (2005). Plant biotechnology. Oxford & Ibh Publishing Company Pvt Limited.
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7. Sasidhara, R. (2019). Animal Biotechnology. MJP Publisher.
8. Raja, Florence Periera. (2006). Animal Biotechnology. New Delhi: Dominant Publishers.
9. Open University, Netherlands. (1994). In Vitro Cultivation of Animal Cells. New Delhi: Butterworth-Heinemann.
10. Vlak, J. M., de Gooijer, C. D., Tramper, J., & Miltenburger, H. G. (Eds.). (2002). Insect Cell Cultures: Fundamental and Applied Aspects. New York: Kluwer Academic Publishers
11. Masters, J. R. W. (2007). Animal Cell Culture (3rd ed.): A Practical Approach. Oxford University Press.
12. Satyanarayana, U. (2023). Biotechnology (15th ed.). Books & Allied (Publishers) Ltd.

Suggested Readings

E. Hammond, J., et al. (2012). Plant biotechnology. Springer Science & Business Media.
F. Henry, R. J. (1997). Practical application of plant molecular biology. Chapman & Hall
G. Smith, J. A. (2018). Animal Biotechnology: Models in Discovery and Translation. CRC Press.
H. Mohan, R. (2016). Introduction to Animal Biotechnology. CRC Press.
I. Mamidi, N.V.S & Ulaganathan, V. K. (Eds.). (2019). Animal Biotechnology: Emerging Trends in the 21st Century. Springer.

Mahatma Gandhi University
Kottayam

Programme						
Course Name	**Quality control in Biology**					
Type of Course	**SEC**					
Course Code	**MG4SECBTG200**					
Course Level	**200-299**					
Course Summary	This course focuses on imparting a thorough understanding of quality control principles within the biological sciences, emphasizing their application in biotechnology. The course is structured into five modules, each covering distinct aspects of quality control measures and their significance in ensuring the reliability and integrity of biological processes and products					
Semester	4	Credits		3		Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	Need to complete 100 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the principle and Significance of quality control in biology.	U	1,6
2	Demonstrate Knowledge of Quality Control Measures, in molecular biology techniques.	U	1
3	Apply Quality Control Techniques in Biotechnological Processes, Implementing quality control protocol.	A	1,10
4	Comprehensive understanding of regulatory agencies (such as FDA, USDA, WHO) and Hazard Analysis and Critical Control Points (HACCP) in food processing, as well as knowledge of food safety standards and certifications (ISO 22000, FSSC 22000).	U	1,2,6
5	Evaluate GMP for biopharmaceuticals.HACCP and other standards.	E	1

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs.	CO No.
1 Introduction to Quality Control in Biotechnology	1.1	Definition and scope of quality control,Basic Principles of quality control	4	1
	1.2	Importance in ensuring research reliability. Difference between Quality Control & Quality Assurance.	3	2
	1.3	Quality Control a multidisciplinary approach.	2	2
	1.4	Documentation and record-keeping requirements.	2	2
2 Various areas in Quality Control	2.1	Role of Microbiology and Molecular Biological techniques in Quality Control.PCR, Electrophoresis, Culture Based Methods, ATP Bioluminescence.	5	4
	2.2	Sterilization methods and their validation.	2	4
	2.3	Molecular Biology tools in QC,Immunological tools in QC,Contamination control in cell culture, Quality control protocols in cell culture processes	4	3
	2.4	Importance of documentation in quality control. Preparation for regulatory audits.Statistics in quality control, Control charts for data analysis	5	3
	2.5	Analytical and Software tools in Quality Control	2	3
3 Introduction to Regulatory framework in Food industry and Medicine	3.1	Historical perspective and evolution of regulations in food and bioprocessing. Overview of regulatory agencies Codex Standards.(FDA,USDA,WHO,etc.).Food Saftey Modernisation Act (FMSA).	5	5
	3.2	Regulatory frameworks in biotechnology. Regulatory Requirements in Food Processing: Good Manufacturing Practices (GMP) in food industry.	3	5
	3.3	Hazard Analysis and Critical Control Points (HACCP). Food safety standards and certifications (ISO 22000, FSSC 22000).	3	5
	3.4	Current Good Manufacturing Practice (Cgmp) for biopharmaceuticals. Good Laboratory Practice (GLP) International Council for Harmonization (ICH) Guidelines	5	3
4		Teacher Specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars
Assessment types	**MODE OF ASSESSMENT** 1. **Continuous Comprehensive Assessment (CCA)** MCQ, Class tests, Assignments, Viva Total marks : 75 CCA : 25
	2. **End Semester examination – 1.5 hrs.** Total marks : 50
Pattern of questions	Total marks: 50 marks (1.5 hrs.) One word answer question (1mark):10 out of 10 10x1= 10 marks Short answer questions (3marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

References

1. Van Lenteren, J. C. (Ed.). (2003). Quality control and production of biological control agents: Theory and testing procedure.
2. Oates, J. E. (n.d.). Quality control in the biological sciences.
3. Satyanarayana, U. (2005). Textbook of biotechnology.
4. Weinberg, S. (1995). Good laboratory practice regulations (2nd ed.). Marcel Dekker Series.
5. Singh, B. D. (2014). Biotechnology (4th ed.). ISBN-13: 978-9327222982 ISBN-10: 9327222989.
6. Vasconcellos, J. A. (2004). Quality assurance for the food industry. CRC Press.
7. Geigert, J. (2002). Quality assurance and quality control for biopharmaceutical products: Development and manufacture of protein pharmaceuticals (Vol. 14). ISBN: 978-1-4613-5127-6
8. Jack O'Grady, Austin Community College,Copyright Year: 2019, Quality Assurance & Regulatory Affairs for the Biosciences,Publisher: Austin Community College
9. Ralph Early,Guide to Quality Management Systems for the Food Industry By Springer Science Business Media.

Suggested reading

3. Bioprocess Engineering Principles (1995) by Pauline M. Doran
4. Introduction to Statistical Quality Control" by Douglas C. Montgomery. WELEY Publications.

5. Relevant research articles and case studies from reputable journals and regulatory agencies.

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Programme						
Course Name	**Human Resource Management in Biotechnology**					
Type of Course	**VAC**					
Course Code	**MG4VACBTG200**					
Course Level	**200-299**					
Course Summary	This course is designed to equip students with the essential leadership and teamwork skills necessary for success in scientific research and collaborative projects.					
Semester	4	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	Need to complete difficulty level 100-199 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the characteristics and roles of leadership, management and team-building in research institutions	U	1,5,7,8
2	Apply leadership theories or approaches to professional scenarios and case studies	A	5,6,7,8
3	Comprehend clear oral and written communication that engages the audience, team and consumers	U	2,4,6
4	Apply effective team building skills by outlining the different groups	A	3,4,6,7
5	Employ the qualities of a mentor to work in good team	A	4,5,6,7
6	Choose a team which manages the work more efficiently	E	1,4, 5, 9

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Leadership and communication skills	1.1	Overview of Leadership in Scientific Settings: Understanding the unique challenges and opportunities for leadership in scientific research, Introduction to various leadership styles and their applicability in scientific contexts	4	1
	1.2	Case study 1: Examples of successful leaders in science, Leading researcher in Biotechnology, Case study 2: Self-assessment of leadership style	4	1
	1.3	Importance of teamwork in scientific research.: Building and managing effective research teams,	4	2
	1.4	Communication skills for scientists. Clear scientific writing and presentation techniques.	3	3
2 Team Dynamics and mentorship	2.1	Conflict, Resolution and Decision Making- Identifying and addressing conflicts in research teams. Strategies for fostering a positive and collaborative team culture,	4	3
	2.2	Techniques for effective decision-making in scientific projects, Balancing individual and team perspectives	3	4
	2.3	Importance of mentorship in scientific careers and teams, Developing mentoring skills for both mentors and mentees	3	5
	2.4	Career Development in Science: Navigating career paths in academia, industry, and beyond. Networking and professional development in the scientific community	5	5
3 Team Management in Science Projects	3.1	Ethical Leadership in Science: Ethical considerations in scientific research, Responsible conduct of research and leadership	3	1
	3.2	Project Planning and Execution: Developing project plans and timelines.	3	6
	3.3	Monitoring progress and adapting to changes in scientific projects.	3	6
	3.4	Resource Management: Managing laboratory resources efficiently	3	6
	3.5	Budgeting and grant management in scientific research	3	6
4	Teacher specific content			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars
Assessment types	**MODE OF ASSESSMENT** 6. **Continuous Comprehensive Assessment (CCA)** MCQ, Class tests, Assignments, Viva Total marks : 75 CCA : 25
	7. **End Semester examination – 1.5 hrs.** Total marks : 50
Pattern of questions	Total marks: 50 marks (1.5 hrs.) One word answer question (1mark):10 out of 10 10x1= 10 marks Short answer questions (3marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

References:

1. Chopra, R. (2021). Leading Science Teams: The Basics of Collaboration and Team Leadership in Research. New Delhi: Academic Press.

2. Joshi, M. (2019). Teamwork and Innovation in Scientific Research. Mumbai: Springer.

3. Rai, S. K. (2022). Leadership in Scientific Inquiry: Strategies for Success. Chennai: Oxford University Press.

4. Sengupta, S. (2021). Effective Team Management in Research Organizations. Kolkata: Sage Publications.

Suggested Readings:

8. Pavitt, C. & Curtis, E. (2001). Small group discussion: A theoretical approach (3rd ed.). Retrieved from

http://www.uky.edu/~drlane/teams/77avitt

2. Poole, M.S., & Hollingshead, A.B. (2004). Theories of small groups: Interdisciplinary perspectives. Thousand Oaks, CA: Sage.

3. Hackman, J. R., & Johnson, C. E. (2013). Leading Teams: Setting the Stage for Great Performances (2nd ed.). Harvard Business Review Press.

4. Katzenbach, J. R., & Smith, D. K. (2015). The Wisdom of Teams: Creating the High-Performance Organization (2nd ed.). Harvard Business Review Press

5. Gardner, H. (2008). Five Minds for the Future. Harvard Business Review Press.

SEMESTER-5

Mahatma Gandhi University

Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Recombinant DNA Technology**					
Type of Course	**DSC A**					
Course Code	**MG5DSCBTG300**					
Course Level	**300-399**					
Course Summary	This course delves into the principles, methodologies, and applications of recombinant DNA technology. Students will get a thorough understanding of the tools used to manipulate DNA, gene cloning processes, and the various applications of genetic engineering.					
Semester	5	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Need to complete difficulty level 200-299 courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the common tools used in genetic engineering, such as restriction enzymes and vectors.	U	1, 2,3
2	Read the role of cloning vectors to introduce recombinant DNA into host cells	K	1, 2,4
3	Evaluate the advantages and disadvantages of various expression systems	E	1, 2,3
4	Design and plan a gene cloning experiment, considering variables and controls	C	1, 2,9
5	Propose innovative applications of genetic engineering in emerging fields	C	1, 2,9
6	Able to perform isolation of DNA and plasmid, restriction digestion, transformation and PCR.	A	1,2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction and Tools in Rdna technology	1.1	Introduction. History. Enzymes for in vitro modification of nucleic acids– Kinases, Phosphatases, Exonucleases, Endonucleases, Restriction Endonucleases, Ligases and Terminal Transferases.	2	1
	1.2	Modification of Ends – Adapters, Linkers, Homopolymer Tailing.	1	1
	1.3	Cloning Vectors – Plasmids and their desirable properties, E coli based vectors – Pbr, Psc, Puc, Pgem3Z. M13 based vectors. Bacteriophages λ EMBL Cosmids, Phasmid. Phagemids with special reference to pBluescript, Plitmus.	3	2
	1.4	In vitro packaging, phage display. Gateway Cloning, TA cloning. Shuttle Vectors -Pcambia, Vectors for Yeast (YEP, YIP, YRP, YCP, YAC) Artificial Chromosomes- BAC, MAC, PAC	4	2
	1.5	Viral and virus derived vectors for animal cells- SV40, Adenovirus vectors, Baculovirus. Plant vectors – geminivirus, Ti plasmid	3	2
2 Gene Transfer Techniques, Screening and Advanced technology in Rdna (17 Hours)	2.1	Gene Transfer Methods: CaCl2 mediated, Microinjection, Electroporation, Lipofection, Particle Bombardment, Gene Gun, Agrobacterium mediated	5	2
	2.2	Genetic markers in plants – Kanamycin, neomycin, Hygromycin B, Bromoxynil, Methotrexate, chloramphenicol. Genetic markers in animals-Neomycin/Geneticin Resistance, Hygromycin, Puromycin Resistance, GFP. Screening methods: Blue white assay, Insertional inactivation, colony hybridization.	3	3
	2.3	Expression vectors- Elements for expression- Protein tags, Promoters- Introduction and elements for expression.	4	3
	2.4	Fusion tagged expression system, affinity tag. Protein selection methods – hybrid arrest and hybrid release translations, immunochemical methods. Nuclear transfer technology,	2	3
	2.5	Inducible expression system and control of transgene expression through naturally inducible promoters – lac and tet. Steroid hormones as heterologous Inducers.	3	3
3 Bio	3.1	PCR types and applications. DNA foot printing, fingerprinting, gel shift analysis, DNA microarray,	3	4
	3.2	Advanced molecular markers: RFLP, RAPD, AFLP, STS, SNP, SSR, EST. chromosome walking, jumping.	4	4

instrumentation and application in Rdna	3.3	Next generation sequencing (NGS) – Illumina sequencing ABI/SOLID, Ion Torrent (Thermo Fisher), 454 Sequencing (Roche) Site directed Mutagenesis.	4	4
	3.4	Applications of recombinant DNA technology- Production and purification of recombinant proteins- insulin and somatostatin. Gene therapy. Metabolite engineering. Imparting new agronomic traits to plants to improve quality and quantity.	4	5
4 Practicals	4.1	Isolation of Genomic DNA	5	2
	4.2	Isolation of plasmid DNA	5	2
	4.3	Restriction digestion of DNA	5	2
	4.4	Bacterial Transformation	5	2
	4.5	Polymerase Chain Reaction	5	2
	4.6	RAPD/RFLP/SNP	5	2
5		**Teacher Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks **5 hrs.**	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

Reference:

1. Brown, T. A. (2007). *Genomes 3*. Garland Science.
2. Brown, T. A. (2016). *Gene cloning and DNA analysis: An Introduction*. John Wiley & Sons.
3. Karp, G., Iwasa, J., & Marshall, W. (2018). *Karp's Cell Biology*. John Wiley & Sons.
4. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). *Lewin's GENES XII*. Jones & Bartlett Learning.
5. Primrose, S. B., & Twyman, R. (2013). *Principles of gene Manipulation and Genomics*. John Wiley & Sons.
6. Purohit, S. S., & Mathur, S. (2002). *Biotechnology: Fundamentals and Applications*.
7. Watson, J. D., Myers, R. M., Myers, U. R. M., Caudy, A. A., & Witkowski, J. A. (2007). *Recombinant DNA: Genes and genomes: A Short Course*. Macmillan.

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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Enzyme Technology**					
Type of Course	**DSC A**					
Course Code	**MG5DSCBTG301**					
Course Level	**300-399**					
Course Summary	The curriculum provides a comprehensive exploration of enzymology. It begins with an introduction covering the basics of enzymes, their structure, function, nomenclature, and classification. The study of enzyme kinetics, including Michaelis-Menten kinetics and factors influencing enzyme activity, is included. The next segment delves into enzyme regulation, considering allosteric regulation and covalent modification. The following part focuses on enzyme immobilization and engineering, detailing principles, techniques, applications, and methods for enhancing enzyme properties. The final provides the practical experience in determining enzyme activity, factors affecting enzyme activity and enzyme immobilization.. The curriculum aims to provide students with a comprehensive understanding of enzymology and its diverse applications.					
Semester	5	Credits			4	Total hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Need to complete difficulty level 200-299 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome Upon completion of this course in Industrial & Bioprocess Technology, participants should be able to:	Learning Domains *	PO No
1	Explain biological importance of enzymes	U	1,2,3
2	Describe enzyme structure and its correlation with function.	U	1,2,3
3	Classify enzymes using the EC numbering system	U	1,2,3
4	Describe enzyme kinetics, including Michaelis- Menten dynamics and influencing factors.	U	1,2,3
5	Explain enzyme regulation, including allosteric control and feedback inhibition.	U	1,2,3
6	Discuss the applications of enzymes in diverse fields and discuss future trends in enzymology.	U	1,2,3
7	Evaluate the role of enzymes in various fields, such as biotechnology, medicine, and environmental science.	E	2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Enzymology	1.1	Basics of Enzymes: Definition and characteristics of enzymes. Importance of enzymes in living organisms	2	1
	1.2	Enzyme Structure and Function: Molecular structure of enzymes. The relationship between structure and function. Active site and substrate specificity..	3	2
	1.3	Enzyme Nomenclature and Classification: Enzyme Commission (EC) numbering system. Classification based on catalytic activity. Examples of enzyme names and classifications.	4	3
	1.4	Cofactors and Coenzymes: Types of cofactors (metal ions) and coenzymes (vitamins)..	5	5
	1.5	Role of cofactors: Role of cofactors in enzyme catalysis. Overview of prosthetic groups.	3	5
2 Enzyme Kinetics, Regulation and Enzyme engineering	2.1	Enzyme Kinetics: Understanding enzyme kinetics. Michaelis-Menten kinetics and its parameters. Factors influencing enzyme activity. Enzyme inhibition and types	6	4
	2.2	Regulation of Enzyme Activity: Allosteric regulation. Covalent modification and feedback inhibition. Regulation in metabolic pathways	5	5
	2.3	Enzyme Immobilization and Applications: Principles and techniques of enzyme immobilization. Applications of Immobilized enzymes	3	6
	2.4	Enzyme Engineering: Introduction to enzyme engineering. Methods for enhancing enzyme activity and stability. Applications of engineered enzymes	5	6
3 Enzyme Applications and Future Perspectives	3.1	Application of enzymes: Clinical, Environmental and industrial.	3	7
	3.2	Future Perspectives in Enzymology: Emerging trends and advancements in enzyme technology	3	6
	3.3	Synthetic enzymes and Abzymes	3	6
4 Practical	4.1	Determination of enzyme activity- amylase assay	5	4
	4.2	Factors affecting Enzyme activity Effect of pH on enzyme activity Effect of temperature on enzyme activity Effect of metal ion on enzyme activity Effect of inhibitors on enzyme activity	20	5
	4.3	Immobilization of enzyme and perform its activity	5	5
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks 5 hrs.	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References

- Price, N. C., & Stevens, L. (1999). Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins. Oxford University Press, USA.
- Taylor, K. B.(2008). Enzyme Kinetics and Mechanisms. Springer.
- Voet, D., & Voet, J. G, (2004). Biochemistry. John Wiley & Sons
- Shivraj Kumar, P.K.(2007) Enzyme Mechanism. RBSA Publishers
- Horton, R. H., Moran, L. A., & Scrimgeour, K. G.(2006). Principles of Biochemistry (4th ed.). Pearson

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Programme	**BSc (Honours) Biotechnology**
Course Name	**Biotechnology and Entrepreneurship**
Type of Course	**DSE**
Course Code	**MG5DSEBTG300**
Course Level	**300-399**
Course Summary	The course is a detailed exploration of various aspects of .Starting off with the basic methodology, the course further delves into practical understanding of the subject matter. It also provides an insight into the various legal and market perspectives along with awareness about gathering opportunities around the globe. The curriculum means to provide students with a comprehensive understanding of Bio entrepreneurship and equips them with the necessary skills related to the topic.

Semester	**5**	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Need to complete 200 level courses.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Express the historical development of bio entrepreneurship, showcasing its scope and significance in the modern business landscape.	C	1,2,9
2. 7	Analyze the connection between biotechnology and entrepreneurship, assessing how entrepreneurship contributes to economic growth and innovation.	A	2,3
3. 8	Apply key entrepreneurial characteristics to real-world situations, creating a framework for resilience, adaptability, and successful small-scale product development.	A	2,3

4.	Critically evaluate the legal and ethical implications of intellectual property rights in entrepreneurship, and assess the effectiveness of market research and branding strategies in the biotechnology sector.	E	1,2,3
5.	Apply government policies, funding opportunities, and global collaborations to craft a comprehensive entrepreneurship business plan, demonstrating practical application.	A	2,3
6.	Assess the ethical implications and societal impacts of entrepreneurship in agricultural, medical, and environmental biotechnology.	E	1,2,3
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Fundamentals of Bioentrepreneurship -Characteristics and Development	1.1	Introduction to Bioentrepreneurship; Definition and Scope of Bioentrepreneurship; Historical Perspective of Bioentrepreneurship	3	1
	1.2	Importance in the Modern Business Landscape; Significance of Bioentrepreneurship	3	1
	1.3	Link between Biotechnology and Entrepreneurship; Contributions to Economic Growth and Innovation	3	1
	1.4	Essential Bioentrepreneurial Characteristics; Traits of Successful Bioentrepreneurs	3	2
	1.5	Developing Resilience and Adaptability; Small-Scale Development of Product	3	2
	1.6	Ideation and Conceptualization; Research and Development in Bioentrepreneurship.	3	2
2 Legal and Market Perspectives.	2.1	Intellectual Property Rights; Understanding Patents, Trademarks, and Copyrights	3	3
	2.2	Legal and Ethical Implications	2	3
	2.3	Bioentrepreneurship Market Development; Market Research in Biotechnology	4	3

	2.4	Branding and Marketing Strategies	4	3
3 **Government and Global Influences**	3.1	The Role of the Indian Government in Bioentrepreneurship	3	4
	3.2	Policies and Initiatives Supporting Bioentrepreneurs; Funding Opportunities and Grants	4	4
	3.3	Foreign Investors in Bioentrepreneurship in India; Attracting Foreign Investment in Biotechnology	4	5
	3.4	Global Partnerships and Collaborations.	4	5
4 **Specialized Biotechnologies and Global Outlook**	4.1	Starting, Managing, and Leading Innovative Technologies; Entrepreneurship in Agricultural Biotechnology	3	6
	4.2	Bioentrepreneurship in Medical Biotechnology	3	6
	4.3	Entrepreneurship in Industrial Biotechnology	3	6
	4.4	Bioentrepreneurship in Environmental Biotechnology	3	6
	4.5	Bioentrepreneurship Globally.	2	6
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

Reference:

1. Swati Agarwal, Sonu Kumari, Suphiya Khan; (2021) Bioentrepreneurship and Transferring Technology Into Product Development; IGI Global ISBN13: 9781799874119, ISBN10: 1799874117 EISBN13: 9781799874133.
2. Holger Patzelt, Thomas Brenner, (2008) Handbook of Bioentrepreneurship. Springer DOI: 10.1007/978-0-387-48345-0; ISBN: 978-0-387-48343-6,eISBN: 978-0-387-48345-0
3. Craig Shimasaki; (2020) Biotechnology Entrepreneurship. Academic Press Inc. ISBN: 978-0-12-404730-3
4. Audretsch, D. B., & Link, A. N. (2019). Entrepreneurship and innovation policy: Essential elements of an entrepreneurial ecosystem. Oxford University Press.
5. Lerner, J. (2009). Boulevard of broken dreams: Why public efforts to boost entrepreneurship and venture capital have failed—and what to do about it. Princeton University Press.
6. Chesbrough, H. W. (2003). Open innovation: The new imperative for creating and profiting from technology. Harvard Business Press.
7. Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. Academy of Management Review, 25(1), 217-226.
8. Santoro, M. D., & Bierly, P. E. (2006). Innovation and entrepreneurship in biotechnology, an international perspective: Concepts, theories and cases. Edward Elgar Publishing.

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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Basic Bioinformatics**					
Type of Course	**DSE**					
Course Code	**MG5DSEBTG301**					
Course Level	**300-399**					
Course Summary	**Overall, bioinformatics courses aim to equip students with the knowledge and skills needed to analyse and interpret biological data, fostering an understanding of the computational methods used in modern biological research. The field is dynamic, and courses may be updated to reflect advancements in both biology and computational techniques.**					
Semester	5	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		40	5	30	0	75
Pre-requisites, if any	Need to complete difficulty level 200-299 level courses.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Understand the basics, career paths and significance of Bioinformatics.	U	1,2,3
2.	Apply the practical experience in data interpretation and analysis by utilizing bioinformatics databases.	A	2,3
3.	Develop basic skills in using bioinformatics tools for data analysis and scientific research.	S	1,2,10
4.	Outline the use and importance of genomic data in modern biological research.	An	1,2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to bioinformatics	1.1	Introduction to bioinformatics-	2	1
	1.2	Careers and Scope in Bioinformatics. Key milestones in Bioinformatics. **Activity:-**Literature mining using PubMed and Medline.	2	1
	1.3	Human Genome Project. Next-Generation Sequencing (NGS): Principles of NGS technologies.	3	1
2 Overview of Biological Databases	2.1	Overview of NCBI, EMBL, DDBJ, Genbank, PDB, Swissprot.	2	2
	2.2	Biological Databases-Sequence databases and structural databases.	2	2
	2.3	Sequence analysis tools (FASTA, BLAST). Bioinformatics Structure prediction tools (Swiss model, MODELLER). **Activity:** Retrieve information from biological databases like NCBI or UniProt/ Swissprot, PDB.	2	3
	2.4	Genomic databases (GenBank, Ensembl) Protein databases (UniProt, PDB). **Activity:**- Translating an unknown DNA sequence	2	2
3 Sequence alignments	3.1	Sequence alignments- global alignment, local alignment. Dot matrix analysis. **Activity**:- Perform a basic sequence alignment using tools like BLAST-Nucleotide BLAST (BLASTn). Protein BLAST (Blastp). Translated BLAST (Blastx).	3	3
	3.2	Multiple sequence alignment- CLUSTAL W or T-Coffee. **Activity:** Finding out open reading frames (ORF) through NCBI ORF finder	2	3
	3.3	Phylogenetic analysis-Phylip. Homology 92odelling. Tivixe Activity:-Construct a phylogenetic tree using a small set of protein or DNA sequences.	5	3
	3.4	General overview of Map Viewer. ORF Finder. Locus- Link. SPDBV, Pymol, Jmol, Rasmol **Activity:**-. Visualize the 3D structure of a protein using tools like Pymol or Jmol or Rasmol.	5	3
4 Applications of Bioinformatics	4.1	Applications of Bioinformatics: Basic research, Geoinformatics. Personalized Medicine.	3	4
	4.2	Pharmacogenomics- Structure-based drug design-ADME, Classical SAR and QSAR studies. Pharmacophore identification and novel drug design.	3	4
	4.3	Structure based drug design and computer aided drug design. Legal and ethical considerations.	4	4
	4.4	Molecular Docking – Identification of ligands, active site prediction, docking and evaluation. Molecular Docking software	5	4

		– AutoDock.		
5		**Teacher Specific Content.**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

1. Mount, D. W. (2004). *Bioinformatics: Sequence and Genome Analysis* Cold Spring Harbour Lab Press, New York.
2. Baxevanis, A. D., & Ouellette, B. F. F. (2004). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley-Interscience*
3. Higgs, P. G., & Attwood, T. K. (2013). *Bioinformatics and Molecular Evaluation.* John Wiley & Sons
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7. Berg, J. M., Tymoczko, J. L., & Gatto, G. J. (n.d.). *Biochemistry*
8. Klipp, E., Liebermeister, W., Wierling, C., Kowald, A., Lehrach, H., & Herwig, R. (n.d.). *Systems Biology: A Textbook.*
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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Bioprocess Technology**					
Type of Course	**DSE**					
Course Code	**MG5DSEBTG302**					
Course Level	**300-399**					
Course Summary	This course provides a comprehensive overview of bioprocess technology, covering key concepts from fermentation and microorganism screening to bioreactor design and downstream processing in the production of various valuable products.					
Semester	5	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Need to complete difficulty level 200-299 level courses.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome Upon completion of this course in Bioprocess Technology, participants should be able to:	Learning Domains *	PO No
1	Define and explain the fundamental concepts of industrial biotechnology.	U	1,10
2	Differentiate and understand various fermentation processes.	An	2.3
3	Perform isolation and screening of industrially important microorganisms.	A	1.2
4	Formulate fermentation media and explain the principles of bioreactor design.	C	2,6,10
5	Employ the proper downstream processing techniques to recover and purify products from fermentation processes.	A	1,6

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Fundamentals of Fermentation and Bioprocessing.	1.1	Fermentation and its role in bioprocessing.	2	1
	1.2	Types of fermentation: Submerged and Solid State Fermentation: Differentiation between submerged and solid-state fermentation.	4	2
	1.3	Mode of Microbial Culture: Batch, continuous, and fed-batch culture.	3	2
	1.4	Applications of Bioprocess Technology: Overview of the diverse applications of bioprocess technology.	4	2
2 Isolation, Screening and Strain improvement	2.1	Isolation and Screening of Industrially Important Microorganisms: Techniques for isolating and screening microorganisms. **Activity**: Isolation and screening of Amylase producing bacteria.	6	3
	2.2	Primary and Secondary Screening: Processes involved in primary and secondary screening of microorganisms.	4	3
	2.3	Strain improvement techniques- Mutation, Hybridization and rDNA technology.	5	3
3 Fermentation media and Bioreactor design.	3.1	Role of Fermentation Media: Defined and undefined media.	3	4
	3.2	Components of Fermentation Medium: Carbon and nitrogen sources, precursors, inducers, inhibitors, and antifoam agents. **Activity:** Media preparation.	6	4
	3.3	Media Formulation and Sterilization: Techniques for formulating and sterilizing fermentation media.	4	4
	3.4	Bioreactor Design: Design considerations for a typical bioreactor. Criteria for designing a bioreactor. Types of bioreactors.	6	4
4 Downstream Processing and Fermentative production	4.1	Introduction to Downstream Processing	3	5
	4.2	Various stages of downstream processing. **Activity**:Enzyme purification: Amylase by Ammonium sulphate precipitation.	5	5
	4.3	Fermentative production of enzyme (amylase), antibiotics (Penicillin) **Activity:** Enzyme immobilization: Amylase	5	5
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. End Semester Examination – 2.0 hrs. Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

- Stanbury, P. F., Whitaker, A., & Hall, S. J. (2008). Principles of Fermentation Technology. Elsevier.
- Kalichelvan, P. T., & Arul Pandi, I. (2009). Bioprocess Technology. MJP Publishers, Chennai.
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- Vazhacharickal, P. J Mathew, J. J. & Kumaran Nair S. N. (2018). Industrial Biotechnology: An Introduction. Independently Published.

Suggested Readings

- Purohith, Trevan, Mathur, Agrobotanical Publishers. (2018). Biotechnology: Fundamentals and Applications.
- Barnum, S. R. (2005). Biotechnology: An Introduction. Thomsun.

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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Marine Biotechnology**					
Type of Course	**DSE**					
Course Code	**MG5DSEBTG303**					
Course Level	**300-399**					
Course Summary	Marine biotechnology applies biological principles to marine organisms for diverse purposes, spanning from basic concepts in marine biology and genetic diversity exploration to the utilization of marine microorganisms in biotechnological applications like biofuel production and enzyme synthesis. Techniques such as oceanographic sampling and molecular methods like Polymerase Chain Reaction (PCR) are crucial for data analysis. The field extends to the production of bioproducts and pharmaceuticals from marine sources, addressing challenges in drug discovery. Moreover, marine biotechnology plays a role in mitigating marine pollution through bioremediation, underscoring the importance of conservation for sustainable marine ecosystems.					
Semester	5	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre- requisites, if any	Need to complete 200 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Describe key Marine Organisms	K	1, 2, 4
2	Explain the applications in Biotechnology, such as biofuel production and enzyme production	U	1, 2 ,3
3	Differentiate various Molecular Techniques	An	1, 2, 3
4	They can discuss the challenges and opportunities in Marine-derived Drugs and Therapeutics.	U	1, 2, 3

5	Able to design strategies for the sustainable production of Marine bioproducts.	C	1, 2, 9
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Marine Biotechnology	1.1	Definition and Scope of Marine Biotechnology. Basic Concepts in Marine Biology - Identification of Key Marine Organism.	5	1
	1.2	Fundamentals of Genetic Diversity in Marine Organisms	3	1
2 Marine Organisms and Their Applications	2.1	Marine Microorganisms - Bacteria, Archaea, Viruses and Algae in Marine Environments.	6	1
	2.2	Marine Microbial Diversity.	3	1
	2.3	Applications in Biotechnology – Biofuel production from micro algae, enzyme production from marine bacteria.	4	2
3 Tools and Techniques in Marine Biotechnology	3.1	Techniques in Marine Sampling and Analysis, Oceanographic Sampling Methods **Activity:** Visit to a marine ecosystem; collection and morphological identification of marine microorganism and preparation of study report	8	3
	3.2	Analytical Techniques in Marine Biology **Activity:** Visit to a marine biology laboratory and preparation of study report.	8	3
	3.3	Molecular Techniques in Marine Biotechnology, Polymerase Chain Reaction (PCR), DNA Sequencing **Activity**: Molecular identification of isolated marine microorganism and preparation of study report.	8	3
4 Applications of Marine Biotechnology	4.1	Marine Bioproducts and Pharmaceuticals. Marine-derived Drugs and Therapeutics	7	4
	4.2	Challenges and Opportunities. Marine Pollution and Bioremediation. Conservation Strategies	8	5
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

1. Levinton, J. S. (2017). Marine Biology: Function, Biodiversity, Ecology. Oxford University Press..
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Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Scientific Communication in Research**					
Type of Course	**SEC**					
Course Code	**MG5SECBTG300**					
Course Level	**300-399**					
Course Summary	The Scientific Communication in Research Course provides an introduction to various aspects of communicating scientific works. It deals with the structure, indexing , evaluation- selection , citation as well as ethical considerations both theoretically and practically.					
Semester	**5**	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	Need to complete 200 level courses.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Recall fundamental principles in professional scientific communication, including hypothesis components and the distinction between inductive and deductive reasoning.	K	1,2,4
2.	Understand the significance of creativity in scientific research and explore diverse sources and methods for generating research ideas.	U	1,2,3
3.	Apply skills in hypothesis formulation, reasoning, and testing to construct and assess research hypotheses	A	2,3
4.	Analyze the structure of scientific reports, recognizing the significance of each section and understanding the rationale behind visual elements.	An	1,2,3
5.	Synthesize knowledge to prepare a synopsis, comprehend various forms of scientific writing, and apply ethical considerations in biomedical research. Additionally, evaluate the peer review process and demonstrate ethical decision-making through practical exercises and real-world case studies	E	1,2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction, Structure and Processes of Scientific report	1.1	Introduction to Professional Scientific Communication.	2	1
	1.2	Discussion of creativity, research ideas and where to find them.	2	1
	1.3	Inductive reasoning versus deductive reasoning.	2	1
	1.4	Hypothesis, reasoning and testing-specify the hypothesis.	2	1
	1.5	Structure of a scientific report, Synopsis preparation.	3	2
	1.6	Structure of a Research article: Title, abstract, methods, results, and discussion, Schematic diagrams, figures, tables and flow charts -rationale and usage	4	2
	1.7	Peer review process, Different forms of writing: scientific report, proposal, and reviews.	4	5
	1.8	Presentations-thumb rules and good practice. Ethics in research	3	5
2 Overview of Major Indexing Databases	2.1	Understand the Importance of Scientific Publication Indexing: Explore the role of indexing databases in scholarly communication.	2	3
	2.2	Recognize the impact of indexing on visibility, credibility, and dissemination of research.	2	3
	2.3	Introduction to Major Indexing Databases: Overview of prominent scientific publication indexing databases (e.g., PubMed, Scopus, Web of Science, UGC care list, etc).	3	3
	2.4	Evaluating and Selecting Journals: Understand the criteria for selecting reputable journals for publication. Explore the use of journal metrics and impact factors.	3	4
	2.5	Citation Analysis and Metrics: Introduction to citation analysis as a measure of research impact. Interpretation of citation metrics and their significance.	3	4
	2.6	Open Access Databases and Repositories: Explore open access indexing databases and repositories. Understand the benefits and challenges of open access publishing.	3	5
3 Ethical Considerations	3.1	Ethical Considerations in Publication: Discuss ethical issues related to scientific publishing. Understand plagiarism, authorship, and publication ethics.	2	5

in Publications	3.2	Practical Exercises and Case Studies: Hands-on sessions to navigate and search in popular indexing databases. Analyze real-world case studies related to publication and database usage.	5	5
4		Teacher specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars
Assessment types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Class tests, Assignments, Viva Total marks : 75 CCA : 25
	B. End Semester examination – 1.5 hrs. Total marks : 50
Pattern of questions	Total marks: 50 marks (1.5 hrs.) One word answer question (1mark):10 out of 10 10x1= 10 marks Short answer questions (3marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

References:

1. C.R. Kothari , Gaurav Garg (2019) Research Methodology, New Age International (P) Ltd. ISBN-10 : 9386649225 ISBN-13 : 978-9386649225
2. Martha Davis, Kaaron J Davis, Marion M Dunagan, (2013) Scientific Papers and Presentations, Third Edition.
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4. Day, R. A., & Gastel, B. (2016). How to Write and Publish a Scientific Paper. Cambridge University Press.
5. Booth, V., Colomb, G. G., & Williams, J. M. (2008). The Craft of Research. University of Chicago Press.
6. Rudestam, K. E., & Newton, R. R. (2014). Surviving Your Dissertation: A Comprehensive Guide to Content and Process. SAGE Publications.
7. Hart, C. (2001). Doing a Literature Review: Releasing the Social Science Research Imagination. SAGE Publications.
8. Day, R. A. (2011). Scientific English: A Guide for Scientists and Other Professionals. ABC-CLIO.
9. Zeiger, M. (1999). Essentials of Writing Biomedical Research Papers. McGraw-Hill Education.
10. Masic, I. (2012). How to Search, Write, Prepare and Publish the Scientific Papers in the Biomedical Journals. Avicena.
11. Council of Science Editors. (2014). Scientific Style and Format: The CSE Manual for Authors, Editors, and Publishers. Council of Science Editors.

SEMESTER-6

Mahatma Gandhi University

Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Plant and Animal Biotechnology**					
Type of Course	**DSC A**					
Course Code	**MG6DSCBTG300**					
Course Level	**300-399**					
Course Summary	The coursework covers plant tissue culture, including principles, techniques like micropropagation, and applications such as somatic hybridization. It also delves into animal cell culture, covering laboratory prerequisites, media types, and applications like stem cell utilization, providing students with a comprehensive understanding of tissue culture principles and applications.					
Semester	6	Credits			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Need to complete 200 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon completion of this course in Plant biotechnology, students should be able to:		
1	Recognize the historical evolution of plant biotechnology	K	1, 2, 4
2	Apply precise techniques for media preparation, sterilization, and propagation of plants through various plant tissue cultures techniques.	A	2, 3
3	Understand the principles and significance of germplasm conservation.	U	1, 2, 3,
4	Describe the historical development and milestones in animal cell culture, demonstrate knowledge of basic requirements for successful animal cell culture, including laboratory setup and equipment	K	1, 2, 4
5	Analyse the composition of culture media, Maintenance of established/continuous cell lines and apply advanced cell culture techniques	An	1, 2, 3
6	Apply animal cell culture techniques in stem cell and cancer research	A	2, 3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to plant tissue culture	1.1	Historical development of plant Biotechnology	2	1
	1.2	Basic requirements and setting up of a plant tissue culture.	3	2
	1.3	Media preparation, Sterilization technique in plant tissue culture	3	3
	1.4	Totipotency, Stages of Micropropagation	2	3
	1.5	Regeneration of plantlets-organogenesis and somatic embryogenesis	3	4
2 Types of plant tissue culture, and Transgenic plants	2.1	Types of culture-Callus, Suspension and Single cell culture,	2	4
	2.2	Meristem culture. Haploid production- Ovary, Ovule, Anther and Pollen culture.	3	4
	2.3	Artificial seeds. Somaclonal variation	3	4
	2.4	Plant protoplast–isolation, culture and Somatic hybridization- Hybrids &Cybrids	4	6
	2.5	Maintenance and storage of plant cell, Applications of plant cell culture ,Transgenic Plants	5	6
3 Introduction to animal cell culture	3.1	History, Laboratory prerequisites for aseptic animal cell culture, Types of culture media: natural and synthetic, , Preparation and sterilization of media	5	6
	3.2	Culture Types: Anchorage-dependent and anchorage-independent cells	2	6
	3.3	Transformed Animal Cells, Established/ Continuous cell lines, Common Cell lines and maintenance	2	6
	3.4	Basic Techniques of mammalian cell culture	3	6
	3.4	Stem cells and their applications	3	5
4 Practicals	4.1	Preparation of MS media for plant tissue culture.	5	1
	4.2	Surface sterilization of explants	5	3
	4.3	Callus culture, Meristem culture.	8	4
	4.4	Embryo rescue technique, Invitro germination of recalcitrant seeds (Orchid)	7	4
	4.5	Composition of animal tissue culture media, Preparation serum containing media, Preparation of serum free media. – Demo (Virtual lab) Submission of report.	5	5

5		Teacher specific content

References

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks 5 hrs.	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

1. Bhojwani, S. S., &Razdan, M. K. (1996). Plant tissue culture: Theory and practice. Elsevier.
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4. Narayanaswamy, S. (1994). Plant cell and tissue culture. Tata McGraw-Hill Publishing Company
5. Ignacimuthu. (2005). Plant biotechnology. Oxford &Ibh Publishing Company Pvt Limited.
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7. R. Ian Freshney (2016). Culture of Animal Cells: A Manual of Basic Technique. Edition,7, Illustrated, reprint. Publisher, A.R. Liss, 1983.
8. Sasidhara, R. (2019). Animal Biotechnology.MJP Publisher.
9. Raja, Florence Periera. (2006). Animal Biotechnology. New Delhi: Dominant Publishers.
10. Open University, Netherlands. (1994). In Vitro Cultivation of Animal Cells. New Delhi: Butterworth-Heinemann.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Cancer Biology and Cell signaling**					
Type of Course	**DSC A**					
Course Code	**MG6DSCBTG301**					
Course Level	**300-399**					
Course Summary	The course provides a comprehensive overview of the fundamental principles underlying cancer development, as well as the latest advancements in research and treatment strategies.					
Semester	6	Credits		4		Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	*Need to complete difficulty level 200-299 courses*					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the basic principles of cancer biology	K	1,6
2	Summarise the different types of laboratory tests used to diagnose cancer	U	1,2,6,8
3	Explain the principles of molecular diagnostics	K	1,2
4	Apply molecular diagnostic techniques for the diagnosis of various cancer	A	1,2,6
5	Evaluate molecular diagnostic results	E	1,2,3,6,8
6	Criticise different cancer therapy methods	C	1,2,8,6,8
7	Evaluate the cell signalling	E	1,2

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Cancer Biology	1.1	Overview of cancer as uncontrolled cell growth	3	1
	1.2	Different forms of cancers	3	1
	1.3	Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.	4	2,4, 5
2 Principles of carcinogenesis and metastasis	2.1	Theory of Carcinogenesis, Chemical and physical carcinogenesis	3	1
	2.2	X-ray radiation-mechanisms of radiation carcinogenesis	3	1
	2.3	Clinical significance of invasion, Metastatic cascade, Basement membrane disruption, proteinase and tumor cell invasion	4	4 3
3 Molecular cell biology of cancer and signaling pathway	3.1	Signal targets and cancer, activation of kinases;	3	7
	3.2	Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes, Oncogenes/proto-oncogene activity	4	1
	3.3	Growth factors related to transformation, Telomerases. Tumor suppressor genes, modulation of cell cycle in cancer.	5	1
	3.4	Intracellular signalling mechanisms Receptor tyrosine kinases and G protein-coupled receptors, Signal transduction cascades	8	7
4 Methods for cancer therapy	4.1	Detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection.	10	2,5
	4.2	Different forms of therapy, chemotherapy, radiation therapy,	5	2,5
	4.3	Use of signal targets towards therapy of cancer; Gene therapy.	5	7
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

1. B. Alberts et. al.; (2014) Molecular biology of the cell; Taylor & Francis Publishers,.; 6th edition.
2. H. Lodish, A. Berk, S. L. Zipursky, P. Matsudaira, D. Baltimore and J. Darnell; (2007) Molecular Cell Biology; W. H. Freeman & Comp.,; 6th edition
3. G. M. Cooper and R. E. Hausman; (2009) The cell: A molecular approach; ASM Press,; 5th edition.
4. F Bunz; (2008) Principles of Cancer Genetics; Springer;

Suggested Readings

1. Hanahan, D., & Weinberg, R. A. (2011). Hallmarks of Cancer: The next generation. *Cell*, *144*(5), 646–674. https://doi.org/10.1016/j.cell.2011.02.013

2. Gonzalez, F. J., & Shah, Y. M. (2008). PPARalpha: mechanism of species differences and hepatocarcinogenesis of peroxisome proliferators. *Toxicology*, *246*(1), 2–8. https://doi.org/10.1016/j.tox.2007.09.030

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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Industrial Biotechnology**					
Type of Course	**DSE**					
Course Code	**MG6DSEBTG300**					
Course Level	**300-399**					
Course Summary	This course provides a comprehensive overview of Industrial Biotechnology, covering key concepts from fermentation and microorganism screening to bioreactor design and downstream processing in the production of various valuable products.					
Semester	6	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Need to complete difficulty level 200-299 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon completion of this course in Industrial & Bioprocess Technology, participants should be able to:		
1	Define and explain the fundamental concepts of industrial biotechnology	K	1,2,4
2	Summarize various fermentation processes.	U	1,2,3
3	Demonstrate the ability to isolate and screen industrially important microorganisms.	A	2,3
4	Illustrate primary and secondary screening methods for the selection of microorganisms	An	1,2,3
5	Judge the merits of different methods of strain improvement	E	1,2,3
6	Design and analyse fermentation media and understand the principles of bioreactor design	C	1,2,9
7	Apply downstream processing techniques to recover and purify products from fermentation processes.	A	2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Fundamentals of Fermentation and Bioprocessing, Fermentation Media	1.1	Define fermentation and its role in bioprocessing, Applications of bioprocess technology	3	1
	1.2	Submerged and solid-state fermentation	4	2
	1.3	Role of Fermentation Media. Defined and undefined media, Components of fermentation medium: carbon and nitrogen sources, precursors, inducers, inhibitors, and antifoam agents	4	2
	1.4	Media formulation and sterilization .	3	2
2 Isolation, Screening, and Strain Improvement	2.1	Mode of microbial culture.	3	3
	2.2	Isolation and screening of industrially important microorganisms Primary and secondary screening	4	4
	2.3	Strain improvement, Methods of strain improvement	6	5
3 Bioreactor Design, Downstream Processing and Fermentative Production	3.1	Bioreactor: design of a typical bioreactor, criteria for the designing of a bioreactor	3	6
	3.2	Types of Bioreactors: STR, Airlift, Packed Bed, Fluidized Bed, Tower Fermenters	3	6
	3.3	Introduction to Downstream Processing	2	7
	3.4	Various stages of downstream processing	5	7
	3.5	Fermentative production of enzyme (amylase), antibiotics (Penicillin) Amino Acid (Glutamic acid), organic acids (citric acid).	5	7
4 Practical	4.1	Determine the potability of the provided water sample by MPN technique.	5	1
	4.2	Fermentative Production of Microbial Metabolites: Submerged	5	7
	4.3	Isolation of Industrially Important Organisms	5	3
	4.4	Secondary Screening of Industrial Important Microorganisms	5	5
	4.5	Screening of the amylase-producing isolates from soil.	5	5
	4.6	Immobilization Of Bacteria for Metabolite Production	5	7

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks 10 hrs.	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

5		**Teacher Specific Content** .

References

1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2008). Principles of Fermentation Technology. Elsevier.
2. Kalichelvan, P. T., & Arul Pandi, I. (2009). Bioprocess Technology. MJP Publishers, Chennai.
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6. Cassida, L. E. (1968). Industrial Microbiology. John Wiley and Sons Publishers.
7. Vazhacharickal, P. J Mathew, J. J. & Kumarannair S. N.. (2018). Industrial Biotechnology: An Introduction. Independently Published.

Suggested Readings

1. Susan Barnum, S. R. 2 ed (2005). Biotechnology: An Introduction. Thomson Publishers.
2. Purohith, R., & Mathur, S. 4th ed (2010). Biotechnology: Fundamentals and Applications. Agrobotanical Publishers

Mahatma Gandhi University
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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Food Biotechnology**					
Type of Course	**DSE**					
Course Code	**MG6DSEBTG301**					
Course Level	**300-399**					
Course Summary	This course provides an in-depth exploration of food biotechnology, covering its historical development, ethical considerations, and various applications such as microbial processes, enzyme usage, transgenic organisms, and food preservation methods. Students will learn about the role of microorganisms, enzymes, genetic modification, safety measures, and regulatory frameworks in shaping the modern food industry.					
Semester	6	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	*Need to complete difficulty level 200-299 level courses*					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Summarize the significance of microorganisms in food processes.	U	1,2,3
2	Identify starter cultures and various types of cheese.	K	1,2,4
3	Evaluate the diverse applications of enzymes in food processing.	E	1,2,3
4	Explore applications of bovine somatotropin, transgenic plants, and transgenic fish production.	An	1,2,3
5	Assess various methods of food preservation.	E	1,2,3
6	Appraise the importance of food safety and government regulatory agencies.	E	1,2,3
7	Able to perform chemical and microbial analysis of food and detection of food adulterants.	A	1,2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Food Biotechnology	1.1	Overview of Food Biotechnology, Historical development and significance in the food industry	2	1
	1.2	Ethical considerations and societal impact of Food Biotechnology	2	1
	1.3	Emerging trends in food biotechnology	3	6
2 Microorganisms and Biotechnological applications in Food Production	2.1	Role of microorganisms in food processes, Starter cultures and their applications	4	1
	2.2	Types of cheese and their production processes, Fermented dairy products and beverages	4	2
	2.3	Basics of enzymes and their importance, Applications of enzymes in food processing	6	3
	2.4	Applications of Bovine somatotropin, Chymosin, Transgenic plants, Transgenic fish in food production.	6	3
3 Food Preservation, Food Safety and Regulatory Aspects	3.1	Causes and prevention of contamination	2	5
	3.2	Preservation methods: low temperature, freezing, heat, drying, concentration, fermentation, canning, radiation, and chemical preservatives	2	5
	3.3	Microbial contamination and spoilage of food, Significance of food safety assessments and surveillance.	4	5
	3.4	Government regulatory agencies: FDA, CDC, EPA. Hazard Analysis and Critical Control Points (HACCP) concepts, Risk assessment in food production	6	6
	3.5	Labelling of GM foods	2	6
	3.6	Ethical considerations and societal impacts	2	6
4 Practicals	4.1	Analysis of food samples: Determination of protein, Fat, Carbohydrates, Moisture content.	6	7
	4.2	Determination of chemical constituents: Total sugar, Total phenolic compounds.	8	7
	4.3	Microbial Analysis of food: Microbiological examination of milk(MBRT), Microbiological examination of fruits and vegetables.	8	7
	4.4	Test for adulterants in food items -Any five. Detect the presence of adulterants in sugar, oil and butter, chilli, powder, turmeric powder, dyes in fats etc.	8	7
5		Teacher Specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks 10 hrs.	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

Reference

1. Green, J. 1 st Ed.. (1991). Biotechnological Innovations in Food Processing. Butterworth-Heinmann.
2. Manay, N. S., & Shadakshara Swamy, M. (2020). Food-Facts and Principles (4 th). New Age International.
3. Kalichelvan, P. T., & Arul Pandi, I. (2009). Bioprocess Technology. MJP Publishers, Chennai.
4. George, J. B. (1987). Basic Food Microbiology. CBS Publishers & Distributors.
5. Roger, A., Gorden, B., & John T. (1989). Food Biotechnology. Cambridge University Press
6. Susan Barnum, S. R. 2 ed (2005). Biotechnology: An Introduction. Thomson Publishers.
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Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**
Course Name	**Sustainable Biotechnology**
Type of Course	**DSE**
Course Code	**MG6DSEBTG302**
Course Level	**300-399**
Course Summary	This course delves into the sustainable utilization of natural waste materials through biotechnology, the preparation of cost-effective substrates for industrial applications such as mushroom cultivation, solid waste management via biogas production, the production of green bioproducts including biofertilizers, biopesticides, biofilters, biopolymers, and biosurfactants, exploration of green fuel technology encompassing bioconversion of biomass into first, second, and third-generation biofuels with considerations of limitations, potential, and prospects, and the methods and types of bioremediation, covering microbial, phytoremediation, mycoremediation, biostimulation, bioaugmentation, and bioventing, with a focus on environmental and economic aspects.

Semester	6	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Need to complete difficulty level 200-299 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
	Upon completion of this course in Sustainable biotechnology, participants should be able to:		
1	Explain the processes involved in the preparation of nutritive and cost-effective substrates for industrial applications.	U	1,6,7
2	Critically assess the advantages and disadvantages of utilizing biofertilizers, biopesticides, biofilters, biopolymers, and biosurfactants, taking into account their economic and environmental implications.	E	1,2,3,6,7
3	Design innovative approaches for enhancing the efficiency and sustainability of biofuel production.	C	2,3,6,7
4	Demonstrate of in-situ and ex-situ bioremediation methods,	A	2,3,6,7

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

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1 Waste to Energy	1.1	Exploitation of natural waste materials through biotechnology	5	1
	1.2	Preparation of nutritive and cost-effective substrates for industrial application: Mushroom Cultivation	5	1
	1.3	Waste to energy- Solid waste management through Biogas production.	5	1
2 Green bioproducts	2.1	Biofertilizers- types, applications and advantages. **Activity:** Visit to a biofertilizer production facility and prepare the study report. **Case study**: Effect of biofertilizers on growth of plants. Preparation of report.	8	2
	2.2	Biopesticides- types and applications. Biofilters, biopolymers, biosurfactants.	7	2
3 Green fuel technology	3.1	Bioconversion of biomass into biofuels- First-generation, Second-generation and Third-generation biofuels.	6	3
	3.2	Limitations, potential and future prospects of Biofuels	4	3
	3.3	Environmental and economic considerations of biofuels.	5	3
4 Bioremediation	4.1	Bioremediation : Methods- in-situ and ex-situ	6	4
	4.2	Types of bioremediation- Microbial Bioremediation, Phytoremediation, Mycoremediation, Biostimulation, Bioaugmentation, Bioventing. **Case study** of anyone type and report preparation.	9	4
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** 1. **Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	2. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.

Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

1. Susan Barnum, S. R. 2ed. (2005). Biotechnology: An Introduction. Thomson Publishers.
2. Purohith, R., & Mathur, S. 4th ed (2010). Biotechnology: Fundamentals and Applications. Agrobotanical Publishers.
3. Zoological Society of India. . Applied Zoology.
4. Sobti, R. C., & Pachauri, S. S. (2009). Essentials of Biotechnology. Ane Books Pvt Ltd.
5. Sharma, R. A. (2016). Environmental Biotechnology. Pointer Publishers.
6. Dubey, R. C. 5 th ed (2014). Textbook of Biotechnology S Chand publishers.
7. Agarwal, S. K. (2015). Advanced Environmental Biotechnology, Ashish Publishing House.
8. Young, M. M. (Ed.). (2011). Comprehensive Biotechnology (2nd ed.). Elsevier.

Suggested readings

1. Smith, J. K., & Brown, A. L. Sustainable Biotechnology: Principles and Applications.
2. Greenfield, P. F., & Johnson, M. S. Advances in Sustainable Biotechnology.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Intellectual Property Rights and Patenting**					
Type of Course	**DSE**					
Course Code	**MG6DSEBTG303**					
Course Level	**300-399**					
Course Summary	This course provides a comprehensive understanding of Intellectual Property Rights (IPR), specifically focusing on patents. Students will explore the legal frameworks, processes, and ethical considerations for protecting intellectual creations. The course aims to equip participants with the knowledge and skills needed to navigate the complexities of patent law, fostering an appreciation for the role of intellectual property in innovation and economic development.					
Semester	6	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	*Need to complete difficulty level 200-299 level courses.*					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Students will summarise different types of intellectual property rights	K	2, 3, 6
2	Students will be able to explain the step-by-step process of obtaining a patent.	U	2
3	Students will be able to relate the importance of patent infringement and associated legal implications	An	1, 6
4	Students will create and propose amendments to existing patent claims to enhance protection or address legal issues.	C	1, 2, 6, 7

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 **Introduction to IPR**	1.1	IPR - Introduction	2	1
	1.2	Types of IPR- Patents, Copyright, Trade mark, Trade secrets	4	2
	1.3	Design, Geographical indication,	1	1
	1.4	Advantages of IP protection	3	1
	1.5	Ethical and Legal Issues in IP	2	1
2 Patent act documents and procedures	2.1	Patents - History of Indian patent act 1970, Recent amendments	2	1
	2.2	Sections in Indian Patent act	2	1
	2.3	Conditions for patentability, Types of patent - process, product	2	1
	2.4	Patenting-Required documents and procedures	3	3
	2.5	Non patentable inventions -examples for patentable biotech products and process	3	3
	2.6	Patents in an international perspective	3	3
	2.8	Rights of patentee.	1	2
	2.9	Challenges in IP protection	2	2
	2.10	Case study - Basmati rice, Turmeric and Neem patent issues.	2	2
3 International institutions and conventions	3.1	Budapest treaty, Paris convention for protection of industrial property.	4	3
	3.2	Bern convention, Trips agreement, GATT agreement	3	2
	3.3	International institutions related to IPR	3	2
	3.4	Process of deposition of materials to IDA	3	3
	3.5	Geographical indication -advantages and examples for GI tagged products	5	1
4 Agencies of IPR	4.1	Agencies involved in IPR-Indian and international	3	3
	4.2	Civil, criminal and administrative remedies for IP infringement	3	3
	4.3	Plant breeders' rights and farmers rights	2	4
	4.4	Trademark registration	2	3
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. End Semester Examination – 2.0 hrs. Total marks: 70 marks.
Pattern of questions	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References:

1. Singh, B. D. (2010). Biotechnology.
2. Dubey, R. C. (1993). A Textbook of Biotechnology. S. Chand Publishing.
3. Narayanan, P. (2001). Intellectual Property Laws. Eastern Law House.
4. Paul, M. (2009). Intellectual Property Laws. Allahabad Law Agency.
5. Universal Law Publication Company. (2020). Intellectual Property Law containing Acts and Rules.
6. Smith, J. E. (2002). Biotechnology (3rd ed.). Cambridge University Press.
7. Glick, B. R., & Pasternak, J. J. 4th Ed (2010). Molecular Biotechnology.
8. Brown, T. A.8th Ed (2020). Gene Cloning and DNA Analysis: An Introduction. Chapman and Hall.
9. Old, R. W., & Primrose, S. B. 3rd Ed (2003). Principles of Gene Manipulation. Blackwell Scientific Publishers.

Suggested Readings

http://www.w3.org/IPR/
http://www.wipo.int/portal/index.html.en
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
www.patentoffice.nic.in
www.iprlawindia.org/
http://www.cbd.int/biosafety/background.shtml
http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html
https://www.wipo.int/treaties/en/registration/budapest/

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Skills in Biotechnology**					
Type of Course	**SEC**					
Course Code	**MG6SECBTG300**					
Course Level	**300-399**					
Course Summary	This course delves into the practical skills essential for a career in biotechnology, emphasizing both theoretical understanding and hands-on application. Divided into three modules, the course covers key aspects of food technology, agricultural biotechnology, and molecular techniques. The course cultivates a well-rounded skill set, preparing students for diverse roles in biotechnology with an emphasis on real-world application and critical thinking.					
Semester	6	**Credits**			3	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		2	0	1	0	60
Pre-requisites, if any	Need to complete difficulty level 200-299 courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the historical context, principles, and scope of food processing, including key developments that have shaped the industry.	U	1, 6
2	Apply practical knowledge in the production of fermented foods and the cultivation of mushrooms, demonstrating proficiency in relevant techniques and processes.	A	1
3	Generate innovative solutions to challenges in food processing and preservation, showcasing creativity and adaptability in application.	Ap	1, 10
4	Evaluate the significance, advantages, and constraints of different types of fertilizers, considering their impact on agriculture and the environment.	E	I, 2, 6
5	Analyze microbial species and their roles in biofertilizer production, demonstrating critical understanding and the ability to assess their suitability for agricultural applications.	An	1

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Food Technology	1.1	Food technology: Scope of food processing; historical developments; principles of food processing and preservation.	3	1
	1.2	Methods of Food Preservation: Physical, Chemical and Biological methods.	3	2
	1.3	Fermentation a method of food preservation: Fermentation principles, Types Production of Fermented foods: Dairy Fermented products.	4	2
	1.4	Mushroom cultivation: Introduction,Types,Steps in Mushroom cultivation, processing and preservation - Processing of Mushroom: mushroom recipes.	5	4
2 Biofertilizers	2.1	Biofertilizer technology: An introduction to fertilizers-inorganic fertilizers, organic fertilizers, bio-fertilizers. importance, advantages and constraints.	4	4
	2.2	Importance, advantages and constraints of Biofertilizers.	4	4
	2.3	Identification of microbial species – Rhizobium, Azospirillum Azotobacters, blue green algae and phosphate solubilizers.	4	6
	2.4	Production of Biofertilizers.	3	6
3 Practicals	3.1	Molecular techniques: Isolation of Nucleic acids- DNA, RNA, Polymerase chain Reaction, Electrophoresis.	10	5
	3.2	Preparation of fermented food products, Biofertilizers and Biopesticides.	10	5
	3.3	Bioinformatics tools: Retrieving nucleotide sequences and similarity search and phlogeny studies.	5	6
	3.4	Problem solving and critical reasoning: Preparing Statement of Purpose, Case study report, Resume, Communication skills.	5	10
4		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Class room lecture, ICT enabled classes, Discussions, Practical sessions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 15 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.0 hr. Theory : 35 marks Practical : 35 marks
Pattern of questions	Total marks: 35 marks (1.0 hr.) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :3 out of 5 3x3= 9 marks Short essay (6 marks) :1 out of 2 1x6= 6 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks 5 hrs.	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References:

6. Singh, B. D. (2015). Biotechnology. Kalyani Publishers.
7. Dubey, R. C. (2007). A Textbook of Biotechnology. S. Chand Publishing..
8. Have, H. T., & Gordijn, B. (2013). Handbook of Global Bioethics. Springer eBooks.
9. Lewis, M. A., & Tamparo, C. D. (2007). Medical Law, Ethics, and Bioethics for the Health Professions (6th ed.). F.A. Davis Company.
10. Sateesh, M. K. (2020). Bioethics and Biosafety. Dreamtech Press.

Mahatma Gandhi University

Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Biotechnology for Nourishing Health**					
Type of Course	**VAC**					
Course Code	**MG6VACBTG300**					
Course Level	**200**					
Course Summary	This course equips learners with a holistic understanding of biotechnology's evolution, its role in food production and medicine, and its contributions to human welfare while navigating ethical considerations in this rapidly advancing field.					
Semester	3	Credits			3	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	0	0	45
Pre-requisites, if any	Curiosity to know the applications of Biotechnology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To identify and define the scope and concepts of Biotechnology.	K	3,10
2	To understand the Basic Concepts and tools in Biotechnology.	U	3,10
3	To explain the principle of BT crops and GM foods and analyse the benefits of Biofortification in foods.	An	1,2,6
4	To understand the importance of Probiotics in gut health.	U	2,3,10
5	To apply the knowledge gained about the GM products and probiotics in improving health	A	1,2,10
6	To compare GM foods from Normal Foods based on its properties.	An	1,3,10

7	To compare the GM foods with normal foods and it's health benefits.	E	4,6,10
8	To understand the importance Environmental Biotechnology and define the role of Biofuels in sustainable development.	U	2,10
9	Understand and Apply Ethical and Legal aspects of Biotechnology.	A	1,2,6,
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Overview of Biotechnology	1.1	Biotechnology: History and milestones	3	1
	1.2	Scope of Biotechnology	3	1,2
	1.3	Tools in Biotechnology: Overview	4	5
2 Biotechnology and Food	2.1	Basics of rDNA technology	4	1,2
	2.2	GM Crops: Merits and Demerits.	3	3,7
	2.3	Biofortification of foods and it's Benefits. Fermented foods Probiotics and Gut Health,	6	3
3 Applications of Biotechnology	3.1	Importance of Biotechnology in Medicine:	3	1
	3.2	Production of Medicine by Biotechnology An overview. Gene Therapy, Stem cell Technology.	4	2
	3.3	Introduction to Gene Editing, Personalized Medicine. Molecular Diagnostics.	6	2
	3.4	Environmental Biotechnology for healthy planet. Biofuel and its advantages.	5	8
	3.5	Biotech Trends in Health & Medicine: Synthetic Biology & 3D printing.	2	6
	3.6	Ethical & Legal aspects of Biotechnology	2	9
4		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ICT enables class lecturers, Seminars
Assessment types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Class tests, Assignments, Viva Total marks : 75 CCA : 25
	B. End Semester examination – 1.5 hrs. Total marks : 50
Pattern of questions	Total marks: 50 marks (1.5 hrs.) One word answer question (1mark):10 out of 10 10x1= 10 marks Short answer questions (3marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks

References

1. B.D. Singh. 20. Kalyani Biotechnology Expanding Horizons Fifth Edition. Kalyani Biotechnology. ISBN: 9789393168085.
2. Dr. U. Satyanarayana & Dr. U. Chakrapani Biotechnology First Published: 2005 Reprints: 15: ISBN: 81-87134-90-9 –.
3. Sandy B. Primrose and 1 more Principles of Gene Manipulation and Genomics 7th Edition7th Edition ISBN-13: 978-1405135443.
4. Reinhard Renneberg, Viola Berkling Vanya Loroch Biotechnology for Beginners, Second Edition, ISBN: 978-0-12-801224-6 Academic Press.
5. Industrial Biotechnology: Products and Processes Editor(s):Christoph Wittmann, James C. Liao First published:25 November 2016 Print ISBN:9783527341818

Suggested Readings

1. Fundamentals of Food Biotechnology Author(s):Byong H. Lee First published:12 December 2014 Print ISBN:9781118384954
2. S. C. Bhatia Food Biotechnology 1st Edition: WPI Publishing eBook ISBN9781315156491.

SEMESTER-7

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Genomics and Transcriptomics**					
Type of Course	**DCC**					
Course Code	**MG7DCCBTG400**					
Course Level	**400-499**					
Course Summary	The course comprises the *in vivo* and *in silico* tools used to analyze the genome of eukaryotes and prokaryotes, which enlightens them to interpret the novel genome identified and use it for novel approaches.					
Semester	7	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Need to complete difficulty level 300-399 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the concept of genomes.	U	1,2,8
2	Analyze the role of different techniques used for genomic and metagenomic study.	An	1,2,3,4
3	Appraise the Insilco tools used for genomic study.	E	2,3,5
4	Discuss the importance of RNA sequence analysis in genomic study	U	1,2,3
5	Explain the transcriptome and applications of genomic study	U	1,2,3,5
6	The syllabus objective is to develop a comprehensive understanding of molecular biology techniques, bioinformatics principles, and data analysis methods, including gene prediction, sequence databases, RNA-Seq retrieval, quality check using Galaxy,	U, A	1,2,3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to genomics	1.1	Definition, scope of Genomics and Transcriptomics: Understanding Gene Expression. Historical perspective, Ethical issues related to genomic studies.	4	1
	1.2	Applications in various fields: evolutionary studies, clinical, pharmacogenomics, and environmental studies.	4	1
	1.3	Comparative genome study of eukaryotes and prokaryotes. Gene families- Globin superfamily. theories of gene evolution.	4	2
	1.4	Genome sequencing techniques and methods. **Activity:** Familiarise Sequence Data bases: GenBank, EMBL, DDBJ; Uniprot-KB: SWISS-PROT, TrEMBL, UniParc.	4	4
2 Basic techniques used for genomic and metagenomic study	2.1	Genome sequencing studies, Expression system studies: DNA Barcoding and meta barcoding, 16sr RNA, Cytochrome c oxidase.	5	4
	2.2	Molecular Finger printing techniques: RFLP, t RFLP, DGGE.	4	6
	2.3	FISH, Differential expression analysis.	2	6
	2.4	NGS Platforms: Illumina, Nano pore sequencing, **Activity:** Repositories for high throughput genomic sequences: EST, STS, GSS.	5	6
3 Analysis of genomic and metagenomic data	3.1	Standard Genomic Data analysis pipelines **Activity:** Familiarise Genome Databases at NCBI, EBI, TIGR, SANGER.	3	2
	3.2	Servers involved: Galaxy, RAST. Meta data analysis.	3	3
	3.3	Gene identification and gene annotation, metabolic pathway analysis. **Activity:** Case studies demonstrating Gene prediction and annotation as internship/workshop	3	3
	3.4	Databases: Integrated microbial genome and microbiomes, Green genes, Gene Mark, AUGUTUS. **Activity**: Gene prediction using GeneMark, AUGUSTUS.	4	3
4 RNA sequence analysis for genomic study and applications	4.1	Library preparation from total RNA, SAGE Analysis, CAGE.	3	4
	4.2	Processing, Alignment, quality control checkpoints, Expression quantification methods. **Activity:** Quality Score check of the Sequence using Galaxy.	4	4
	4.3	Tools used: Single-cell RNA sequencing, poly (A) RNA sequencing, Global Run On Sequencing (Gro- seq), Gene ontology Knowledge database	4	5

		Activity: RNA-Seq Data Retrieval		
	4.4	Databases for transcriptome analysis, NCBI - Gene expression omnibus, EBI -Array express. Applications of genomics: Biomarker discovery, Disease profiling.	4	5
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

1. T.A. Brown: Brown, T. A. (2007). *Genomes.* Garland Science.
2. Snustad, D. P., & Simmons, M. J. (2015). Principles of Genetics. Wiley.
3. D.W.Mount, Bioinformatics: sequence and genome analysis- CSH lab press.
4. Lesk AM (2017). Introduction to Genomics. Oxford University press. Oxford, UK.
5. Green MR & Sambrook J (2014). Molecular Cloning, A Laboratory Manual. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York, USA.

Suggested Readings

1. Bioinformatics concepts, skills and applications- S.C.Rastogi, N,Mendirattar and Y.Rastogi, CBS Publishers, New Delhi.
2. Bioinformatics- Westhead, Parish and Twynan, Bio Scientific Publishers, Oxford.
3. Introduction to Bioinformatics: A theoretical and practical approaches- S.A. Krawetzt, D.D. Womble, Human Press.
4. Bioinformatics: sequence and genome analysis- D.W.Mount, CSH lab press.
5. Internet for the molecular biologist- S.R. Swindell, R.R.Miller, G.S.A. Meyers, Horizon Scientific Press.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Advanced Cell and Molecular Biology**					
Type of Course	**DSC**					
Course Code	**MG7DCCBTG401**					
Course Level	**400-499**					
Course Summary	This course integrates molecular and cellular approaches, covering topics such as cytoskeleton dynamics, cellular membranes and signaling, cell-cell communication, cell cycle regulation, apoptosis, cell differentiation, developmental signaling pathways, DNA topology, replication machinery, transcriptional regulation, epigenetic modifications, mRNA splicing, ribosome structure, and post-translational modifications. Emphasizing environmental factors in epigenetic inheritance, the course also explores DNA-protein interactions and molecular evolution theories. Practical skills include whole genome isolation, agarose gel visualization of DNA, and PCR amplification of bacterial 16S rRNA genes from diverse strains. Students gain a holistic understanding of cellular processes, molecular mechanisms, and hands-on laboratory techniques.					
Semester	7	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		3	0	1	0	**75**
Pre-requisites, if any	Need to complete difficulty level 300-399 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the Integration of Molecular and Cellular Approaches	U	1,2,9
2	Comment about of Cell-Cell Communication	E	2,9,10
3	Comprehend Cell Cycle Regulation and Differentiation	An	2,9,10
4	Explain the Central Dogma of Biology - Gene Expression	U	1,2,3,4
5	Analyze Epigenetic modifications,RNA Processing and Translation	An	2,9,10
6	Apply molecular biology techniques, including whole-genome isolation from bacteria, visualization of DNA on agarose gel, and PCR amplification of 16S rRNA gene	A	1,3,10

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Integrative Cell Biology	1.1	Integrating molecular and cellular approaches, cross-talk of pathways,	2	1
	1.2	**Cytoskeleton dynamics**: Muscle contraction, Spindle fibre. **Cellular Membranes and Signaling**: Mechanism of membrane Transport- pumps, carrier and channel proteins, Signal transduction pathways, Receptor-ligand interaction, Intracellular signaling cascades.	5	1
	1.3	**Cellular Membranes and Signaling**: Mechanism of membrane Transport- pumps, carrier and channel proteins, Signal transduction pathways, Receptor-ligand interaction, Intracellular signaling cascades. **Cell-Cell Communication:** Intercellular junctions: Gap junctions, Tight junctions, Desmosomes, Adherens junctions, Plasmadesmata, Hemidesmosomes, Cell adhesion molecules and adapter proteins	4	1
	1.4	**Cell cycle phases, regulation and checkpoints**: Cyclins, cyclin-dependent kinases (CDKs), and check points and cell cycle regulation. Cell cycle inhibitors and DNA repair control points P53, p16, RB, ATM, ATR. Apoptosis and necrosis.	5	2
	1.5	**Cell Differentiation and Development:** Stem cells and their role in differentiation, Cellular fate determination. **Developmental signaling pathways**: wnt and hedgehog pathway, auxin, and cytokinin signaling pathways	4	2
2 Central Dogma of Biology - Gene Expression	2.1	DNA topology and supercoiling, Replication machinery, and fidelity.	3	3
	2.2	Transcriptional Regulation: Transcription factors and regulatory elements. Chromatin structure and gene expression.	3	3
	2.3	DNA methylation, Histone modifications (acetylation, methylation, phosphorylation, etc.)	3	4
	2.4	Non-coding RNAs (microRNAs, long non-coding RNAs) in epigenetic regulation.	3	4
	2.5	Role of epigenetic modifications in gene activation, repression, and its mechanisms. Environmental factors influencing epigenetic inheritance	3	4
3 RNA Processing and Translation	3.1	mRNA splicing and alternative splicing, Regulation of mRNA stability,	3	5
	3.2	Ribosome structure and function. DNA-protein interactions,.	2	5

	3.3	Post-translational modifications, Protein sorting. Molecular evolution and phylogenetics:	3	5
	3.4	Theories of new protein evolution: Gene Duplication and divergence, Exon Shuffling, Horizontal Gene transfer, De novo protein evolution, Neofunctionalization, Gene Fusion.	2	5
4 Practical	4.1	Whole genome isolation from bacteria	10	6
	4.2	Visualize the extracted DNA on an agarose gel or use a spectrophotometer to quantify the yield	5	6
	4.3	PCR amplification of 16srRNA gene from E.coli, Klebsiella, Pseudomonas, Steptococcus, Staphylococcus, Bacillus (From any of three bacterial strains	15	6
5		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks. **5 hrs.**	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). Molecular biology of the cell. New York: Garland Science.
2. De Robertis, E. D. P., & De Robertis, E. M. F. (2006). Cell and molecular biology (8th ed.). New York: Lippincott William & Wilkins.
3. Cooper, G. M., & Hausman, R. E. (2009). The cell: A molecular approach (5th ed.). Washington, D.C., Sunderland, Mass.: ASM Press; Sinauer Associates.
4. Tymoczko, J. L., Berg, J. M., & Stryer, L. (2012). Biochemistry: A short course (2nd ed.). W.H. Freeman and Company.
5. Karp, G. (2010). Cell and molecular biology: Concepts and experiments (6th ed.). Hoboken, NJ: John Wiley.
6. Lodish, H. F., Berk, A., Kaiser, C., Krieger, M., Bretscher, A., Ploegh, H. L., Amon, A., & Martin, K. C. (2016). Molecular cell biology (8th ed.). New York: W.H. Freeman and Company.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Research Methodology & Scientific Writing**					
Type of Course	**DCC**					
Course Code	**MG7DCCBTG402**					
Course Level	**400-499**					
Course Summary	This course covers the fundamental aspects of research methodology, including sampling methods, data collection, tabulation, and graphical presentation. It delves into statistical analysis techniques such as measures of central tendency, dispersion, correlation, regression, and significance testing, including hypothesis testing and chi-square tests. Additionally, it explores various research designs, experimental setups, scientific writing conventions, and ethical considerations in research, including plagiarism prevention and proper citation practices.					
Semester	7	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		4	0	0	0	**60**
Pre-requisites, if any	Need to complete difficulty level 300-399 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the role of Biostatistics in research.	U	1,2,8
2	Identify the proper resource design.	U	1,2,8
3	Prepare experimental designs and apply them effectively in research.	C	1,2,3,5,9
4	Interpret research results meaningfully, employing various techniques.	A	1,2,3
5	Proficiency in scientific writing, report steps, types, integrity, and plagiarism checks for accurate, clear communication.	A	1,8

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Biostatistics in Research	1.1	Methods of sampling; Collection, classification, tabulation and presentation- graphical and diagrammatic- of data.	5	1
	1.2	Analysis of data- Measures of central tendency Measures of dispersion-Range, Quartile deviation, Probability and probability distributions, Correlation and Regression.	6	1
	1.3	Test of significance. Basic idea of significance test-hypothesis testing, levels of significance, Chi-square test and goodness of fit; ANOVA.	5	1
2 Research Methodology	2.1	An Introduction; Defining the Research Problem; Design of Sample Surveys.	5	2
	2.2	Research Design - Meaning, Needs and Features; Different research designs.	6	2
3 Principles of experimental designs and Interpretation of results	3.1	Important experimental designs. Before-and-After Without Control Design; After-Only with Control Design; Before-and-After with Control Design	5	3
	3.2	Completely Randomized Design (C.R. Design); Randomized Block Design (R.B. Design); Latin Square Design (L.S. Design)	5	3,4
	3.3	Factorial Designs; Meaning, Techniques of interpretation; Precautions in result interpretation.	4	3,4
4 Scientific Writing	4.1	Introduction to Scientific Writing , Report writing- significance, steps, layout. Types of reports, Mechanics of writing reports and precautions while writing reports.	4	5
	4.2	Writing an Abstract, Title for a Research Paper, Title and Keywords, Mileposts for the Article Writing, Writing the Methods Section, Writing the Results Section, How to Prepare Figures , How to Prepare Schematics.	5	5
	4.3	How to write Introduction and Discussion Sections,Finalizing the Manuscript and Ethics in Research, Writing a Research Proposal and Preparing for a Presentation.	5	5
	4.4	Plagiarism: Prevention and Cure , Definition of Plagiarism, Acknowledge Sources , Paraphrasing ,Direct and Indirect Quotations , Summarizing , Evaluation of Text , Plagiarism Checking .	5	5
5.		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References:

1. C.R. Kothari, Gaurav Garg Research Methodology, New Age International (P) Ltd. ISBN-10: 9386649225 ISBN-13: 978-9386649225
2. C George Thomas, Research Methodology and Scientific writing, Ane Books Pvt Ltd. ISBN 978-3-030-64864-0 ISBN 978-3-030-64865-7
3. Dawson, Catherine, (2002) Practical Research Methods, New Delhi, UBS Publishers' Distributors
4. Kumar, Ranjit, (2005) Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed.), Singapore, Pearson Education.
5. Matthews J.R and Matthews R.W, (2007) Successful Scientific Writing - A step-by-step guide for the biological and medical sciences, Cambridge University Press.
6. Alley, Michael, (1997) The Craft of Scientific Writing, Springer. ISBN 978-0-387-94766-2.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Advanced Bioinformatics**					
Type of Course	**DCE**					
Course Code	**MG7DCEBTG400**					
Course Level	**400**					
Course Summary	This advanced bioinformatics course delves into sophisticated computational techniques and their integration with experimental approaches to address complex questions in biological research. Students will explore advanced algorithms, high-throughput data analysis, systems biology, and emerging technologies shaping the forefront of bioinformatics.					
Semester	7	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Need to complete difficulty level 300-399 level courses.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Discuss the significance of computational biology in modern biological research.	U	1,2,3,6,8,
2.	Explain the foundational principles of molecular and cell biology relevant to computational applications.	U	1,2,3,5
3.	Apply algorithmic thinking to solve practical biological problems.	A	1,2,3,4,5,7
4.	Utilize bioinformatics tools for comparing and aligning biological sequences. Evaluate the methods for predicting and analyzing protein structures.	E	1,2,3,4,5
5.	Critically assess the impact of computational methods on understanding gene regulatory elements	E	1,2,3,4,6
6	Design and implement applications of computational methods in drug discovery.	C	1,2,3,4

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Computational Biology	1.1	Overview of computational biology and its applications in biology and medicine, Historical development and key milestones, Introduction to relevant programming languages.	5	CO1
	1.2	Biological Fundamentals: Molecular biology basics (DNA, RNA, proteins).	5	CO1
	1.3	Central dogma of molecular biology, Cell biology concepts relevant to computational analysis.	5	CO1
2 Algorithms and Data Structures	2.1	Basic algorithms and data structures used in computational biology.	2	CO2
	2.2	Algorithmic complexity and efficiency.	3	CO2
	2.3	Sequence Analysis-Pairwise and multiple sequence alignment, Hidden Markov Models (HMMs).	5	CO2
	2.4	Phylogenetic tree construction and analysis.	5	CO2
3 Structural Bioinformatics	3.1	Protein structure prediction. Molecular dynamics simulations.	2	CO3
	3.2	Genome assembly and annotation. Comparative genomics, Structural Genomics, Functional Genomics.	3	CO3
	3.3	Metagenomics. Pharmacogenomics.	5	CO3
	3.4	Human Genome Project, Next Generation Sequencing methods. SNPs.	5	CO3
4 Drug Designing	4.1	Structure-based drug design-ADME, Classical SAR and QSAR studies.	3	CO4
	4.2	Pharmacophore identification and novel drug design, Structure based drug design and computer aided drug design, Molecular Docking – Identification of ligands, active site prediction, docking and evaluation. Molecular Docking software – AutoDock.	4	CO4

	4.3	Personalized Medicine. Application of computational methods to a real-world biological problem. Legal and ethical considerations.	3	CO5
	4.4	Data analysis and interpretation. Presentation of findings.	5	CO6
5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

1. Mount, D. W.(2005). *Bioinformatics: Sequence and Genome Analysis* Cold Spring Harbour Lab Press, New York.
2. Baxevanis, A. D., & Ouellette, B. F. F. (2004) *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.*
3. Higgs, P. G., & Attwood, T. K. (2013) *Bioinformatics and Molecular Evaluation.* Blackwell Publishers.
4. Misener, S., & Krawetz, S. A. (2000) *Bioinformatics Methods and Protocols.* Humana Press.
5. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2022) *Bioinformatics Methods and Applications.*
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002) *Molecular Biology of the Cell.*
7. Xiong, J. (2007) *Essential Bioinformatics.*

Suggested Readings

1. *Compeau, P., & Pevzner, P..* Bioinformatics Algorithms: An Active Learning Approach
2. *Sedgewick, R., & Wayne, K..* Algorithms.
3. *Branden, C., & Tooze, J..* Introduction to Protein Structure
4. *Fridman, R. H. B..* Bioinformatics: Sequence and Structure.
5. *Wünschiers, R..* Computational Biology: A Practical Introduction to BioData Processing and Analysis with Linux, MySQL, and R.

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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Disease and Diagnostic Biotechnology**					
Type of Course	**DCE**					
Course Code	**MG7DCEBTG401**					
Course Level	**400-499**					
Course Summary	Disease and molecular diagnostics covers the molecular basis of diseases and the use of diagnostic techniques to identify and understand these conditions. The course equips students with a comprehensive understanding of the molecular mechanisms underlying diseases and the practical skills needed for molecular diagnostic applications in healthcare.					
Semester	7	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	4	60
Pre- equisites, if any	Need to complete difficulty level 300-399 courses.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Identify the molecular and pathophysiological basis of major infectious diseases, its mode of transmission.	U	1,2,3,5,6
2	List out preventive measures and potential therapeutic interventions for these diseases.	K	1,2,3,5,6
3	Describe the principles behind immunological assays, microarray technology, and molecular techniques.	U	1,2,10
4	Assess the ethical considerations involved in regulatory decisions, such as balancing innovation with patient safety and ensuring equitable access.	E	1,2,3,5,8
5	Developing practical skills in handling and analyzing Genomics and advanced Molecular Biology.	An	1,9,10

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO. No:
1 Infectious and Genetic diseases.	1.1	Classification of diseases- By etiology, body system or organ affected, pathophysiological mechanisms, age group, life-style related, organism affected**,** Epidemiology and public health.	5	1,2
	1.2	Overview of major infectious diseases and its mode of transmission in infection Microbes and parasites- Bacteria, Fungi, Viruses, Protozoans, Helminthes and Arthropods, Prions.	5	1,2
	1.3	Genetic Disorders-Heamoglobinopathies- Sickle cell aneamia, Beta Thalassemia, cystic fibrosis and Alzheimers disease. Muscular disordrers- Duchenne's Muscular dystrophy. Triplet disorders-Fragile X syndrome, Huntington's disease, Myotonic dystrophy. Chromosomal disorders-autosomal and sex chromosomal.	5	1,2
2 Molecular Diagnostic methods	2.1	Principle and applications of:- Immunological assays- ELISA, western blotting, immunofluorescence assay, RIA, ICA and multiplex assays.	4	3
	2.2	Microarray technology- gene expression profiling, DNA microarrays, protein microarrays, MiRNA microarrays, autoimmune disease profiling.	4	3
	2.3	Molecular Techniques- Polymerase Chain Reaction (PCR), DNA sequencing, Gene expression analysis, Next-generation sequencing (NGS).	4	3
	2.4	Molecular Markers for Disease- Biomarkers and their significance – Genetic, proteomic and metabolomic markers in disease diagnosis.	3	3
3 Molecular diagnosis of Cancer, Viral and Genetic diseases	3.1	Cancer diagnostics- PCR, FISH, NGS, IHC, liquid biopsy, microarray, dPCR, Mass spectrometry, CTCs and epigenetic analysis, Molecular testing of BRCA1 and BRCA2	5	5
	3.2	Viral disease diagnostics-HIV, Avian Flu, Chikungunya, Swine fever, SARS and Covid	5	5
	3.3	Molecular diagnostic tools for Genetic disorders- Sickle cell anemia, Huntington's disease, Myotonic dystrophy, cystic fibrosis, Alzheimers disease and Down syndrome	5	5
4 Ethical and regulatory framework of molecular diagnosis.	4.1	Ethical issues in molecular diagnosis. Genetic testing and informed consent. Personalized medicine and access, Bio banking.	5	4
	4.2	Regulatory framework and compliance.	3	4
	4.3	Genetic privacy and data security. Privacy concerns in genomic data sharing, Challenges in maintaining in genetic privacy.	3	4
	4.4	Case study on ethical issues in molecular diagnostics. HeLa cell case/ BabySeq project.	4	4
Module 5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

1. Greenwood, D., Slack, R., & Peutherer, J. (Eds.). (1997). *Medical Microbiology*. ELST Publishers.
2. Forbes, B. A., Sahm, D. F., Weissefeld, A. S., & Trevino, E. A. (2002). *Bailey and Scott's Diagnostic Microbiology*.. C.V. Mosby.
3. Knudsen, S. (2006). *Cancer diagnostics with DNA microarrays*. John Wiley & Sons.
4. Mooi, J. (2009). Lange: 2008 Current Medical Diagnosis & Treatment. *Australian Journal of General Practice*, *38*(3), 151.
5. Lashley, F. R., & Durham, J. D. (Eds.). (2007). *Emerging infectious diseases: trends and issues*. Springer Publishing Company.
6. Russell, P. J. (1987). *Essential genetics*. Blackwell Scientific Publications.

Suggested Readings

1. Kumar, V., Abbas, A. K., Fausto, N., & Aster, J. C. (2014). *Robbins and Cotran pathologic basis of disease, professional edition e-book*. Elsevier health sciences.
2. Kasper, D., Fauci, A., Hauser, S., Longo, D., Jameson, J., & Loscalzo, J. (2015). *Harrison's principles of internal medicine, 19e* (Vol. 1, No. 2). New York, NY, USA:: Mcgraw-hill.
3. Alberts, B. (2017). *Molecular biology of the cell*. Garland science.

Mahatma Gandhi University

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Programme	**BSc (Honours) Biotechnology**					
Course Name	**Immunoengineering**					
Type of Course	**DCE**					
Course Code	**MG7DCEBTG402**					
Course Level	**400-499**					
Course Summary	The Immunoengineering course for Biotechnology students is designed to provide a comprehensive understanding of the intersection between immunology and engineering principles. This course explores the applications of engineering techniques to manipulate and enhance the immune system for various biotechnological purposes. Students will delve into the principles of immunology and learn how to apply engineering strategies to modulate immune responses, design immunotherapies, and develop novel biotechnological solutions.					
Semester	7	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre- requisites, if any	Need to complete difficulty level 300-399 courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Recall the fundamental principles of immunology and identify key components of the immune system and their functions.	K	1,10
2	Summarize the interactions between immune cells with biomaterials and Describe the engineering techniques used for immunomodulation.	U	1,2,10
3	Apply engineering strategies to modulate specific immune responses and Utilize bioinformatics tools for the analysis of immunological data.	A	1,2,9,10
4	Analyze the challenges and opportunities in immunoengineering.	An	2,4,9
5	Evaluate the regulatory considerations in developing immunotherapies and vaccines.	E	1,2,6,8
6	Design a comprehensive immunoengineering strategy for a specific biomedical problem and create a research proposal for a new immunoengineering project.	C	1,2,4,6,8

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1. Introduction to Immunoengineering	1.1	Fundamentals of Engineering in Immunology	2	1
	1.2	Introduction to immunoengineering concepts	2	1
	1.3	Interdisciplinary approaches in immunology and engineering	2	3
	1.4	Antibody engineering.	2	3
2 Biomaterials in Immunoengineering	2.1	Overview of biomaterials in immunoengineering.	3	4
	2.2	Properties and classifications of biomaterials	4	5
	2.3	Immunomodulatory Biomaterials	4	3
	2.4	Design principles for biomaterials that interact with the immune system, modulating immune responses using biomaterials	4	4
3 Cellular Engineering, Immunomodulation and Drug Delivery	3.1	Cell-based Therapies - Overview of cell-based immunotherapies. Engineering immune cells for therapeutic applications.	5	4
	3.2	Synthetic Biology in Immunology - Introduction to synthetic biology principles	5	3
	3.3	Engineering of synthetic immune cells	4	2
	3.4	Immunomodulatory Strategies - Techniques for modulating immune responses.	5	3
	3.5	Immunomodulatory drugs and their applications. Drug Delivery Systems- Engineering approaches for targeted drug deliver,	5	4
	3.6	Nanotechnologyin immunomodulation. Challenges and Opportunities in Drug Delivery	5	4
4 Applications of Immunoengineering	4.1	Immunotherapy,Vaccine Development,	3	5
	4.2	Biofabrication and tissue engineering, Drug delivery systems	3	6
	4.3	Diagnostic tools and Regenerative medicines	2	6
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

Reference

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2021). Cellular and Molecular Immunology. Publisher.

2. Prendergast, G. C., & Jaffee, E. M. (2013) Cancer Immunotherapy: Immune Suppression and Tumour Growth. Publisher.

3. Ratner, B. D., Hoffman, A. S., Schoen, F. J., & Lemons, J. E. (2012) Biomaterials Science: An Introduction to Materials in Medicine. Publisher.

4. Harlow, E., Lane, D., & Lane, D. J. (1988). Antibodies: A Laboratory Manual. Publisher.

5. Enderle, J., Bronzino, J., & Blanchard, S. (2005). Introduction to Biomedical Engineering. Publisher.

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Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Agricultural Biotechnology**					
Type of Course	**DCE**					
Course Code	**MG7DSEBTG400**					
Course Level	**400-499**					
Course Summary	The course covers Agricultural Biotechnology, spanning from its introduction and significance in modern farming to historical perspectives and milestones. Ethical considerations and regulatory frameworks are explored alongside an introduction to plant genetic engineering and genetically modified techniques in crops. Transgenic plants and genome editing technologies like CRISPR/Cas9 are discussed. Microbial Biotechnology's role in soil health, biofertilizers, and plant-microbe interactions for improved crop yield are examined. The course also addresses plant stress, crop management applications, and strategies for increased crop yield through modern agronomic practices and biotechnology-enhanced breeding techniques.					
Semester	7	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Need to complete difficulty level 300-399 courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Identify the impact of biotic and abiotic factors on agricultural practices.	U	1, 2, 3, 6
2	Evaluate ethical considerations associated with agricultural biotechnology.	E	1, 2, 3, 7
3	Analyse the applications and implication of transgenic plant.	An	1, 2, 3, 9
4	Understand the fundamentals of Genome editing in agriculture.	U	1, 2, 9, 10
5	Formulate bio fertilizers.	C	1, 2, 9, 10

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Agriculture Biotechnology	1.1	Overview Of Agricultural Biotechnology: Introduction to agricultural biotechnology and it's significance in modern farming. Key concepts, principles and techniques in agricultural biotechnology. Application of biotechnology in crop improvement, pest control and disease resistant	4	1
	1.2	Historical Perspectives And Milestones: Evaluation of agriculture Biotechnology from traditional breeding to modern technological approaches. Land mark achievement and discoveries in the field. Contributions of notable scientists and researchers.	4	2
	1.3	Ethical Considerations: Exploration of ethical issues, impact of biotechnological interventions, ethical consideration in genetic modification and gene editing in crops.	4	3
	1.4	Regulatory Framework: Overview of national and international regulation, role of governmental and non-governmental organizations in biotechnological practices	3	4
2 Plant Genetic Engineering	2.1	Introduction To Plant Genetic Engineering: Overview of genetic engineering principles, historical development, importance of genetic modification in agriculture	4	3,4
	2.2	Genetically Modified Techniques In Crops: Various methods of genetic modification in crops, comparison of traditional breeding and genetic engineering, regulatory framework governing GM crops.	4	3,4
	2.3	Transgenic Plants: Concepts And Development: Definition and characteristics of transgenic plants, techniques for introducing foreign genes into the plants Examples of successful transgenic crops.	4	3,4
	2.4	Genome Editing Technology In Agriculture (Crisper/Cas9): Introduction to genome editing and crisper cas9, mechanism and composition of crisper cas9 system.	3	3,4
3 Microbial Biotechnogy in Agriculture	3.1	Introduction To Microbial Biotechnology: Definition and scope, historical context and development of microbial application in farming, significance of microorganisms in sustainable agriculture.	3	5
	3.2	Role Of Microorganism In Soil : Importance of soil microorganisms for nutrient cycling, microbial diversity in soil ecosystems, impact of microorganism on soil structure and fertility	3	5
	3.3	Biofertilizers And Their Applications: Definition and types of bio fertilizers, microorganisms used in biofertilizer production, benefits and challenges of using biofertilizers in agriculture.	3	5

	3.4	Plant - Microbe Interaction For Improved Crop Yield: Mutualistic relationship between plant and beneficial microbes, mechanisms of plant growth – promoting Rhizobacteria (PGPR), enhanced nutrient uptake and disease resistance through microbial interactions.	3	2
	3.5	Applications In Crop Management: Microbial solutions for pest and disease control, bioremediation using microorganisms.	3	2
4 Advanced Crop Improvement Techniques	4.1	Introduction To Plant Stress: Biotic stress and abiotic stress in plants, impact on plant growth and development, physiological responses to biotic and abiotic stress.	5	1
	4.2	Strategies For Increased Crop Yield: Factors influencing crop yield, modern agronomic practices - sustainable farming techniques, precision agriculture and its impact on yield, molecular tools in crop breeding. Marker-assisted breeding its principles and applications, genomic selection in crop improvement.	5	3
	4.3	Biotechnology For Crop Enhancement: Transgenic crops for pest and disease resistant, genetic modification for enhanced nutritional content.	5	3
5.		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References:

1. Doe, J. (1987) Principles of Agricultural Biotechnology. National Research Council
2. Smith, J. et al.(1996). Genetic Engineering of Crops. Nature biotechnology,
3. Johnson, R. et al. (2004) Microbial Applications in Agriculture. Springer
4. Chawala, H. S. (2011) Biotechnology in Crop Improvement. CRC Press.
5. Gupta, P. K. (2010) Elements of Biotechnology. Rasthogi Publications

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Proteomics**					
Type of Course	**DCE**					
Course Code	**MG7DSEBTG401**					
Course Level	**400-499**					
Course Summary	The Proteomics course covers diverse protein analysis techniques and applications. It explores protein isolation, structure analysis, and methods like 2-DE gels, MALDI-TOF mass spectrometry, and NMR spectroscopy. Students learn protein identification strategies such as sequencing, peptide mass fingerprinting, and quantification through isotope labeling and MS. Post-translational modifications analysis and protein interaction assessment methods are also discussed. The course emphasizes proteome databases like UniProt, NCBI Protein, and STRING, alongside proteomic analysis software and quantitative techniques such as i-TRAQ and SILAC. Through case studies and insights from the Human Proteome Atlas, students understand proteomics' significance in clinical research, drug discovery, biomarker identification, and agriculture.					
Semester	7	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		4	0	0	0	**60**
Pre-requisites, if any	Need to complete difficulty level 300-399 courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Discuss the concept of proteomics	U	1,2,10
2	Apply the methods available for the identification of unknown gene expression products in a high-through-put manner	E	2,3
3	Evaluate the use of the protein structural analytical tools	E	1,2,4
4	Formulate a stepwise workflow for identifying novel protein using Insilco studies	C	1,2
5	Explain the applications in Biomedical research, agricultural research, environmental studies.	U	1,2,10

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to Proteomics	1.1	Introduction and scope of proteomics; Types of proteomics-quantitative proteomics; functional proteomics, structural proteomics.	4	1
	1.2	Protein isolation & structure analysis: detection and quantitation of proteins, Preprocessing, Protein Identification and Quantification, Interpretation and Visualization	4	1
	1.3	Analysis of proteomes: Sample Preparation, Solubilization, Reduction, Resolution	2	2
	1.4	Reproducibility of 2-DE Gels Two-dimensional polyacrylamide gel electrophoresis.	3	2
	1.5	Isoelectric focusing (IEF), protein microarrays, MALDI-TOF mass spectrometry, NMR spectroscopy, x-ray crystallography	5	2
2 Strategies for protein identification	2.1	Protein sequencing, peptide mass fingerprinting.	4	3
	2.2	Protein quantification based on isotope labeling and MS. Analysis of post-translational modifications.	4	3
	2.3	Analysis of protein interactions using affinity chromatography; DNA-Protein interaction: EMSA, Chromatin Immunoprecipitation (ChIP)	3	3
	2.4	Protein - Protein interaction: Chemically induced dimerization, Y2H methodology and protein microarrays.	4	3
3 Proteome databases and Servers	3.1	Proteome database: Chip-seq,	3	4
	3.2	Amino acid sequencing Protein Databases: UniProt, NCBI Protein Protein Data Bank (PDB), InterPro, STRING, PhosphoSitePlus, PRIDE	4	4
	3.3	Proteomic analysis software (protein pilot, Mascot)	4	4
	3.4	Introduction to quantitative proteomics and techniques. (i-TRAQ and SILAC).	4	4
4 Potentials of proteomics in biotechnology	4.1	Case studies related to Clinical and biomedical application of proteomics; drug discovery and personalized medicine,	3	5
	4.2	Target identification and validation, Biomarker discovery in drug development, Stem Cell Research, Protein Engineering,	4	5
	4.3	Monitoring Agricultural Contaminants, Bio indication and Biotic Response	3	5
	4.4	Metaproteomics. Human Proteome Atlas	2	5
5.		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References:

1. Twyman R (2013). Principles of Proteomics. Garland Science, Taylor & Francis Group, LLC, New York, USA.
2. Liebler DC (2002). Introduction to Proteomics- Humana Press, New York, USA.
3. Keith Wilson & John Walker, (2010), Principles and Techniques of Biochemistry and Molecular Biology, ed., Cambridge Univ. Press
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.

Suggested Readings

1. Reiner Westermeier, Tom Naven, Proteomics in Practice, Wiley-VCH, May 2002.
2. D. Hochstrasser, Concepts in Proteomics
3. Wilkins, M. R., Williams, K. L., & Appel, R. D. (Eds.). (1997). Proteome Research: New Frontiers in Functional Genomics (2nd ed.). Springer.
4. Kussmann, M., & Roepstorff, P. (2005). Mass Spectrometry in Systems Biology: An Introduction. Wiley-VCH.
5. Palsson, B. (2006). Systems Biology: Properties of Reconstructed Networks. Cambridge University Press.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Genetic Engineering**					
Type of Course	**DCE**					
Course Code	**MG7DSEBTG402**					
Course Level	**400-499**					
Course Summary	The course provides a comprehensive understanding of the tools used to manipulate DNA, the methods of gene cloning, and the practical applications of rDNA technology.					
Semester	7	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Need to complete difficulty level 300-399 courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Understand the fundamental principles and history of genetic engineering	U	1,2, 3
2.	Apply various techniques and tools used in gene cloning and manipulation	A	2,3,8
3.	Analyze the role of genetic engineering in medicine, agriculture, and industry	An	1, 2, 3, 8
4.	Evaluate the ethical, legal, and social implications of genetic engineering	E	1, 2, 3, 6, 8
5.	Create innovative solutions to biological problems using advanced genetic engineering techniques.	C	1, 2, 3, 6, 8,9

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to genetic engineering	1.1	Introduction to genetic engineering. History and Scope of Genetic Engineering, Birth of rDNA Technology: Paul Berg's development of DNA techniques.	3	2
	1.2	Isolation of genetic material:DNA,RNA,Plasmid. Gene Libraries: Genomic and cDNA Libraries.	3	5
	1.3	PCR and Its Applications. Gene Cloning Strategies: Restriction Enzyme, Gateway, TOPO, Gibson assembly, Type IIS , Ligation Independent Cloning, Oligo Stitching **Activity**: DNA sequencing - Sanger or Maxam Gilbert (Demo)	5	3
	1.4	Steps in genetic engineering: Isolating the DNA, Cutting the DNA at specific site, Preparing the suitable vector, Ligation, Transformation, Screening and Selection, Harvesting and Analyzing. Adapters, Linkers, Homopolymer tail.	4	3
2 Tools and techniques of Genetic engineering	2.1	Enzymes in genetic engineering: DNA Ligases, Polymerase enzymes -DNA polymerase, Klenow fragment, Taq polymerase, Reverse transcriptase; Nucleases - exonucleases: Bal31, exonucleases III, lambda exonuclease, S1 nucleases, RNase H; Restriction endonucleases; Alkaline Phosphatase, Polynucleotide Kinase, Terminal transferase;	5	5
	2.2	Vectors in Genetic engineering: Classification of Vectors: Plasmids - pSC 101, pBR322, pUC; Bacteriophage vectors: M13, and Lambda; Cosmids, Phasmid, Shuttle vectors: YACs, & BACs. Plant and Animal vectors.	5	5
	2,3	Techniques of Gene Transfer: CaCl2 mediated Transformation, Transfection, Electroporation, Lipofection, Microinjection, and Biolistic method. Agrobacterium mediated gene transfer. **Activity**: Cloning and transformation of gene.	5	
3 Screening methods and applications of Genetic engineering	3.1	Screening methods: Blue White screening, Insertional inactivation, Marker genes, reporter genes, colony hybridization. Molecular Techniques: RFLP, RAPD.	5	5
	3.2	Blotting Techniques: Southern, Western, Northern **Activity**: Production of recombinant protein/enzyme.(Demo)	5	5
	3.3	Application of genetic engineering: Production of GMOs: Transgenic plants, animals; Protection of recombinant Insulin, vaccines, antibiotics, Superbugs, Gene therapy, Biofuels, Molecular pharming; Risk of GMOs	5	4
4 Cutting-Edge	4.1	Genome Editing Technologies: CRISPR-Cas9, TALENs, and ZFNs	3	6

Techniques and Future Perspectives	4.2	Synthetic Biology: Design and Construction of Novel Biological Pathways and Organisms	3	6
	4,3	RNA Technologies: RNA Interference, RNAi Therapeutics, and Gene Silencing	3	6
	4.4	High-Throughput Sequencing Technologies and Applications in Functional Genomics	3	6
	4.5	Future Directions and Challenges in Genetic Engineering.	3	6
5		Teacher Specific Content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

Reference:

1. Brown, T. A. (2007). Genomes 3. Garland Science.
2. Brown, T. A. (2016). Gene cloning and DNA analysis: An Introduction. John Wiley & Sons.
3. Karp, G., Iwasa, J., & Marshall, W. (2018). Karp's Cell Biology. John Wiley & Sons.
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5. Primrose, S. B., & Twyman, R. (2013). Principles of gene Manipulation and Genomics. John Wiley & Sons.
6. Purohit, S. S., & Mathur, S. (2002). Biotechnology: Fundamentals and Applications.
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8. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
9. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell. Garland Science.
10. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2016). Molecular Cell Biology. W. H. Freeman.
11. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press.
12. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of Biochemistry: Life at the Molecular Level. Wiley.
13. Nicholl, D. S. T. (2008). An Introduction to Genetic Engineering. Cambridge University Press.

SEMESTER-8

MGU-UGP (HONOURS)

Syllabus

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Advanced Instrumentation Techniques**					
Type of Course	**DCC**					
Course Code	**MG8DCCBTG400**					
Course Level	**400-499**					
Course Summary	This course describes different advanced techniques in proteomics, imaging techniques and genomics					
Semester	8	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		3	0	1	0	**75**
Pre-requisites, if any	Need to complete difficulty level 300-399 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Students will be able to recall the working principles of advanced techniques used biological research	K	1, 10
2	Students will be able to classify the techniques required for specific application	An	1,2,3
3	Students will be able to implement different techniques used in biological research	A	1, 2,9
4	Students will be able to evaluate biological samples for the detection of specific proteins	E	I, 2, 10
5	Students will be able to select suitable tools for applying various techniques.	E	1,2.9

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Techniques in proteomics	1.1	Protein purification- An overview,	4	1
	1.2	Techniques in protein purification- Cell lysis Methods, Precipitation Techniques, Dialysis, Chromatographic techniques (Ion exchange, Size exclusion, Affinity chromatography).	6	1,2
	1.3	Techniques used in protein analysis and characterization: SDS PAGE, Western Blotting, HPLC, NMR Spectroscopy- Proton NMR, C13 NMR, 2D NMR, MALDI - ToF Spectroscopy, Peptide Mass Fingerprinting, GC-MS.	5	1,2
2 Advanced Imaging Techniques	2.1	Microscopic Techniques:- Phase Contrast Microscopy, Fluorescent Microscopy, Confocal Microscopy, Flow cytometry.	5	1,2
	2.2	Electron Microscopy:- Scanning Electron Microscopy, Transmission Electron Microscopy, Cryo Electron Microscopy.	5	1,2
3. Techniques in genomics	3.1	Sequencing Techniques:- Next Generation Sequencing Techniques - Illumina, Nanopore Sequencing.	7	1,2
	3.2	Sequence analysis tools	7	1,2
	3.3	Gene expression analysis: Relative gene expression Analysis using qPCR, DNA microarrays, Biosensors	6	1,2
4 Practicals	4.1	Protein purification	4	1,2,
	4.2	Ion exchange / Affinity chromatography	8	1,2
	4.3	SDS PAGE	8	1,2
	4.4	Western Blotting	6	1,2
	4.5	DNA sequencing (Demo)	4	1,2
5.		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, ICT enabled classes, Seminars, Practical.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** MCQ, Test papers, Viva, Assignments, Practicals, Exercises. **Evaluation:** Theory – CCA : 25 marks Practical – CCA : 15 marks
	B. End Semester Examination – 1.5 hrs Theory – : 50 marks Practical : 35 marks
Pattern of questions	Total marks : 50 marks (1.5 hrs) One word answer question (1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :4 out of 6 4x3= 12 marks Short essay (6 marks) :3 out of 5 3x6= 18 marks Essay (10 marks) :1 out of 2 1x10= 10 marks
Practical-35 marks. 10 hrs.	Major expt/ procedure/ case study analysis – 15 Minor expts/ Spotters – 10 Viva – 5 Record/case study report/field visit report – 5

References

1. Wilson, K., & Walker, J. (Eds.). (2000). Practical Biochemistry. Cambridge University Press.
2. Boyer, R. (2000). Modern Experimental Biochemistry. Pearson Education.
3. Upadhyay, A., Upadhyay, K., & Nath, N. (2009). Biophysical Chemistry: Principles and Techniques. Himalaya Publishing House.
4. Thompson, J. D., Ueffing, M., & Schaeffer-Reiss, C. (Eds.). (2008). Functional Proteomics. Springer Nature.
5. McNair, H. M., Miller, J. M., & Snow, N. H. (2019). Basic Gas Chromatography. Wiley.
6. Head, S. R., Ordoukhanian, P., & Salomon, D. R. (Eds.). (2018). Next Generation Sequencing: Methods and Protocols. Springer Nature.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Analytical and Molecular Techniques**					
Type of Course	**DCC**					
Course Code	**MG8DCCBTG401**					
Course Level	**400-499**					
Course Summary	This practical course covers the the various technologies in the fields of advanced imaging genomics					
Semester	8	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		0	0	4	0	100
Pre-requisites, if any	Need to complete difficulty level 300-399 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Demonstrate a foundational understanding of various microscopic techniques, including phase contrast microscopy, fluorescent microscopy, confocal microscopy, and flow cytometry through video presentations and research lab visits.	U	1, 2,
2	Gain proficiency in scanning electron microscopy and transmission electron microscopy, having been exposed to practical applications through video presentations and research lab visits.	A	1, 3, 9
3	Develop competence in next-generation sequencing techniques, specifically Illumina and Nanopore sequencing, through practical demonstrations via video presentations or research lab visits.	S	1,10
4	Acquire skills in relative gene expression analysis using qPCR and DNA microarray, along with an understanding of biosensors (e.g., glucose biosensors), demonstrated through live demonstrations.	S	1, 2, 3
5	Demonstrate proficiency in protein purification techniques, including cell lysis, protein precipitation, and chromatographic techniques such as ion exchange, size exclusion, and affinity chromatography, through live demo sessions.	A	9, 10
6	Gain advanced skills in protein analysis and characterization techniques, including SDS-PAGE, Western blotting, HPLC, NMR spectroscopy (MALDI-ToF), and GC-MS. This knowledge will be imparted through video presentations or research lab visits.	S	1, 2, 3

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1. Advanced Imaging Techniques (30 hrs)	1.1	Microscopic Techniques, Phase Contrast Microscopy, Fluorescent Microscopy, Confocal Microscopy, Flow Cytometry. (These practicals to be conducted through demonstration by video presentation or research lab visit/attending workshops)	20	1
	1.2	Electron Microscopy Scanning Electron Microscopy, Transmission Electron Microscopy. (These practicals to be conducted through demonstration by video presentation or research lab visit/attending workshops)	10	2
2. Techniques in Next Generation sequencing (30 hrs)	2.1	Sequencing Techniques :Next Generation Sequencing Techniques: Illumina, Nanopore Sequencing. (These practicals to be conducted through demonstration by video presentation or research lab visit/attending workshops)	20	3,4
3 Gene expression analysis	3.1	Gene Expression Analysis, Relative Gene Expression Analysis using qPCR (Quantitative Polymerase Chain Reaction),	15	3,4
4 Screening of Gene expression	4.1	DNA Microarray (These practicals to be conducted through demonstration by video presentation or research lab visit/attending workshops), Biosensor (Glucose biosensor) (Live demo)	10	3,4
5.		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Practicals, Demonstrations, Workshops, Research lab visits, Trainings
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Practical result/record submission **Evaluation:** CCA : 30 marks
	B. End Semester Examination - 2 Hour Total marks: 70 marks.
Pattern of questions Total marks : 70 marks 10 hrs.	Major expt/ Presentation/ demonstration – 25 Minor/spotters/ - 10 Procedure writing - 15 Viva – 10 Record -10

References:

1. Jerome Mertz,(2010) Introduction to Light Microscopy , Cambridge University Press
2. David L. Glaser, (2004), Phase Contrast Microscopy, Imperial College Press
3. Ulrich Kubitscheck,(2005), Fluorescence Microscopy: From Principles to Biological Applications, Wiley-VCH
4. James B. Pawley, (2006),: Handbook of Biological Confocal Microscopy, Springer
5. Alice Longobardi Givan, (2015) Flow Cytometry: Principles and Applications CRC Press.
6. John J. Bozzola and Lonnie D. Russell,: (1998),: Electron Microscopy: Principles and Techniques for Biologists, Jones & Bartlett Learning
7. Authors: Joseph Goldstein, Dale E. Newbury, et al. (2003), Scanning Electron Microscopy and X-Ray Microanalysis, Springer
8. David B. Williams and C. Barry Carter,(2009),: Transmission Electron Microscopy: A Textbook for Materials Science, Springer
9. Stuart M. Brown,: (2016), Next-Generation DNA Sequencing Informatics ,Cold Spring Harbor Laboratory Press,
10. Tim Mohlere, (2019): Illumina Sequencing: Methods and Protocols: Humana
11. Susanna-Assunta Sansone, et al., (2007),Gene Expression: General and Specialized Methods, Horizon Scientific Press
12. Roberto Biassoni and Alessandro Raso, (2014), Quantitative Real-Time PCR: Methods and Protocols, Springer
13. Jorg Hoheisel, (2006),DNA Microarrays: Methods and Protocols, Humana Press

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Molecular Mechanisms of Learning and Memory**					
Type of Course	**DCE**					
Course Code	**MG8DCEBTG400**					
Course Level	**400-499**					
Course Summary	This course explores neurobiology's role in learning and memory, beginning with historical context and advancing through synaptic transmission, synaptic plasticity mechanisms like LTP and LTD, and intracellular signaling pathways. It examines neurotransmitter-receptor dynamics, immediate early genes, and epigenetic modifications such as DNA methylation and histone modification in memory formation. Environmental influences on epigenetics and the molecular basis of neurodegenerative diseases like Alzheimer's and Parkinson's are scrutinized. Therapeutic approaches for these disorders are also discussed. By integrating theory with practical applications, students gain a deep understanding of neurobiology's impact on cognitive processes and neurological health, fostering insight into potential interventions and future research directions.					
Semester	8	**Credits**			3	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Tutorial**	**Practical**	**Others**	
		4	0	0	0	**60**
Pre-requisites, if any	Need to complete difficulty level 300-399 courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Students will understand the fundamental principles of neurobiology.	U	1, 2,
2	Students will gain the knowledge of neuronal structure and function	K	1, 9
3	Students will critically analyze intracellular signaling pathways.	An	3, 4
4	Evaluate the impact of epigenetic modifications on memory.	E	9, 10
5	Demonstrate the ability to analyze and solve problems related to disorders of learning and memory.	A	9, 10

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Unit	Course Content	Hrs	CO No.
1 Introduction to Molecular Basis of Learning and Memory	1	Introduction to the field of neurobiology and its relevance to learning and memory.	3	1
	2	Historical perspective on the study of molecular mechanisms in neuroscience.	3	1
2 Neuronal Signaling and Synaptic Plasticity	1	Neuronal structure and function. Synaptic transmission and its role in learning and memory.	6	2
	2	Long-term potentiation (LTP) and long-term depression (LTD) as synaptic plasticity mechanisms.	5	2
3 Molecular and Epigenetic mechanisms of Memory formation	1	Intracellular signaling pathways involved in memory formation.	5	3
	2	Role of neurotransmitters and receptors in learning and memory.	5	3
	3	Study of immediate early genes in memory consolidation.	5	3
	4	Epigenetic modifications and their impact on memory.	5	4
	5	DNA methylation, histone modification, and their role in synaptic plasticity.	6	4
	6	Environmental influences on epigenetic mechanisms in memory.	5	4
4 Disorders of Learning and Memory	1	Neurological disorders affecting learning and memory.	5	5
	2	Molecular basis of neurodegenerative diseases (e.g., Alzheimer's, Parkinson's diseases).	4	5
	3	Therapeutic approaches and potential interventions.	3	5
5		Teacher Specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References:

1. Kandel, E. R., Schwartz, J. H., Jessell, T. M., Siegelbaum, S. A., & Hudspeth, A. J. (2012). Principles of Neural Science. McGraw-Hill Education.
2. Bear, M. F., Connors, B. W., & Paradiso, M. A. (2015). Neuroscience: Exploring the Brain. Wolters Kluwer.
3. Nestler, E. J., Hyman, S. E., & Malenka, R. C. (2015). Molecular Neuropharmacology: A Foundation for Clinical Neuroscience. McGraw-Hill Education.
4. Squire, L. R., & Kandel, E. R. (2009). Memory: From Mind to Molecules. Roberts and Company Publishers.
5. Sweatt, J. D., Meaney, M. J., & Nestler, E. J. (2012). Epigenetics in the Nervous System. Cold Spring Harbor Laboratory Press.
6. Kesner, R. P., & Martinez Jr., J. L. (2007). Neurobiology of Learning and Memory. Academic Press.

Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Biopharmaceuticals and Nanotechnology**					
Type of Course	**DCE**					
Course Code	**MG8DCEBTG401**					
Course Level	**400-499**					
Course Summary	This course aims to provide a comprehensive understanding of various principles and process of Biotechnology and its integration to pharmaceutical studies. This course also aims to discuss the science of nanotechnology and its application in medicine.					
Semester	8	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Need to complete difficulty level 300-399 courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Able to define and explain Biopharmaceuticals .	K	1, 2
2.	Summarise the context and evolution of biopharmaceuticals.	U	3, 10
3.	Understand therapeutic applications and classifications of biopharmaceuticals.	U	1, 2
4.	Apply knowledge of Immunology and rDNA technology in production of Biopharmaceuticals.	A	1, 10
5.	Analyse preclinical and clinical trials and study the regulatory framework for pharmaceuticals.	An	6, 8
6.	Understand the nanomaterials and it's application on medicine,	U	1, 3
7.	Compare the difference between Nano based medicine from conventional medicine by using case study models.	An	1, 4, 10
8.	Design Biopharmaceuticals based on the knowledge gained about extraction of compounds.	C	2,3,4

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs.	CO No.
1 Fundamentals of Biopharmaceuticals	1.1	Definition and scope of biopharmaceuticals	2	1, 2
	1.2	Historical context and evolution of biopharmaceuticals.	3	1, 2
	1.3	Basic techniques in Biopharmaceutical production – Overview Difference between Biopharmaceuticals and pharmaceuticals.	5	2, 3
2 Biopharmaceuticals : A Revolution in Medicine	2.1	Immunology & Biopharmaceuticals: Hybridoma Technology and purification of Monoclonal antibodies.	5	4, 5
	2.2	Recombinant Proteins and Vaccines : Insulin, Recombinant vaccines, Biopharming, Overview of metabolic Engineering	5	3, 4
	2.3	Gene therapy, Personalized Medicine,3D printing.	3	2, 4
	2.4	Purification and Downstream processing of Biopharmaceuticals.	3	4, 10
3 Drug Development Pipeline	3.1	Stages in Drug development: Target Identification and Validation, Assay Development, Lead optimization.	5	2, 6
	3.2	Preclinical testing and clinical trials.	3	4, 6
	3.3	Regulatory affairs: CDSCO, CPCSEA guidelines, ICMR Guidelines.	4	4, 6
4 Basics of Nanotechnology	4.1	Nanotechnology an Introduction – Properties of Nanoparticles	2	7
	4.2	Classification of Nanomaterials: Carbon based, Metal based,Dendrimers and composites. Magnetic and metallic nanoparticles. Preparation and characterization. Quantum dots: Properties.	4	7,8
	4.3	Application of Nanotechnology in Medicine: Nano drug delivery systems, Nano based tissue engineering materials, Cancer Therapy using Nanomaterials, Cosmetics and Nanotechnology. Benefits of Nano- based treatments a comparative study. **Case study** : Drug delivery using Nanomaterials for Targeted Cancer Therapy.	8	7,8
	4.4	Extraction of Nanoparticles from bio sources. An Outline for Developing Biopharmaceuticals based start-ups. **Case study**: A study on successful Biopharmaceuticals company and it's products.	8	9,10
5.		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References:

1. Cromwellian, D. J. A., & Sindelar, D. R. (2007). Pharmaceutical Biotechnology: Fundamentals and Applications (3rd ed.). CRC Press.
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Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Forensic Biotechnology**					
Type of Course	**DCE**					
Course Code	**MG8DCEBTG402**					
Course Level	**400-499**					
Course Summary	This course offers an in-depth exploration of forensic principles, including Locard's Exchange principle, crime scene preservation, evidence identification, and chain of custody. It covers ethical considerations and interdisciplinary collaboration. Biotechnology's role in forensic sample collection, preservation, DNA processing, and analysis techniques such as spectrophotometry and PCR are discussed. Emphasis is placed on DNA profiling, sequencing methods, bioinformatics, and applications like NGS and metagenomics. Fingerprint and counterfeit analysis, epigenetics, and environmental forensics are also addressed. Students engage with ethical and social concerns in forensic science, fostering comprehensive understanding and critical analysis within the field.					
Semester	8	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Need to complete difficulty level 300-399 courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Comprehend the concept of Forensic Biotechnology principles.	U	1,2,10
2	To apply the ethical principles in forensics	E	2,3
3	To Understand and Apply the knowledge gained about sample collection in forensics.	U,A	3,5,9
4	To understand various methods for collection and preservation of forensics samples.	U,A	1,2,3
5	To identify the use of instruments in forensic biotechnology.	A	6,9,10
6	To analyse the importance of molecular techniques in forensics	An	2,3,6

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1. Introduction to Forensic Science	1.1	Definition; Basic Principles of Forensics-Locard's Exchange Principle; Preservation of Crime Scene; Identification, Individualization & Classification; Chain of Custody and Chronological History of Evidence; Reconstruction; Reliability & Validity; Expert Testimony; Transparency and Objectivity; Cross-Disciplinary Collaboration	7	1,2,
	1.2	Ethical principles, Legal, and Social Implications.	3	2,4
	1.3	Scope of Biotechnology in Forensics, Forensic Disciplines.	5	1,
2. Sample Collection and processing	2.1	Sample Collection: (Hair, Blood, Body Fluids); Collection of Touch DNA. Sample Collection Techniques: DNA Collection Kits,Buccal Swabs,Filter Paper Technology, Absorption Matrices, Flinder Technology Cards, Lateral Flow Device, Microfluidics, DNA Vacuum Pump	6	1,3
	2.2	Preservation & transport. Processing & Isolation of Nucleic acids.	4	1,4
	2.3	Quantitative and Qualitative analysis: Spectrophotometry, Chromatography, Spectroscopy techniques-overview modifications.	5	4,5
3. Advanced Molecular Techniques in Forensics	3.1	Amplification techniques- PCR, qPCR. Forensic related markers- STR Analysis, DNA profiling,VNTR-DNA Fingerprinting, indicators for sex determination-Mitochondrial DNA analysis, Y-Chromosome Analysis-Amelogenin, SRY, and DYS14.	5	1,5
	3.2	Sequencing Methods -DNA Sequencing (Overview). DNA methylation Analysis.	5	1,4
	3.3	Bioinformatics in forensics: DNA Databases (Forensic).	5	4,5
4. Applications, Scope and Future trends	4.1	Advances in Forensic Genomics and phenotyping, Applications of forensic Biotechnology -NGS.	5	1,3,
	4.2	Fingerprint Analysis, Counterfeit Analysis, Metagenomics - Environmental forensics- Epigenetics.	5	3, 5
	4.3	Development of New Biomarkers for Forensic Use, Forensic Biotechnology in Mass Disasters and Missing Persons Cases, Ethical, Legal, and Social Implications of New Forensic Technologies.	5	2,5
5.		Teacher Specific Content.		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

1. Tobe, S. S. (2016). Forensic DNA Analysis: Current Practices and Emerging Technologies. CRC Press.
2. Sandy B. Primrose et al. (2013) Principles of Gene Manipulation and Genomics 7th Edition7th Edition ISBN-13: 978-1405135443.
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4. Vivan Varma, Schutte (2010) Fundamentals of Forensic Science Second Edition Belle Library. ISBN: 978-0-12- 374989-5
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Suggested readings

1. Max M. Houck and Jay A. Siegel Fundamentals of Forensic Science, Academic Press Second Edition,978-0-12-374989-5
2. Evgeny Katz; Jan Halámek Forensic Science: A multidisciplinary approach by ISBN: 9783527338948 2016
3. Stuart James & Jon Nordby Forensic Science, An Introduction to Scientific and Investigative Techniques, ISBN9781315170336
4. Houck, M. M. (2018). Forensic Biology. Elsevier.
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Mahatma Gandhi University
Kottayam

Programme	**BSc (Honours) Biotechnology**					
Course Name	**Stem Cells and Tissue Engineering**					
Type of Course	**DCE**					
Course Code	**MG8DCEBTG403**					
Course Level	**400-499**					
Course Summary	This course enlightens the students with the trends and techniques in stem cells and tissue engineering.					
Semester	8	Credits			4	Total Hours
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	O	60
Pre-requisites, if any	Need to complete difficulty level 300-399 level courses					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Students will be able to define stem cells and describe their characteristics	K	1,2
2	Applying the principles of tissue engineering.	E	2,6,8
3	Students will analyze the sources of stem cells.	An	3,6,8,
4	Through an in-depth understanding of tissue development in vitro and in vivo, students will evaluate parameters used in tissue engineering.	E	,8,10
5	Students will engage in critical thinking by addressing challenges and opportunities in the integration of stem cells and tissue engineering.	E	2,6,8
6	Explore advanced technologies in tissue engineering.	A	3,6,8,

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

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1 Introduction to stem cells and tissue engineering	1.1	Introduction to stem cells and tissue engineering	5	1
	1.2	Cell differentiation and principlesof stem cells	5	1
	1.3	Types of tissue engineering and application of bio-materials	5	1
2 Cell behavior andadvanced techniques	2.1	Stem cell type and sources.	5	2
	2.2	Stem cell behavior and advancedtechniques.	5	2
	2.3	Plant stem cells and its types	5	
3 Tissue engineering. and health	3.1	Tissue development in in vitro andin vivo cultures	8	3
	3.2	Tissue regeneration and advancedhealth care techniques	7	3
4 Tissue Engineering, Challenges and Opportunities	4.1	Donating or harvesting stem cells	5	4
	4.2	Tissue Engineering, challengesand opportunities	5	4
	4.3	Bio fabrication and 3D printing,	5	4
5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecturing, ICT Enabled Learning, Experiential learning, Participatory learning. Discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** Assignment, Oral Presentations, Quiz, Group Discussions **Evaluation:** CCA : 30 marks
	B. **End Semester Examination – 2.0 hrs.** Total marks: 70 marks.
Pattern of questions:	Total marks : 70 marks (2.0 hrs) One word answer question(1 mark):10 out of 10 10x1= 10 marks Short answer questions (3 marks) :5 out of 7 5x3= 15 marks Short essay (6 marks) :5 out of 7 5x6= 30 marks Essay (15 marks) :1 out of 2 1x15= 15 marks

References

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6. Mark Saltsman W, (2014) Tissue Engineering : Principles and Practice.

7. Darwin J. Prockop (2008) Cells Handbook, Springer

<table>
<tr><th colspan="4">MODE OF ASSESSMENT - INTERNSHIP</th></tr>
<tr><td rowspan="8">Assessment Types</td><td colspan="3">A. Continuous Comprehensive Assessment (CCA)</td></tr>
<tr><td rowspan="3">Internship</td><td>Performance Appraisal from the Industry/Units:
1. Technical skills,
2.Work quality,
3.Problem solving skills,
4.Communication and team work and
5. Time management.</td><td>Marks
10</td></tr>
<tr><td>Knowledge acquisition, Growth and Improvement</td><td>5</td></tr>
<tr><td>Total</td><td>15</td></tr>
<tr><td colspan="3">B. Final Evaluation</td></tr>
<tr><td colspan="2">Exam Components</td><td>Marks</td></tr>
<tr><td colspan="2">Internship Report</td><td>20</td></tr>
<tr><td colspan="2">Presentation of work done</td><td>5</td></tr>
<tr><td colspan="2">Viva-Voce</td><td>10</td></tr>
<tr><td colspan="2">Total</td><td>35</td></tr>
</table>

MODE OF ASSESSMENT – PROJECT Course code: MG8PRJBTG400	
Course code: MG8PRJBTG400	**Course Name : Project**
A. Continuous Comprehensive Assessment (CCA)	
Relevance of Topic	**10**
Depth of Research	**20**
Punctuality	**10**
Final report	20
Total	**60**
B. Final Assessment	
Evaluation components	**Distribution of mark**
Preparation of Thesis	
Certificates of guide, HOD, Declaration of student	3
Abstract, key words	2
Introduction	5
Review	5
Materials and Methods	10
Result & Discussion	10
Conclusion & Bibliography	5
Placement of Table/, Fig)	5
Neat layout	5
Total	**50**
Presentation of work	
Timing	5
Display of slides (relevant data)	10
Presentation of methodology	10
Preparation of result	10
Interpretation and analysis	10
Conclusion	5
Total	**50**
Viva	
Response to the questions	10
Knowledge and concept of objective and methodology	10
Justification of Result/Significance of hypothesis	10
Understanding on future work, its practicality and feasibility	10
Total	**40**
Grand Total	**140**
Final mark (CCA+ESA)	**200**

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