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(Accredited by NAAC)

GU/Acad –PG/BoS -NEP/2024/122 Date: 21.05.2024

Ref: GU/Acad –PG/BoS -NEP/2023/102/11 dated 16.06.2023

CIRCULAR

In supersession to the above referred Circular, the Syllabus of Semester III to VIII of the **Bachelor of Science in Biotechnology** Programme approved by the Standing Committee of the Academic Council in its meeting held on 06th, 07th and 21st March 2024 is enclosed. The syllabus of Semester I and II approved earlier is also attached.

The Dean/ Vice-Deans of the School of Biological Sciences and Biotechnology and Principals of the Affiliated Colleges offering the **Bachelor of Science in Biotechnology** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2024.05.21 12:48:30 +05'30'

(Ashwin Lawande)
Assistant Registrar – Academic-PG

To,
The Principals of Affiliated Colleges offering the Bachelor of Science in Biotechnology Programme.

Copy to:
1. The Director, Directorate of Higher Education, Govt. of Goa
2. The Dean, School of Biological Sciences and Biotechnology, Goa University.
3. The Vice-Deans, School of Biological Sciences and Biotechnology, Goa University.
4. The Chairperson, BOS in Biotechnology.
5. The Controller of Examinations, Goa University.
6. The Assistant Registrar, UG Examinations, Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

Programme Structure for Semester I to VIII Under Graduate Programme- Biotechnology										
Semester	**Major Core**	**Minor**	**MC**	**AEC**	**SEC**	**I**	**D**	**VAC**	**Total Credits**	**Exit**
I	**GBT-100 Biotechnology in Everyday Life (4)**	**GBT-111 Biotechnology: Insights and Progression (4)**	**GBT-131 Nutrition and Dietetics (3)**		**GBT-141 Laboratory Essentials (3)**	**-**	**-**		**20**	**-**
II			**GBT-132 Lifestyle Diseases and Management (3)**		**GBT-142 Bakery and Fermented Beverage Technology (3)**	**-**	**-**		**20**	**GBT- 161 Eco Friendly Bioproducts (4)**
III	**GBT-200 Cell Biology (3T+1P)** **GBT-201 Elementary Microbiology (3T+1P)**	**GBT-211- Biomolecules (4)**	**GBT-231 Emergency Response and First Aid (3)**		**GBT-241 Modern Agricultural Practises and Home Gardening (1T+2P)**	**-**	**-**		**20**	**-**

IV	**GBT-202 Biochemical Processes and Metabolism (3T+1P)** **GBT-203 Principles of Ecology and Evolution (4)** **GBT-204 Mammalian Physiology (4)** **GBT-205 Bio-entrepreneurship (2)**	**GBT-221 Plant Physiology (4) (VET)**	**-**		**-**	**-**	**-**	**-**	**20**	**GBT -261 Laboratory Skills and Techniques in Biotech-nology (1T+3P)**

V	GBT-300 Genetics (3T+1P) GBT-301 Bioanalytical Tools (3T+1P) GBT-302- Immunology (3T+1P) GBT-303 Research Methodology (2)	GBT-321 Biostatistics and Bioinformatics (3T+1P) (VET)	-	-	-	Internship (2)		-	20	-
VI	GBT-304 Plant tissue culture (3T+1P) GBT-305 Animal Tissue Culture (4)	GBT- 322 Food Biotechnology (3T+1P) (VET)	-	-	-	-	-	-	20	-

	GBT-306 Molecular Biology and Genetic Engineering (3T+1P) **GBT-307 Minor Project (4)**									
VII	**GBT-400 Industrial Biotechnology and Enzyme Technology (3T+1P)** **GBT-401 Environmental Biotechnology (3T+1P)** **GBT-402 Forensic Science and Toxicology (3T+1P)**	**GBT-411 Developmental Biology (4)**							**20**	**-**

	GBT-403- Biotechnology in Healthcare (4)									
VIII	**GBT-404 Pharmaceutical Biotechnology (3T+1P)** **GBT-405 Agricultural Biotechnology (3T+1P)** **GBT-406 Nano-biotechnology (3T+1P)** **GBT-407 Stem Cell Biology and Tissue Engineering (4)**	**GBT-412 Cancer Biology (4)**	-	-	-	-	-	-	**20**	-

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-100**
Title of the Course : **Biotechnology in Everyday Life**
Number of Credits : **04**
Effective from AY : **2023-24**

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To understand the fundamental concepts and various applications of biotechnology in different fields. 2. To explore the role of microorganisms in fermentation technology, use of genetically modified organisms in agriculture, animal husbandry, and medicine, applications of diagnostic tools, biosensors and vaccines in disease prevention and diagnosis. 3. To examine the role of biotechnology in waste treatment and environmental remediation, and the potential for sustainable solutions to environmental problems. 4. To study the applications of biomimetic, enzymes, and bioinformatics in biotechnology, and their potential for innovation and commercialization.	
Content:		**No. of Hours**
	MODULE I General overview and concept Biotechnology. Fermented foods (cheese, yoghurt, sauerkraut, bread), prebiotics and probiotics, Alcoholic beverages (beer, wines), Study of Microbial flora from fermented products, antimicrobial agents (antibiotics), Nutraceuticals, SCP and mushroom cultivation, genetically modified foods, Organic acids, amino acids, vitamins.	**15**
	MODULE II Genetically modified organisms: Plants (resistance to biotic and abiotic stresses, improved crop yield and quality improved nutrition (Case study of Golden rice); animals (mice, cattle, pigs, fish, sheep), microorganisms (Insulin production). Development of Vaccines. Vaccine types-recombinant vaccines, bacterial vaccines, viral vaccines (COVID), Diagnostic and molecular tools (readily available kits, molecular scissors) Biosensors.	**15**
	MODULE III Bio-fertilizers, bio-pesticides, vermicomposting. Bioethanol, Biofuels, Bioplastics. Treatment of industrial wastes, bioremediation, sewage/ waste water treatment, bioleaching, bioaugmentation. Bioindicators. Enzymes and applications in Industries (Amylase, cellulase, pectinase, protease, lipase**.** Introduction to Biomimetics and their applications (jellagen, tissium, greenbone).	**15**

	Dark Biotechnology (biowarfare, biological weapons and Bioterrorism) (Case studies: Anthrax). Concept of Bioinformatics and Databases in Biotechnology.	
	PRACTICALS 1. Study of Microbial flora from fermented products- Curd. 2. Preparation of Sauerkraut. 3. Preparation of Ethanol by yeast. 4. Mushroom cultivation. 5. Microbiological assay of antibiotics - Diffusion method. 6. Study of ABO blood group and Rh factor in Humans. 7. Pregnancy test using kit. 8. Biosensors - Estimation of blood glucose (Demonstration). 9. Qualitative study of Amylase. 10. Qualitative study of Protease. 11. Study of phosphate solubilizing activity of microorganisms. 12. Demonstration of bacteria as biocontrol agents of plant diseases. 13. Composting of kitchen waste. 14. Introduction to biological databases- NCBI and PDB. 15. Visit to a sewage / waste water treatment plant.	**30**
Pedagogy:	Lectures and class discussions to introduce basic principles and concepts. Use of ICT tools. Case studies to provide real-world examples of biotechnological products and processes. Fundamental theoretical concepts will be explained by practical demonstration.	
References/ Readings:	1. R. Renneberg, V. Berkling, V. Loroch, D. Süssbier, Biotechnology for Beginners. Elsevier Science. 2023 2. U. Satyanarayana and U. Chakrapani, Biotechnology. Books and Allied. 2021. 3. Willey, J.M., Sherwood, L.M., and C.J. Woolverton, Prescott's Microbiology (11th ed.). McGraw-Hill Education. 2021. 4. Dr. H.K Das, Textbook of Biotechnology. Wiley India. 2017. 5. B.D. Singh, Biotechnology: Expanding Horizons. Kalyani Publishers. 2014. 6. F. Mitha, "Biomimicry in Biotech: Taking Inspiration from Nature" Labiotech.eu[online document], 2021 Available: https://www.labiotech.eu/in-depth/biomimicry-biotech-nature-inspiration/	
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the basic principles and techniques used in biotechnology research and development with the help of demonstrations and case studies. 2. Evaluate the impact of biotechnology on human health, agriculture, industry, and the environment. 3. Understand the principles and methods of genetic engineering in plants, animals and microorganisms.	

	4. Recognise the implications of biotechnology in biological weapons development.

Name of the Programme : **B.Sc. Biotechnology**
Course code : **GBT-111**
Title of the course : **Biotechnology: Insights and Progression**
Number of credits : **04**
Effective from AY : **2023-24**

Prerequisites for the Course:	Nil	
Course Objectives:	1. To gain an accurate and deep understanding in the field of biotechnology. 2. To appreciate developments in biotechnology from ancient civilizations to modern times. 3. To familiarize students with the applications of biotechnology in agriculture, medicine, environment, food and beverage industries and conservation of biodiversity. 4. To encourage students to pursue biotechnology as a promising career.	
Content:		**No. of Hours**
	MODULE I Ancient biotechnology: Domestication of crops & livestock, traditional fermented products, preservation & storage of food. Classical biotechnology: Discovery of microscope & microorganisms, early medicinal development, pasteurisation & sterilization, discovery of penicillin. Overview of Mendelian genetics. Discovery of chromosomes, gene as carrier of hereditary: phenotype & genotype, gene theory, jumping genes. Modern biotechnology: DNA structure-Double helix model of DNA, central dogma, genetic code, first recombinant DNA molecule, sequencing technology: revolutionary breakthrough, first vaccine, DNA fingerprinting, human genome project, Dolly 'the cloned' sheep.	**15**
	MODULE II Pre-independence Indian scenario of food and agriculture (1997-1990). Green revolution, Golden rice, eugenics, improved crops, GM foods, Flavour savour tomatoes, designer milk, Cultured food products, Cereal fermentation, genetically modified fishes & meat, Role of biotechnology in managing the carbon footprint of food industry, Smart food delivery systems, way forward-policy and actions.	**15**
	MODULE III	**15**

	Disease outbreaks (Smallpox, Bubonic Plague, Spanish Flu, and COVID), Development of vaccines, Clinical Trials, Molecular Diagnosis (immunological kits, monoclonal antibodies and Biosensors). Recombinant DNA technology (Recombinant Insulin, Edible Vaccines, Genome editing & Gene Therapy), Biomedical Innovations – 3D Bioprinting, Stem cell therapy, Regenerative medicine, Biomaterials, Implants, Bionics & Scaffolding, Nanomedicine & Drug delivery, the Role of IoT in medicine.	
	MODULE IV Environmental problems: Pollution (air, water and soil), Ozone depletion, global warming, oil spills, invasive species. Pollution monitoring systems using Biotechnology - Bioindicators: lichens, animal and plant test systems, biosensors, reporter genes. Case studies on development of genetically engineered organisms in mitigation of environmental issues. Bioremediation (microorganisms and plants; *Pseudomonas aeruginosa*, *Pseudomonas putida* and degradative plasmids). Cloning and *in vitro* techniques. Role of gene editing and AI in tackling environmental problems.	**15**
Pedagogy:	Lectures and tutorials. Seminars / term papers /assignments / presentations / or a combination of these.	
References/ Readings:	1. Godbey, W.T.. An Introduction to Biotechnology: The Science, Technology and Medical Applications. Netherlands, Elsevier Science, 2014. 2. Cimpeanu, Carmen, and Pele, Maria. Biotechnology: An Introduction. United Kingdom, Wit Press, 2012. 3. Stevens, Hallam. Biotechnology and Society: An Introduction. United Kingdom, University of Chicago Press, 2016. 4. Jay, James M., Loessner, Martin J., Golden, David A. Modern Food Microbiology, 2005. 5. Casida LE. Industrial Microbiology.1st edition.Wiley Eastern Limited, 1968. 6. Indu Shekar Thakur, Environmental Biotechnology:Basic concepts and applications. .K.International Pvt.Ltd. NewDelhi, 2011. 7. Singh B.D.,Biotechnology.4th ed, KalyaniPublishers, 2010. 8. Kenneth J. Ryan and C. George Ray. Sherris Medical Microbiology: An introduction to infectious diseases. McGraw-Hill, Medical Publishing Division, 2004.	

Course Outcomes:	At the end of the course, students will be able to: 1. Define the term 'Biotechnology' and appreciate its scope. 2. Discuss the national and global significance of biotechnology and the key events in the development of biotechnology. 3. Understand the multidisciplinary nature of biotechnology and the associated role that has been played by "enabling technologies" in the development of biotechnology. 4. Evaluate the issues, prospects and impact of biotechnology on the ecosystem.

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-131**
Title of the Course : **Nutrition and Dietetics**
Number of Credits : **03**
Effective from AY : **2023-24**

Prerequisites for the Course:	Nil	
Course Objectives:	1. To acquire knowledge of various concepts of Food Science – facts and principles 2. To understand the composition of food. 3. To understand the diet pattern for various age groups. 4. To provide a thorough knowledge of the subject and to help the learner to analyse the accurate body requirements.	
Content:		**No. of Hours**
	MODULE I **Role of nutrition in health**– An overview, Concept of nutrition, Current Nutritional status of India, Scope of nutrition and dietetics. **Basic Nutrition**: 1. Macronutrients: Carbohydrates, Proteins & Fats - Their Classification, Functions, Digestion and absorption, Sources Requirements, Deficiency, and related diseases 2. Micronutrients – Their Classification, Functions, Digestion and absorption, Sources, Requirements, Deficiency, and related diseases, & role of antioxidants I. Minerals: a) Macro: i. Calcium ii. Phosphorus iii. Sodium iv. Potassium b) Micro: i. Iron ii. Iodine iii. Zinc II. Vitamins –a) Fat soluble –A, D, E, K b) Water Soluble - B Complex Vitamin C.	**15**
	MODULE II **Functional foods** - Antioxidants, Probiotics & Prebiotics, Phytonutrients, emerging trends in Nutraceuticals (Nootropics and Adaptogens). **Basal Metabolic Rate-** Metabolism and energy requirements. Balance; underweight, overweight, obesity,	**15**
	MODULE III **Meal Planning-** Factors affecting meal planning, Basic steps in planning a meal, Balanced Diet, RDA and Dietary Guidelines for Indians, ICMR, 2010, Diet during different stages of life – Nutrition for infants, toddlers, adults (men & women), pregnant women, lactating mothers, and aged individuals.	**15**
Pedagogy:	Lectures, Tutorials, ICT Tools.	
References/ Readings:	1. Srilakshmi, B., Nutrition Science, 7th edition. New Delhi: New Age International Publishers. 2021. 2. Alex M, "Role of nutrition in maintaining health" International Journal of Physical Education, Sports and Health, vol. 7, no. 4, 2020. [Online serial] Available	

	https://www.kheljournal.com/archives/2020/vol7issue4/PartE/7-4-14-997.pdf. 3. Manay, N.S. Food: Facts and Principles. New Delhi, India: New Age International Publishers. 4th Edition, 2020. 4. S. Rodey, Food Science and Nutrition, Oxford University Press, Second edition. 2018 5. R., Chaddha and P., Mathur, Nutrition a lifecycle approach, The Orient Blackswan, 2015. 6. Dr. Laxmaiah, Dietary Guidelines for Indians a manual, Second edition, National Institute of Nutrition. Generic Publisher, 2011.
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the principles of food essential for good health and its importance in preventive health care. 2. Describe the current scope of nutrition and the importance of a healthy diet in today's world. 3. Understand the concept of RDA and its importance in meal planning. 4. Plan a meal with ideal dietary requirements for various stages of life. 5. Discuss the current trends in nutraceuticals and probiotics.

Name of the Programme : **B.Sc. Biotechnology**
Course code : **GBT-132**
Title of the course : **Lifestyle Diseases and Management**
Number of credits : **03**
Effective from AY : **2023-24**

Prerequisites for the course:	Nil	
Course Objectives:	1. To understand the concept of lifestyle diseases and the significance of lifestyle factors in preventing the development of diseases. 2. To analyse the components of nutrition, as well as label reading and the use of supplements. 3. To examine the characteristics, causes, diagnosis, prevention, and management of various lifestyle diseases and related disorders. 4. To evaluate the importance of a balanced diet and exercise in maintaining good health, reducing the risk of lifestyle diseases, and preventing obesity.	
Content:		**No. of Hours**
	MODULE I Concept of lifestyle diseases- importance of lifestyle factors in preventing disease development: diet, exercise, smoking, alcohol etc. The food pyramid, components of nutrition- carbohydrates, fiber, protein, fat and types of fat and label reading. Supplements.	**15**
	MODULE II Diabetes- Type 1 and type 2, characteristics, causes, diagnosis, prevention and management. Cancer- Characteristics, Causes, Diagnosis, Prevention, Management, basics of treatment modalities. Stress related disorders- insomnia, depression and anxiety. Eating disorders- anorexia nervosa and bulimia nervosa. PCOS and its management.	**15**
	MODULE III Atherosclerosis and cardiovascular diseases- Myocardial infarction, congestive heart failure, ischemic diseases-Causes, diagnosis and management. Importance of diet and exercise in health- balanced diet, BMR, calorific value, reducing cholesterol and risk of heart attack through lifestyle changes, use of medication to treat disorders**.** Body mass index, determination and significance. Obesity- causes, prevention and management.	**15**
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments /presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	

References/ Readings:	1. George, Jesiya Susan, et al. A Holistic and Integrated Approach to Lifestyle Diseases. United Kingdom, Apple Academic Press, 2022. 2. Gattani, S. G. Lifestyle Diseases. India, Nirali Prakashan, 2017. 3. Hall, John E., et al. Guyton and Hall Textbook of Medical Physiology. United Kingdom, Saunders/Elsevier, 2011. 4. M. Kumar R. Kumar. Guide to Prevention of Lifestyle Diseases. India, Deep & Deep Publications, 2004.
Course Outcomes:	At the end of the course, students will be able to: 1. Appreciate the importance of a healthy lifestyle and nutrition. 2. Rationalise nutritional habits with lifestyle management. 3. Describe how personal decisions and behaviors affect health and impact the most common lifestyle diseases. 4. Identify basic principles of nutrition and ways to obtain/maintain a healthy body composition.

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-141**
Title of the Course : **Laboratory Essentials**
Number of Credits : **03(1T+2P)**
Effective from AY : **2023-24**

Prerequisites for the Course:	Nil	
Course Objectives:	1. To study the various risks and hazards involved in a laboratory. 2. To study the protective equipment and be prepared for emergency situations in the laboratory. 3. To follow the general procedures for lab safety. 4. To impart basic practical skills in laboratory sciences.	
Content:		**No. of Hours**
	MODULE I **Introduction to GLP-** History, scope, fundamental points of Good Laboratory Practices (GLP), levels of laboratories, infrastructure, personal, training and development, documentation of raw data and data collection, handling of specimens (seized materials, biological specimens), specimen labelling and transportation of samples.	**07**
	MODULE II **Safety in Laboratories-** Use of Personal protective equipment (PPE) and conduct in labs, waste and its disposal (recycling, general waste, non-hazardous identifiable lab waste, incineration bags, sharps, uncontaminated glassware, solvent waste, sink), general safety measures, laboratory hygiene and sanitation, electrical safety, biosafety precautions and biological safety cabinets (BSCs). Dealing with Burns, Spills, Scalds, basic working of fire extinguishers, Data safety sheets, Risk assessment, Working with Hazardous chemicals, Decontamination and Fumigation.	**08**

	PRACTICAL 1. Basic SOPs for instrument and equipment handling, calibration and maintenance: weighing balance, pH meter, autoclave, hot air oven, laminar air flow, water baths, incubators, fume hoods, microscopes, micro pipettes; spectrophotometer, centrifuge, rotary shaker, filter assembly, vacuum pump, desiccators, distillation unit. 2. First aid in the laboratory. 3. Documentation: Lab notebook & Lab report, log book maintenance. 4. Math skills (conversion of metric units, determining significant figures and rounding off). 5. Data analysis using Microsoft Excel - calculation and graphical representation. 6. Preparation of stock and working solutions (normality, molarity, molality, ppm, percentage solutions) 7. Preparations of buffers – acidic, basic, neutral pH and measurement. 8. Sterilization using physical agents (dry heat, moist heat, UV). 9. Sterilization using chemical agents (alcohol, formaldehyde, sodium hypochlorite, chromic acid). 10. Verification of Beer Lambert Law, Molar Extinction Coefficient using spectrophotometer/ colorimeter. 11. Sample collection techniques (environmental samples). 12. Disposing harmful chemicals (guidelines) and microbial decontamination. 13. Extinguishing fires in a laboratory (demonstration).	**60**
Pedagogy:	Lectures, Integrated Learning, Practical skill-based learning.	
References/ Readings:	1. Handbook of Laboratory Safety. 1st Edition, Elsevier, 2022. 2. Clinical Laboratory Science Concepts. Procedures and Clinical Applications, 9th Edition, 2022. 3. M., Pahuja, Guidelines for good laboratory practices - Indian council of Medical Research (ICMR), New Delhi, 2021. 4. Nigam, P.K., Vijay, K. ICMR Guidelines for Good Clinical Laboratory Practices (GCLP), ICMR, New Delhi, 2021. 5. Life Science protocol manual. Reddy and Govil, 2018. 6. Laboratory Manual and Practical science. T.N Pattabiraman, 4th Edition, 2015. 7. P.H., Reddy, S. Govil, Life science protocol manual - DBT star college scheme, 2018. 8. Dubey, R.C., Maheshwari, D.K. Practical Microbiology. S Chand Publications, 2018. 9. Handbook Good Laboratory Practices - World health organization (WHO), 2009.	

Course Outcomes:	At the end of the course, students will be able to: 1. Practice basic procedures and protocols, safely and accurately in a lab setting. 2. Understand the rationale behind laboratory procedures. 3. Handle and maintain laboratory equipment and apparatus correctly. 4. Appreciate the need of maintaining a timely, comprehensive, detailed laboratory notebook depicting experimental results in a clear and concise manner to repeat experiments, troubleshoot procedures, and analyze data. 5. Perform basic lab calculations to prepare solutions and samples for experiments.

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-142**
Title of the Course : **Bakery and Fermented Beverage Technology**
Number of Credits : **03**
Effective from AY : **2023-24**

Prerequisites for the Course:	Nil	
Course Objectives:	1. To impart basic knowledge of the science and techniques of baking and fermentation. 2. To familiarize the students with different types of baking tools and equipment and their use. 3. To understand the fermentation process and requirements of various alcoholic and non- alcoholic fermented beverages. 4. To learn to prepare different types of bread, cake, pastry and fermented beverages.	
Content:		**No. of Hours**
	MODULE I **The Science of Baking-** Origin and history of baking, baking v/s cooking; types of baking; Scope of Bakery and Confectionery in India and Abroad, Bakery terms, baking tools and equipment, Ingredients and their role- Flours, sweeteners, salt, leavening agents, fats, eggs, liquids. Mixing Methods- Basic steps involved in mixing ingredients – Kneading, stirring, whipping, creaming. Methods of bread making- Straight dough method, Delayed salt method, No time dough method, Sponge and dough method; Cake Making Methods- Sugar butter process, Flour butter process, Genoise method, Blending and rubbing method Pastry - basic formulation - different types – shortcrust, choux, flaky, puff and filo / phyllo pastry.	**07**
	MODULE II **The Art of Brewing-** Origin and history of fermented beverages. Types of fermented beverages, their properties and health benefits, Alcoholic and Non-alcoholic beverages, carbonated and non-carbonated, Fermented whey beverages, The process and principle of Brewing, ingredients and additives used in brewing, knowledge of appropriate machines/ tools - fermenter, seed germinator, vinegar generator, autoclave, bottle washer, required fermentation agents, packaging machines.	**08**

	PRACTICAL 1. Simple yeast fermented products- Bread Rolls, Soft Rolls, Sour dough. 2. Rich Yeast Fermented Breads- Cinnamon Rolls, Fermented Doughnuts. 3. Bread loaf, French Bread. 4. Flavoured Breads- Fruit Buns, Burger Buns. 5. Basic Cake Making- Victoria Sponge, Fruit cake, Chocolate cake. 6. Icing Cakes – Buttercream, Whipped Cream. 7. Shortcrust pastry - jam tart, apple pie. 8. Choux pastry - Chocolate eclairs. 9. Puff pastry- Khari Biscuits, Patties, Cheese straws. 10. Filo pastry- Baklava. 11. Preparation and maintenance of starter cultures for fermented beverages. 12. Preparation of Buttermilk. 13. Preparation of wine - Grapes, Pineapple, Beetroot, Dates 14. Preparation of milk Kefir and water Kefir. 15. Preparation of Kombucha. 16. Preparation of Sake. 17. Preparation of Apple cider. 18. Preparation of Beet Kvass 19. Preparation of Sima. 20. Preparation of Ginger ale. 21. Preparation of Mead.	**60**
Pedagogy:	Lectures, Integrated Learning, Practical skill-based learning.	
References/ Readings:	1. Jyoti Prakash Tamang, Patricia Lappe-Oliveras, Baltasar Mayo, Insights of Fermented Foods and Beverages: Microbiology and Health-Promoting Benefits. Frontiers Media SA., 2022. 2. Ashokkumar Y., Textbook of bakery and confectionery (2nd Edition), 2019. 3. NPCS Board of Consultants & Engineers, The Complete Technology Book on Alcoholic and Non-Alcoholic Beverages, 2nd Revised Edition, 2018. 4. Rosentrater, K. A., & Evers, A. D., Kent's technology of cereals: An introduction for students of food science and agriculture. Woodhead Publishing, 2017. 5. Louise Davidson, Fermented Beverages for Healthy Guts, The Cookbook Publisher; 1st edition, 2016. 6. Kulandaivel, S., and Janarthanan, S., Practical manual on fermentation technology. IK International Publishing House Pvt. Limited., 2012. 7. Katz, S. E., The art of fermentation: an in-depth exploration of essential concepts and processes from around the world. Chelsea green publishing, 2012.	

	8. James Peterson, Baking. Ten Speed Press, 2009. 9. Hui, Y. H., Corke, H., De Leyn, I., Nip, W. K., and Cross, N. A. (Eds.),Bakery products: science and technology. John Wiley & Sons, 2008. 10. Khetarpaul, N.,Bakery science and cereal technology. Daya Books, 2005. 11. Kulp, K., & Lorenz, K. (Eds.) Handbook of dough fermentations (Vol. 127). Crc Press., 2003. 12. Andrew G. H. Lea, John R. Piggott, Fermented Beverage Production, 2nd Edition, 2003.
Course Outcomes:	At the end of the course, students will be able to: 1. Identify and differentiate the small and large equipment used in baking. 2. Identify and indicate the use of the different types of ingredients used in baking. 3. Prepare yeast fermented products, flavoured breads, bread loaf and French bread, basic sponges and iced cakes, basic pastries and its derivatives. 4. Prepare various fermented beverages.

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT -161**
Title of the Course : **Eco-Friendly Bioproducts**
Number of credits : **04**
Effective from AY : **2023-24**

Prerequisites for the course	Nil	
Course objectives	1. To provide an understanding of the various types of biofertilizers and their applications in agriculture. 2. To explore the different types of biopesticides and their mechanism of action. 3. To familiarize students with the production and properties of different biofuels. 4. To introduce students to various eco-friendly bioproducts and their applications. 5. To enable students to prepare and evaluate different types of biofertilizers, biopesticides	
		No.of Hours
Contents	**Module (I) Theory** **Biofertilizers**: Bacterial, Fungal (Endo, Ecto & VAM mycorrhizae) and Algal (Blue green algae) biofertilizers. Applications and uses of effective microorganisms [E.M.] solutions, Panchagavya, Sanjivani solutions. Problems of biofertilizers. **Biopesticides**: Definition, mechanism of action and application of bacterial (Bacillus thuringiensis) fungal (Neozygites floridana) protozoal (Malamoeba) and nematode (Heterorhabditis bacteriophora) based biopesticides. Neem based biopesticides. **Biofuels**: Types (Biodiesel, Bioethanol, Biomethane, Biohydrogen), Raw materials used in production, process technology, feed stocks. Advantages and limitations. **Eco-Friendly Bioproducts**- Production and applications of Bioplastics: (PHA, PHB). Natural dyes: Curcumin (Turmeric), chlorophyll (spinach), anthocyanin (red hibiscus), carotenoids (henna), Characteristics of Biocomposites (Starch & cellulose based). Composting products: Manure and vermicompost.	**15**
	Practicals	
	1. Preparation of biofertilizer: Panchagavya. 2. Demonstrate the application of Panchagavya on plant growth. 3. Preparation of biofertilizer: Sanjivani. 4. Demonstrate the application of Sanjivani on plant growth. 5. Preparation of biofertilizer: Beejamrut 6. Demonstrate the application of Beejamrut on plant growth. 7. Preparation of biofertilizer: Jeevamrut. 8. Demonstrate the application of Beejamrut on plant growth. 9. Microscopic examination of blue green algae.	**30**

	10. Preparation of bacterial biofertilizer.	
	11. Demonstrate the application of bacterial biofertilizer on plant growth. 12. Microscopic examination of Mycorrhizal fungi. 13. Production of fungal biofertilizer. 14. Demonstrate their application of fungal biofertilizer on plant growth. 15. Preparation of Effective Microorganisms (EM) solution. 16. Evaluating the impact of EM solution on plant growth. 17. Demonstration of different methods of biofertilizer application, such as seed treatment, root dipping, soil inoculation, foliar spraying, using suitable crops 18. Preparation of Neem based biopesticide. 19. Preparation of Citrus Enzyme based biopesticide. 20. Preparation of Lignocellulosic biomass	**30**
	21. Production of bioethanol from lignocellulosic biomass. 22. Production of biomethane from kitchen waste. 23. Demonstration of PHA formation using Bacillus sp. 24. Extraction and preparation of natural dyes from beetroot and pomegranate peels. 25. Extraction and preparation of natural dyes from henna leaves. 26. Preparation of starch-based bio composites. 27. Preparation of biopackaging material. 28. Preparation of cocopeat from coconut husk. 29. Preparation of compost using kitchen waste. 30. Demonstration of vermicomposting technique.	**30**
Pedagogy	Lectures and tutorials, Seminars / assignments /presentations, interactive and peer group learning sessions and use of ICT tools.	
References/ Readings	1. U. Satyanarayana and U. Chakrapani, Biotechnology. Books and Allied. 2021. 2. Indu Shekar Thakur, Environmental Biotechnology:Basic concepts and applications. .K. International Pvt.Ltd. NewDelhi, 2011. 3. Blackburn, R.S., Sustainable textiles: Life cycle and environmental impact. Elsevier Science Publishers, The Netherland. 2009. 4. Natrajan, K. Panchagavya. Organic Farming Association of India, Mapusa- Goa, 2009. 5. Board, N., The complete technology book on vermiculture and vermicompost CRC Press. 2004. 6. Kannalyan, S. Biotechnology of Biofertilizer, Narosa Publishing House, New Delhi. 2002.	
Course outcomes	At the end of the course, the students will be able to: 1. Discuss the various types of biofertilizers and their importance in agriculture. 2. Understand the mechanism of action of different types of biopesticides	

	3. Evaluate the suitability, effectiveness, advantages and limitations of different types of biofuels and eco-friendly bioproducts for specific applications 4. Prepare and evaluate different types of biofertilizers, biopesticides, biofuels and eco-friendly bioproducts in the laboratory. 5. Understand the environmental impact of different types of biofuels and eco- friendly bioproducts.

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT-200
Title of the Course : Cell Biology
Number of Credits : 04 (3T+1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic understanding of Biology.	
Course Objectives:	1. To introduce the basics of the cell and its components and provide a strong foundation on the basic unit of life. 2. To provide an in-depth understanding of cell function, the diverse cellular processes, signaling and division. 3. To offer a foundation needed in cell biology for advanced courses. 4. To develop practical skills in Cell biology.	
Content:		**No. of Hours**
	MODULE I Cell as a basic unit of living Systems: Introduction, Discovery of cell, the Cell Theory. Classification of organisms by cell structure, Ultrastructure of prokaryotic and eukaryotic cells- (plant and animal cells). Cytosol, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, Membrane lipids, proteins and carbohydrates; Organization and Fluid Mosaic Model, membrane as a dynamic entity. Membrane transport –Solute transport by Simple diffusion, Facilitated diffusion and Active transport. Cell wall - distribution, chemical composition, functions. Cytoskeleton structures: Structure and function of microtubules, Microfilaments, Intermediate filaments. Composition of extracellular matrix in plants and animals.	**15**
	MODULE II Nucleus: Structure and function, transport across nuclear membrane chromosomes and their structure. Euchromatin and Heterochromatin, Special type of chromosomes: Salivary gland and Lampbrush chromosomes. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Transport in mitochondria and chloroplasts (Tim/Tom; Tic/Toc) and semi-autonomous nature of mitochondria and chloroplast Ribosomes: Structures and function including a role in protein synthesis. Golgi complex: Structure, biogenesis and functions including role in protein secretion. Endoplasmic reticulum: Structure, function including role in protein segregation. Lysosomes, Vacuoles and microbodies (Glyoxysomes and Peroxisomes): Structure and functions	**15**

	Membrane trafficking, Protein sorting and Transport: Endomembrane System: Golgi, Lysosomes Vesicular Traffic, Secretion, and Endocytosis, exocytosis; Pinocytosis, Phagocytosis. Translocation of secretory proteins across the ER membrane; protein modifications, folding and quality control in the ER; export and sorting of proteins to mitochondria, chloroplast and peroxisomes.	
	MODULE III Cell cycle: An overview of cell cycle; Mitosis & Meiosis, Significance of cell cycle, cell cycle checkpoints, Components of cell cycle control system, Regulation of cell cycle and enzymes involved in regulation. Cell interactions: Cell-cell and Cell-Basal membrane adhesion, cell adhesion molecules. Signal transduction- Cell membrane receptors and types, cytosolic and nuclear receptors, signalling molecules, intracellular signal transduction; G protein-coupled receptors; endocrine signalling, quorum sensing and intercellular signalling.	**15**
	PRACTICAL (Each practical of 2 hours) 1. Microscopic study of plant cells (onion peel/rheo leaf) 2. Microscopic study of animal cells (buccal squamous epithelial cells). 3. Study the effect of temperature on semi-permeable membranes. 4. Study the effect of organic solvents on semi-permeable membrane. 5. Study of plasmolysis and de-plasmolysis. 6. Preparation of dialysis membrane and demonstration of dialysis. 7. Study of Mitosis using microscopy. 8. Study of Meiosis using microscopy. 9. Study of polyploidy in Onion root tip by colchicine treatment. 10. Isolation of Chloroplasts. 11. DNA staining (Feulgen technique) 12. Preparation of Drosophila Chromosome Squash 13. DNA Extraction from plant cells 14. Agarose Gel Electrophoresis of extracted DNA. 15. Microtomy (demonstration)	**30**
Pedagogy:	Lectures, tutorials, assignments, presentations and use of ICT tools.	
References/ Readings:	1. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2015). *Essential cell biology*. Garland Science. 2. Alberts, B. (2017). *Molecular biology of the cell*. Garland science. 3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2008). T*he World of the Cell*. 7th edition. Benjamin Cummings Publishing, San Francisco.	

	4. Cooper, G.M. and Hausman, R.E. (2019). *The Cell: A Molecular Approach.* 7th edition. Oxford University Press. 5. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology.* 8th edition. Lippincott, Williams and Wilkins, Philadelphia. 6. Karp, G. (2009). *Cell and molecular biology: concepts and experiments*. John Wiley & Sons. 7. Verma, P. S., & Agarwal, V. K. (2004). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evolution and Ecology*. S. Chand Publishing.
Course Outcomes:	At the end of the course, students will be able to: 1. Describe the fundamental principles of cellular biology. 2. Understand in-depth cell structure and how it relates to cell functions. 3. Comprehend how cells grow and divide and how important cell processes are regulated. 4. Acquire practical skills in Cell biology.

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-201**
Title of the Course : **Elementary Microbiology**
Number of Credits : **04 (3T + 1P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic understanding of Biology.	
Course Objectives:	1. To acquaint students with basic concepts in microbiology – history, microbial diversity, microbial growth, and its control. 2. To provide a brief overview of the distribution & cultivation of microbes. 3. To recognize microbial interactions with the environment. 4. To impart skills in microbiology.	
Content:		**No. of Hours**
	MODULE I: Fundamentals of Microbiology History and Evolution of Microbiology, Microbial taxonomy & phylogeny, Cell structure & features of major groups of microorganisms: Bacteria, Archaea, Algae, Fungi, Protozoa and Acellular forms (Viruses, Prions, Viroids). Distribution of Microorganisms in nature and their econiches; Metabolic diversity of microorganisms based on energy, carbon, and electron donors. Microbial Interactions: Symbiosis, synergism, neutralism, commensalism, mutualism, amensalism, competition, parasitism, predation. Microbe Plant interaction: Symbiotic and non-symbiotic, introduction of biological nitrogen fixation, mycorrhizae.	**15**
	MODULE II: Cultivation and Maintenance of microorganisms Methods of isolation: Preparation, storage and types of culture media: Natural and synthetic, complex and chemically defined media, selective media, differential media, enriched and enrichment media, transport media; Purification techniques: enrichment, streaking, serial dilution and plating methods; Direct and indirect methods of enumeration: Counting Chamber, Membrane filtration technique, Flow cytometry, Coulter counters, Use of fluorescent dyes to determine viability; Methods of preservation of pure cultures in suspended and continuous metabolic state, period transfer, overlaying with mineral oil, storage in sterile soil and silica gel, drying in vacuum, lyophilization, cryopreservation, Culture collection centres / culture banks and their importance. Control of Microorganisms: physical, chemical and chemotherapeutic agents.	**15**
	MODULE III: Microbial ecology & environment	**15**

	Microbes in their natural habitats: Aquatic, Terrestrial, Atmospheric, and Extreme Environments. Ecological pyramid and role of microorganisms in food chain, biogeochemical processes - carbon, nitrogen, phosphorus. Microbial biofilms. Environmental pollutants, Bacterial indicators of water quality (coliforms and non-coliforms), Biomagnification, Eutrophication; Concept of BOD and COD. Major types of beneficial and harmful microorganisms in soil for agriculture, Microorganisms as Bio-fertilizers and bio-pesticides. Food Microbiology: Important microorganisms in food, major food borne infections and intoxications, Fermented Foods. Microbial Reproduction, Horizontal transfer of genome among the microbial community - transformation, conjugation, transduction - generalized transduction, specialized transduction –co-transduction.	
	PRACTICAL (Each practical of 2 hours) 1. Methods of isolation of bacteria from different sources (2 sessions) 2. Enumeration of microorganisms by plating techniques - total and viable count (2 sessions) 3. Morphological characterization of bacteria – Capsule and EPS staining (2 sessions) 4. Determination of Metabolic Activities of Bacteria through Biochemical Tests – IMViC test, Carbohydrate fermentation, Catalase, Nitrate reduction, Oxidase, Citrate utilization (2 sessions) 5. Morphological characterisation of actinomycetes. 6. Determination of bacterial cell size by micrometry. 7. Determination of bacterial motility (microscope and stab method. 8. Determination of coliforms using membrane filtration technique. 9. Antibiotic sensitivity assay – Disk diffusion test and well diffusion method (2 sessions). 10. Fluorescence staining	**30**
Pedagogy:	Lectures, tutorials, assignments, presentations and use of ICT tools.	
References/ Readings:	1. Ananthnarayan, R and Jeyaram Panicker, C. K. (2010) T*extbooks of Microbiology*. 17th edition. Orient Longman. 2. B.D. Singh, (2014) *Biotechnology: Expanding Horizons*. Kalyani Publishers. 3. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. (2009) *Brock Biology of Microorganisms* 12th edition, Pearson International edition, Pearson Benjamin Cummings. 4. Modi HA, *Elementary Microbiology Vol I,* (2019) *Fundamentals of Microbiology*. 5. Nelson D. Cox. M; (2107) *Lehninger Principles of Biochemistry,* 7th edition, W.H. Freeman.	

	6. Pelczar MJ, Chan ECS and Krieg NR (2002) *Microbiology.* McGraw Hill Book Company. 7. Willey, J.M., Sherwood, L.M., and C.J. Woolverton, (2021) *Prescott's Microbiology* (11th ed.). McGraw-Hill Education.
Course Outcomes:	At the end of the course, students will be able to: 1. Understand and apply the basic principles and techniques used in obtaining and preserving pure cultures of microbes. 2. Elaborate on the need and methods of microbial control. 3. Analyze the diversity of microorganisms and interpret their interaction with the environment. 4. Evaluate the role of microorganisms in disease outbreaks and emerging infectious diseases.

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT-211
Title of the Course : Biomolecules
Number of Credits : 04 (Theory)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic understanding of Biology	
Course Objectives:	1. To describe oligosaccharides and lectin interactions in biochemical processes. 2. To understand the structural organization and characterization of proteins. 3. To study the physicochemical properties and characterization of fats and oils. 4. To gain knowledge on nucleotides as energy carriers and other important functions.	
Content:		**No. of Hours**
	MODULE I Carbohydrates: Classification, Physicochemical properties; Chemistry, Biological roles and Structural elucidation of polysaccharides - homo and heteropolysaccharides, Peptidoglycans, Glycosaminoglycans; Glycoconjugates – Proteoglycans, Glycoproteins and Glycolipids; Oligosaccharides - Lectin interactions in biochemical processes.	**15**
	MODULE II Amino acids: Classification, Structure and Physicochemical properties; Peptide bond, Peptides of biological importance; Chemical synthesis of peptides – Solid phase peptide synthesis; Proteins – Classification, Isolation, Purification and Characterization of proteins, Criteria of homogeneity; Structural organization of Proteins – Ramachandran plots; Denaturation of proteins.	**15**
	MODULE III Lipids: Classification; Structure, Properties and Biological roles of Phospholipids and Sphingolipids; Fatty acids and their physicochemical properties; Fats and Waxes - Physicochemical properties and characterization of fats and oils; Structure, properties and functions of Eicosanoids - Prostaglandins, Prostacyclins, Thromboxanes, Leukotrienes; Chemistry and Properties of Sterols and Steroids – Bile acids and Bile salts; Salient features of Bacterial and Plant lipids.	**15**
	MODULE IV Nucleic acids: Bases, Nucleosides, Nucleotides; Nucleotides as Energy carriers, Enzyme cofactors and Chemical messengers; Synthetic nucleotide analogy; Chemical synthesis of oligonucleotides; Structure of DNA and different types of DNA, Supercoiled DNA; Structure of RNA and different types of RNA**.**	**15**

Pedagogy:	Lectures and tutorials, assignments, and use of ICT tools.
References/ Readings:	1. Berg, J. M., Tymoczko, J. L. and Stryer, L., (2019) *Biochemistry.* IXth Edition. W.H Freeman and Co. 2. Conn, E., & Stumpf, P., (2009) *Outlines of biochemistry*. John Wiley & Sons. 3. D. Papachristodoulou, A. Snape, W. H. Elliott, and D. C. Elliott; (2018) *Biochemistry and Molecular Biology.* Oxford University publisher. 4. D.L. Nelson & Cox. M. (2017) *Lehninger Principles of Biochemistry.* W.H. Freeman & Co. 7th edition. 5. E. E. Abali, S. D. Cline, D. S. Franklin, S. M. Viselli, (2021). Lippincott Illustrated *Reviews: Biochemistry* Wolters Kluwer publisher. 6. Mishra, S. R., (2003) *Biomolecules*. Discovery Publishing House. 7. R. . Murray, et al. (2022) Harper's llustrated Biochemistry McGraw Hill publisher. 8. R. L . Miesfeld, M. M. McEvoy, (2020) *Biochemistry*. Worldwide publisher. 9. Provost, J. J. (2005). *Principles and techniques of biochemistry and molecular biology:* Wilson, Keith, and Walker, John.
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the role of oligosaccharides and lectin interactions in biochemical processes. 2. Analyse the structure and properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins, and glycolipids. 3. Acquire knowledge of physicochemical properties and characterization of fats and oils. 4. Evaluate the role of nucleic acids in biological systems.

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT-231
Title of the Course : Emergency Response and First Aid
Number of Credits : 03 (Theory)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To understand the basics and significance of first-aid. 2. To develop knowledge and skills to provide first aid in the event of various injuries. 3. To equip the students with the management of medical emergencies with timely and proper actions.	
Content:		**No. of Hours**
	MODULE I First aid basics: Importance of first aid, first aider, laws of first aid, contents of an ideal first aid kit, dealing with an emergency. Need for First responders, Concept of golden hour. Duties and responsibilities of first responder, Professionalism ethical issues and well-being of first responder, Code of conduct, professional accountability and responsibility, misconduct Handling objections, Dealing with emotional reactions, family members and bystanders, Personal protection in each of the following situations: Hazardous materials, Rescue operations, Violent scenes, Crime scenes, Electricity, Water and ice, Exposure to blood-borne pathogens, Exposure to airborne pathogens.	**15**
	MODULE II First aid in wounds and injuries: types of wounds- small cuts and abrasions, Head injury - nose bleed First aid in poisoning: poisoning by swallowing, gases, injections, skin absorption, Animal bites, snake bites and insect stings. First aid in foreign objects entering the sense organs: foreign body in the eye, ear, nose, skin, swallowing of foreign objects. Bleeding and Soft Tissue Injuries- Difference between arterial and venous bleeding, Stopping external bleeding, Identification of Internal bleeding, Functions of dressings and bandages. Injuries to Muscles and Bones- Suspecting bony/spinal injury fractures of bones, causes and types of fractures, dislocation. Splinting –materials used, Importance of splinting.	**15**
	MODULE III First aid in burns & scalds: Types of burns, electrical burns, chemical burns, sunburn, heatstroke. First aid in drowning. Shocks- causes of shock and its first aid. Medical Emergencies- Steps in providing first aid to a patient with i. A general medical complaint- Seizures ii. Chest pain-	**15**

	Evaluate the cardiac status of the patient iii. Shortness of breath iv. Exposure to heat v. Including other medical complaints like allergy, diarrhoea, fainting, low blood sugar, stroke Emergency response: CPR, steps for performing CPR, CPR for newborns and infants, recovery position. Transportation And Disaster Preparedness- Identify patients' condition and take appropriate action to transport the patient safely. The importance of timely and proper transportation. Importance of spine protection. Preparedness and risk reduction.	
Pedagogy:	Lectures, Tutorials, Assignments, use of ICT tools, video demonstrations.	
References/ Readings:	1. Austin, M. Armstrong, V.J. Crawford, R. St. John Ambulance and St. Andrew's First Aid and British Red Cross. (2014) *First Aid Manual: The Authorised Manual*, Dorling Kindersley publishing. 2. E.M. Singletary, D.A. Zideman, et al. (2015) International Consensus on First Aid Science With Treatment Recommendations. 3. Indian Red Cross Society – Belgian Red Cross Flanders. (2014) Indian First Aid Guidelines. 4. M.F. Hazinski, J.P. Nolan, et al. (2015) International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. 5. Meenakshi Kubade, First Aid and Emergency Care, ISBN-13: 978-8195616763, Jain Publications, Jaipur (Rajasthan). 6. St. John Ambulance India – Indian Red Cross Society (2016) *Indian First Aid Manual*, 7th edition.	
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the fundamentals and importance of first aid. 2. Evaluate specific medical emergencies & responses. 3. Provide first aid in case of wounds, burns, drowning, poisoning and injuries to muscles and bones. 4. Manage general medical complaints, provide first aid and administer basic life support, including CPR.	

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-241**
Title of the Course : **Modern Agricultural Practices and Home Gardening**
Number of Credits : **03 (1T+2P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic understanding of Biology	
Course Objectives:	1. To explore different modern farming and home gardening techniques in India. 2. To learn environmentally friendly techniques for controlling pests and diseases. 3. To acquire practical skills in home gardening.	
		No. of Hours
Content:	**Module I** **Modern Agricultural Practices** Modern Farming Technology: Scope, branches and importance of modern farming technology, Greenhouse cultivation of important horticulture crops and weed management, Introduction to Protected cultivation, Importance and cultivation of medicinal and aromatic plants, Innovations - vertical gardening, sub-surface irrigation, aquaponics, hydroponics and smart farming. Micropropagation, role in urban and rural economy and employment generation.	**08**
	Home Gardening Importance and scope of gardening, fundamentals of gardening (soil preparation, manuring, environmental factors, etc.), sources of seeds, plants and garden inputs including tools and equipment, organically grown crops in Goa (solanaceous, cole, pods and beans, leafy vegetables, cucurbits), Panchagavya, Sanjivani, Beej Amrut solutions: their efficacy, application and uses. Beneficial and Effective Micro-organisms (EM) solutions, home composting.	**07**
	PRACTICAL (Each practical of 4 hours) 1. Study of plants with respect to requirement of water, light, shade, nutrients [orchids, anthurium, cacti and succulents], Preparation of pot with appropriate soil mix, manures, PSB/Rhizobium/VAM or other media. 2. Preparation of compost and vermicomposting. 3. Preparation of cocopeat. 4. Study of specific vegetable crops and fruit plants - light and water requirements, harvesting and PHT [Okra/Solanaceous crops/Cucurbits/ Banana/Mango/locally available plants] 5. Study of specific flowering plants - light and water requirements, harvesting techniques and PHT [Chrysanthemums, Roses]	**60**

	6. Preparation of Effective Microorganisms [E.M.] solutions. 7. Formulation of Panchagavya, Sanjivani, Beej Amrut. 8. Determination of Water Holding Capacity of different soils and improvement using compost/coco-peat/ clay. 9. Study shelf life in conventionally grown and organically grown fruits and vegetables/ herbs in different packaging [polythene, butter paper, brown paper, newsprint bags] and different storage conditions [ambient, refrigeration]. 10. Study shelf life in conventionally grown and organically grown flowers in different packaging [polythene, butter paper, brown paper, newsprint bags, etc] and other storage conditions [ambient, refrigeration, etc]. Extension of vase-life of flowers with additives. 11. Transect walk to evaluate and understand the role of plants; Discussion based on the observations. 12. Calculation of space required for plants - recommended spacing, design and layout for home garden. 13. Weeds: Identification and Eradication. 14. Identification of common pests and diseases. 15. Field visit to a nursery.	
Pedagogy:	Lectures, tutorials, assignments, use of ICT tools.	
References/ Readings:	1. Adams, C.R. and M. P. Early. (2004) *Principles of horticulture.* Butterworth Heinemam, Oxford University Press. 2. Braganza Miguel. (2015) *Growing Organically*. Botanical Society of Goa, Panaji-Goa. 60 3. Chadha K. L. (2008). *Handbook of Horticulture* I.C.A.R., Delhi. 4. Figueiredo , Nelson. (2000) *Integrated Pest Management.* Agriculture Officers' Association. Panaji-Goa. Pp 159 5. Kumar N. (2017) *Introduction to Horticulture*. Medtech Publishers. 6. Naidu, V.S.G.R. (2012) *Hand Book on Weed Identification*. Directorate of Weed Science Research, Jabalpur, India Pp 354. 7. Natrajan K. (2009) Panchagavya. Organic Farming Association of India, Mapusa-Goa. 8. Sengar VS, Chandra S, Kumar Deo, Singh AS, RK Doharey (2023) A textbook of modern organic farming. Bookrivers Publisher. 9. Singh Jitendra. (2018) *Fundamentals of Horticulture*. Kalyani Publishers.	
Course Outcomes:	At the end of the course, students will be able to: 1. Apply modern farming technologies to optimize crop production and address agricultural challenges. 2. Cultivate and manage a home garden effectively. 3. Understand common challenges in pest management, disease control, and weed management. 4. Apply concepts to increase the shelf life of vegetables and fruits.	

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-202**
Title of the Course : **Biochemical Processes and Metabolism**
Number of Credits : **04 (3T+1P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of biomolecules.	
Course Objectives:	1. To help students understand the physicochemical properties and biochemical role of carbohydrates, proteins, lipids, and nucleic acids. 2. To lay a strong foundation of concepts in enzyme and enzyme kinetics. 3. To provide insight into the metabolism of carbohydrates and amino acids, proteins, and lipids. 4. To develop skills in Biochemical techniques.	
Content:		**No. of Hours**
	MODULE I Introduction to Metabolism, Terminology: Catabolism, Anabolism, Amphibolic pathways, Intermediary metabolism, Types of Metabolic regulations. Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Michaelis-Menten equation. Factors affecting enzyme activity, Enzyme inhibition: Reversible and Irreversible inhibition - Competitive, Non-competitive and mixed inhibition. Feedback inhibition.	**15**
	MODULE II **Carbohydrate metabolism:** Glycogenolysis, Catabolism of glucose: Glycolysis- cellular location, sequence of reactions, products, energetics Fate of pyruvate in aerobic and anaerobic conditions. Kreb's cycle: cellular location, sequence of reactions, products, energetics, amphibolic nature. Substrate level phosphorylation, Oxidative Phosphorylation: Electron transport chain: electron carriers, redox potentials, basic chemistry (Free energy, free energy change, exergonic and endergonic reactions), sequence and location of electron carriers in the mitochondrial membrane, Q cycle. High energy compounds- ATP, Structure of ATPase (FoF1 ATPase). Mechanism of ATP synthesis. Anabolism - HMP Shunt (Synthesis of pentose phosphates) - Cellular location, sequence of reactions, oxidative and non-oxidative phases of pathway and multifunctional nature. Gluconeogenesis, Glyoxylate pathway. Glycogenesis.	**15**
	MODULE III	**15**

	Protein metabolism: Catabolism - reactions –Transamination (GOT/GPT and mechanism of transamination) Decarboxylation of His, Trp, Glu and physiological significance of the products Deamination: Oxidative (NAD, FAD, FMN-linked oxidases) & Non-oxidative – Asp, Cys, Ser Urea Cycle - Cellular location, sequence of reactions, labelling of N-atom, formation and transport of ammonia. **Lipid metabolism**: Catabolism - Knoop's experiment, Beta–oxidation of even carbon saturated fatty acids, role of carnitine, energetics from C4 to C20. Anabolism - Fatty acid biosynthesis (only Palmitic acid), fatty acyl synthetase complex. **Metabolism of nucleotides**: Degradation of purine and pyrimidine nucleotides. Recycling and biosynthesis of purines and pyrimidines.	
	PRACTICAL (Each practical of 2 hours) 1. Qualitative tests for Carbohydrates. 2. Qualitative tests for lipids. 3. Qualitative tests for proteins. 4. Estimation of reducing sugar -DNSA method. 5. Estimation of protein – Folin-Lowry's method. 6. Estimation of protein – Biuret method. 7. To study the effect of pH on the activity of salivary amylase. 8. To study the effect of temperature on the activity of salivary amylase. 9. Determination of K_m value and V_{max} value of acid phosphatase enzyme. 10. To study the effect of inhibitor (Inorganic phosphate) on acid phosphatase. 11. Estimation of blood glucose by glucose oxidase method. 12. Isolation of lecithin and cholesterol from egg yolk. 13. Determination of peroxide value of oil. 14. Separation of amino acids by paper chromatography. 15. Separation of fatty acids by TLC.	**30**
Pedagogy:	Lectures, class discussions, ICT tools, assignments, practicals.	
References/ Readings:	1. D. Papachristodoulou, A. Snape, W. H. Elliott, and D. C. Elliott. (2018) Biochemistry and Molecular Biology. Oxford University publisher. 2. D. Voet, J.G. Voet, W.P.Charlotte, (2018) *Fundamentals of Biochemistry. Life at the molecular level*. Wiley publisher. 3. D. Voet, J.G. Voet, W.P.Charlotte (2012) *Principles of Biochemistry*. Wiley publisher. 4. D.L. Nelson & Cox. M. (2017) *Lehninger Principles of Biochemistry.* W.H. Freeman & Co. 7th edition. 5. E. E. Abali, S. D. Cline, D. S. Franklin, S. M. Viselli, (2021). Lippincott Illustrated *Reviews: Biochemistry* Wolters Kluwer publisher. 6. R. Murray, et al. (2022) Harper's llustrated Biochemistry McGraw Hill publisher.	

	7. R. L. Miesfeld, M. M. McEvoy, (2020) *Biochemistry*. Worldwide publisher. 8. Provost, J. J. (2005). *Principles and techniques of biochemistry and molecular biology:* Wilson, Keith, and Walker, John. 9. L. Stryer, J. Berg, J. Tymoczko, G. Gatto. (2019) *Biochemistry* New York, Freeman publisher.
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the concepts in enzyme and enzyme kinetics. 2. Outline the importance of metabolic pathways. 3. Elaborate on the processes of anabolic and catabolic pathways of carbohydrates, proteins, lipids, and nucleic acids. 4. Perform experiments in qualitative and quantitative analysis of biomolecules, enzyme kinetics, and metabolic products.

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT- 203**
Title of the Course : **Principles of Ecology and Evolution**
Number of Credits : **04 (Theory)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic understanding of Biology and Environmental Science.	
Course Objectives:	1. To learn essential aspects of ecology, including abiotic and biotic components, their structure, and function. 2. To understand different species' interaction and their inter-relationship with the environment. 3. To ascertain ourselves with evolutionary timescale and to study the major events in evolution. 4. To gain knowledge on different theories of evolution.	
Content:		**No. of Hours**
	MODULE I: General Concepts of Ecology Definition: ecology, ecosystems, population, community; major terrestrial biomes; Liebig's Law of Minimum; Shelford's law of tolerance; ecotypes; ecoclines; acclimation; thermoregulation; concept of population and meta-population, r- and K- selection; Soil - formation, components (physical, chemical and biological) and types. Water: Importance; water table; atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological cycle.	**15**
	MODULE II: Community and Ecosystem Ecology Types of species interaction with examples: mutualism, commensalism, amensalism, protocooperation, predation, competition, parasitism, mimicry, herbivory; types of niches: fundamental and realised; Inter-specific competition - Galapagos finches. Predator-prey interactions: Functional responses of predator to prey; co-evolution – Red Queen hypothesis; primary and secondary ecological succession; climax community; Ecosystem structure and function; types of ecosystems: forest, grassland, lentic, lotic, estuarine, desert, wetlands; biotic and abiotic components of ecosystem; ecosystem connections: food chain, food web, detritus pathway; ecological efficiencies; trophic level and their interactions; concept of island biogeography.	**15**
	MODULE III: Evolutionary concepts Evolutionary time scale; eras, periods and epoch; major events in evolutionary time scale; Pre-Darwinian ideas – List of contributors influencing Darwin indicated as a timeline. Lamarckism – Merits and demerits. Darwinism – Merits and demerits, post-Darwinian era – Modern synthetic theory;	**15**

	biomathematics and the theory of population genetics leading to Neo-Darwinism; Darwin's theory of evolution: variation, adaptation, fitness and natural selection; adaptive radiation; isolating mechanisms; speciation (allopatric, sympatric, peripatric and parapatric); convergent evolution; coevolution; mosaic evolution; sexual selection.	
	MODULE IV: Chemogeny and Paleobiology Chemogeny – An overview of prebiotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. The current concept of chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid micro-spheres). Origin of photosynthesis – Evolution of oxygen and ozone buildup. Endosymbiotic theory – Evolution of Eukaryotes from Prokaryotes. Paleobiology – Concept of Stratigraphy and geological timescale; fossil study (types, formation and dating methods). Anatomical – Vestigial organs; Homologous and Analogous organs (concept of parallelism and convergence in evolution). Taxonomic – Transitional forms/evolutionary intermediates; living fossils. Phylogenetic – a) Fossil based – Phylogeny of horse as a model. b) Molecule-based – Protein model (Cytochrome c); gene model (Globin gene family).	**15**
Pedagogy:	Lectures, tutorials. Assignments and use of ICT tools.	
References/ Readings:	1. Odum, E.P. (2005). Fundamentals of Ecology. 5th edition. Cengage Learning India Pvt. Ltd., New Delhi. 2. Singh, J.S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi, India. 3. Sharma, P.D. (2010). Ecology and Environment. 8th edition. Rastogi Publication, Meerut, India. 4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth System Approach. Oxford University Press., U.S.A. 5. Kormondy, E.J. (1996). Concepts of Ecology. 4th edition. PHI Learning Pvt. Ltd., Delhi, India. 6. Campbell, M.A and Reece J.B (2011) Biology. IX Edition. Pearson, Benjamin, Cummings 7. Ridley, M (2004) Evolution III Edition Blackwell Publishing 8. Hall, B. K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers	
Course Outcomes:	At the end of this course, the students will be able to: 1. Understand the foundational concepts of ecology and identify its key components. 2. Explore the different types of species interactions and study ecosystem connections. 3. Analyse ecosystem structure and function and understand the concept of island biogeography.	

	4. Assess major events in the evolution of life on Earth and understand different underlying evolutionary processes.

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT- 204
Title of the Course : Mammalian Physiology
Number of Credits : 04 (Theory)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic understanding of Biology.	
Course Objectives:	1. To understand the metabolic activities in the mammalian body. 2. To learn the processes of digestion, respiration and blood circulation. 3. To compare the coordination between the nervous system and endocrine system. 4. To attain practical skills in Mammalian Physiology.	
Content:		**No. of Hours**
	MODULE I **Digestion:** Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Mechanical and chemical digestion of food. Enzymes and hormones actions in the digestion process [bile, Saliva, Pancreatic, gastric and intestinal juice]. **Respiration:** Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of O_2 and CO_2 in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Control of respiration. **Circulation:** Composition of blood, Plasma proteins & their role, blood cells, Haemopoiesis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heartbeat.	**15**
	MODULE II **Muscle physiology:** Types of muscles, Structure of cardiac, smooth & skeletal muscle. Threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of the mechanism of muscle contraction. **Osmoregulation:** Structure of kidney and its functional unit, modes of excretion, Ornithine cycle, Mechanism of urine formation.	**15**
	MODULE III **Nervous system:** Structure of synapse, synaptic conduction, Neurotransmitters. Mechanism of generation & propagation of nerve impulse. **Endocrine system:** Mechanism of action of hormones (insulin and steroids). Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.	**15**

	Reproduction: Anatomy of the human male reproductive system, structural and functional aspects of testis (in brief). Anatomy of the female reproductive system [in brief], estrous cycle, menstrual cycle in relation to ovarian cycle and menopause. Methods of fertility control-mechanical, chemical and surgical.	
	PRACTICAL (Each practical of 2 hours) 1. Determination of blood coagulation time. 2. Mounting of haemin crystals. 3. Quantitative estimation of blood cholesterol. 4. Detection of the presence of albumin, sugar, uric acid, ketone/ acetone bodies, chlorides, phosphates, calcium, bilirubin in urine samples. (3 sessions) 5. Permanent slides of the Transverse section of mammalian gonads. 6. Study of Transverse Sections of mammalian pituitary and thyroid glands using permanent slides. 7. Measurement of blood pressure and determination of pulse rate before and after exercising. 8. Effect of osmolarity on RBC 9. Determination of ESR and study of ECG using recorded graphs. 10. Diffusion of glucose through the chicken intestine. 11. Estimation of liver glycogen from chicken by Anthrone method. 12. Study of clinical conditions associated with hypo/hyperactive endocrine glands using photographs (Gigantism, dwarfism, acromegaly, cretinism, myxoedema, Graves', Cushion's disease) (2 sessions)	**30**
Pedagogy:	Lectures, tutorials. Assignments and use of ICT tools.	
References/ Readings:	1. Agarwal R A, Anil K Srivastava & Kaushal Kumar (2022). *Animal Physiology and Biochemistry*. S Chand Publication. 2. Guyton, A.C. & Hall, J.E. (2006). *Textbook of Medical Physiology.* XI Edition. Harcourt Asia PTE Ltd. /W.B. Saunders Company. 3. Nagabhushanam, (2008), *Textbook of Animal Physiology*, Oxford and IBH. 4. Rastogi, S.C. (2007), *Essentials of Animal Physiology*, New Age International Publishers. 5. Singh, H.R. & Neeraj Kumar (2017) *Animal Physiology and Biochemistry*, Vishal Publishing Co. 6. Tortora, G.J. & Grabowski, S. (2006). *Principles of Anatomy & Physiology.* XI Edition. John Wiley & Sons, Inc.	
Course Outcomes:	At the end of the course, students will be able to: 1. Explain the processes of digestion, respiration, and circulation in mammals. 2. Describe events of muscle contraction and overall muscle physiology in mammals.	

	3. Analyse the mechanism of working of nerve cells and the nature of endocrine glands and their secretion in mammals. 4. Develop practical skills in mammalian physiology.

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT- 205
Title of the Course : Bioentrepreneurship
Number of Credits : 02 (Theory)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To introduce concepts of entrepreneurship & business management 2. To help students recognize the opportunities of enterprises in the field of life sciences. 3. To encourage students to think independently & explore start-ups.	
Content:		**No. of Hours**
	MODULE I Introduction to entrepreneurship: Meaning, Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship. Business model canvas: Choose a location & set up for business, market your business, hire and manage staff. Establishing a Bioenterprise: Develop a business plan, Project Identification, Selection of the product, Project formulation & assessment. Raising funds: public & private, financial management. Government incentives for entrepreneurship. Legal, ethical & social obligations.	**15**
	MODULE II Industry-based learning: Setting up of diagnostic labs, Incubation centres, Eco farms- Biopesticides, Biofertilizer. Mushroom cultivation, Hydroponics, Aquaponics, Aquaculture: Mussels, Oysters, Prawns, Seaweed farming. Ayurvedic formulations. Consultation services: Clinical data management services, Bioinformatics services.	**15**
Pedagogy:	Lectures, Class discussions, Assignments, Experiential learning.	
References/ Readings:	1. Bhamare A.M, Mascarenhas R.S. (2015). Entrepreneurship Development. Vipul Prakashan, Mumbai. 2. Entrepreneurship Ideas in Action- Teacher's workbook, (2000), South-Western Educational Publishing 3. Kumar S.A, Poornima S.C, Abraham M.K, Jayshree K. (2003). Entrepreneurship Development. New Age International (P) Ltd, New Delhi. 4. Jordan, J. F. Routledge. (2014) Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press, 5. Sharma S. (2016). Entrepreneurship Development. PHI Learning Private Limited, Delhi.	

Course Outcomes:	At the end of the course, students will be able to: 1. develop a business plan related to life science projects. 2. be familiar with methodologies & regulations to start an enterprise. 3. develop independent thinking skills required to begin a business. 4. evaluate the strategies & manage finances for the business.

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT-221
Title of the Course : Plant Physiology
Number of Credits : 04 (3T+1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Biology	
Course Objectives:	1. To familiarize students with the fundamental principles and concepts of plant physiology. 2. To acquaint the students with the physiological processes underlying the role of phytohormones in plant growth, development, and adaptation. 3. To provide an overview of photoperiodism, flowering stimulus, florigen concept, vernalization, photosynthesis photorespiration and seed dormancy. 4. To promote hands-on practical skills and research skills and develop scientific thinking in the area of plant physiology.	
Content:		**No. of Hours**
	MODULE I Nutrient uptake in plants, water potential, and its components, water absorption by roots, aquaporins, the pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, and guttation. Ascent of sap– cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, and mechanism of stomatal movement. Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.	**15**
	MODULE II **Mineral Nutrition:** Essential and beneficial elements, macro and micronutrients, study methods and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, and chelating agents. **Nutrient Uptake**: Soil as a nutrient reservoir, transport of ions across the cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.	**15**
	MODULE III **Plant Growth Regulators in Growth:** Discovery, Bioassay, and Physiological Roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid. **Plant response to light:** Photoperiodism, phototropism, photomorphogenesis, skotomorphogenesis, Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction centre, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.	**15**

	PRACTICAL 1. Determination of osmotic potential of plant cell sap by plasmolytic method. 2. Determination of water potential of given tissue (potato tuber) by weight method. 3. Study of rate of transpiration using a simple conical flask method & Ganong's photometer. 4. Study of the effect of temperature and light on the rate of transpiration in excised twigs/leaf. 5. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte. (2 sessions) 6. To calculate the area of an open stoma and the percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces). 7. To study the phenomenon of seed germination (effect of light). 8. To study the effect of different concentrations of IAA on *Zea mays* coleoptile elongation (IAA Bioassay). 9. To study the induction of amylase activity in germinating wheat grains. 10. Study of Photosynthesis by Hill Reaction. 11. To study the effect of light intensity & bicarbonate concentration on O_2 evolution in photosynthesis. 12. Comparison of the rate of respiration in any two parts of a plant. 13. Rooting of plants using cutting and layering methods. 14. Study of respiration in roots.	**30**
Pedagogy:	Lectures, Practical Assignments, ICT tools.	
References/ Readings:	1. Bajracharya D. (1999). *Experiments in Plant Physiology* - A Laboratory Manual. Narosa Publishing House, New Delhi. 2. Hopkins, W.G. and Huner, A. (2008). *Introduction to Plant Physiology.* John Wiley and Sons. U.S.A. 4th edition. 3. Pandey, B. P., & Sinha, S. (2017). *Plant Physiology*. Vikas Publishing House. 4. Salisbury, F. B., & Ross, C. W. (1991). *Plant Physiology.* Wadsworth Publishing. 5. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). *Plant Physiology and Development*. Sinauer Associates Inc. USA. 6th edition. 6. V.K. Jain, (2018), *Fundamentals of plant physiology* S.Chand publications. 19th edition.	
Course Outcomes:	At the end of the course, students will be able to: 1. Describe the absorption of water and transport of water through the tracheid. 2. Differentiate various water transport processes. 3. Explain the components and mechanisms of photosynthesis. 4. Analyze the physiological role and mechanism of action of phytohormones.	

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT- 261**
Title of the Course : **Laboratory Skills and Techniques in Biotechnology**
Number of Credits : **04 (1T + 3P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Completion of Semesters I - IV of UG Biotechnology.	
Course Objectives:	1. Understand the basic concepts of bioanalytical tools and serology. 2. Familiarise with the concepts of food and plant technology. 3. To provide proficiency in basic molecular biology & cell culture techniques. 4. Acquire skills in food, plant biotechnology, and serology.	
Content:		**No. of Hours**
	MODULE I **Instrumentation:** Basic principles and working of modern analytical equipment: HPLC, FTIR, GC-MS, SEM, TEM, Soxhlet. **Serology:** Components of blood, Blood grouping, Sero-diagnostics – Introduction and types with examples. **Food Biotechnology:** Basics of Food Quality, Quality Control, Quality Assurance and Food Safety. Sensory Evaluation applies to foods. **Plant tissue culture:** Introduction to the basic principles of PTC, Callus culture, Totipotency of cells, Sterilization (physical and chemical methods), Tissue culture and crop improvement. Crop breeding techniques; polyploidy, protoplast fusion, RNA interference, transgenics and genome editing. **Fermentation:** Principle of fermentation, Types of fermentation with examples. Introduction to microorganisms involved in the fermentation process.	**15**
	PRACTICAL 1. Preparation & dilutions of solutions: Simple and serial dilutions. 2. Quantitative analysis of solutions by Calorimetry and Spectrophotometry. 3. Haemocytometer and its working. 4. Microscopic study of basic blood components (RBC, WBC, plasma) (2 sessions) 5. Antigen and Antibody precipitation. 6. Haemoglobin estimation by Sahli's haemometer. 7. DOT- ELISA 8. Estimation of blood glucose level using the GOD-POD method. 9. Estimation of blood urea level using Berthelot's method. 10. Preparation of permanent slides.	**90**

	11. Study of human pathogens/ parasites (Trypanosomes, helminths, *Entamoeba histolytica*, *Plasmodium* sp.) using permanent slides 12. Microbiological analysis of food-borne bacteria using staining technique. 13. Detection of food adulteration (chilli powder, turmeric/ dal, wheat flour, milk) (3 sessions) 14. Identification of food-borne pathogens using permanent slides. 15. Dye-reduction tests (MBRT, Resazurin) 16. Determination of Thermal death time in the given food sample. 17. Determination of Thermal death point in the given food sample. 18. Evaluating the quality of canned food. 19. Isolation of psychrophilic bacteria from frozen foods. 20. Sterilisation of plant material (leaves, buds, stems) for plant tissue culture. 21. Preparation and sterilization of Plant Tissue Culture medium. 22. Callus induction using carrot explant. 23. Callus induction using hypocotyl as explant. 24. Microscopic identification of contaminants in PTC using staining techniques. 25. Micropropagation of succulents. 26. Enzymatic isolation of protoplast from leaves. 27. Effect of biofertilizer on the growth of mung bean. 28. Estimation of DO and BOD from different water sources (2 sessions) 29. Isolation of DNA from bacteria and plant cells (2 sessions) 30. Separation of DNA by Agarose Gel electrophoresis (2 sessions) 31. Restriction digestion of DNA. 32. Blotting technique. 33. SDS-PAGE 34. Bioinformatic tools - RasMol, BLAST (2 sessions) 35. Measurement of Central tendency (Mean, Median, Mode) 36. Demonstration of HPLC, SEM, FTIR (3 sessions)	
Pedagogy:	Lectures, tutorials, practicals.	
References/ Readings:	1. Dash, Sanjaya K., Pitam Chandra, and Abhijit Kar. (2023) *Food Engineering: Principles and Practices*. CRC Press. 2. Joshi, Vinod K., and R. S. Singh, eds. (2012) *Food Biotechnology: Principles and Practices*. IK International Pvt Ltd. 3. Pagana, Kathleen Deska, and Timothy J. Pagana. (2017) *Mosby's manual of diagnostic and laboratory tests-ebook*. Elsevier Health Sciences.	

	4. Sivagamasundari, U. (2022) Concepts of Plant Tissue Culture." *Current Research and Innovations in Plant Pathology*: 57. 5. Trigiano, Robert N., and Dennis J. Gray, (2016) eds. *Plant tissue culture, development, and biotechnology*. CRC Press. 6. Turgeon, Mary Louise. (2020) *Immunology & Serology in Laboratory Medicine-E-Book*. Elsevier Health Sciences. 7. Turgeon, Mary Louise. (2015) *Linne & Ringsrud's Clinical Laboratory Science-E-Book: The Basics and Routine Techniques*. Elsevier Health Sciences.
Course Outcomes:	At the end of the course, students will be able to: 1. Understand and perform various serological tests. 2. Acquaint themselves with the concepts of food biotechnology and fermentation technology. 3. develop practical skills in serology, food technology, and plant biotechnology 4. Conduct practical work using instruments such as a microscope, LAF, spectrophotometer, and electrophoretic set-up.

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT-300
Title of the Course : Genetics
Number of Credits : 04 (3T+1P)
Effective from AY : 2025-2026

Pre-requisites for the Course:	Basic understanding of Cell Biology	
Course Objectives:	1. To learn about Mendelian genetics, their principles and gene interaction. 2. To detail the structure of chromosomes and know how changes in structure and number of chromosomes can impact gene expression, genome stability, and phenotype. 3. To provide a basic understanding of human genetics and hereditary. 4. To develop practical skills in Genetics.	
Content:		**No. of Hours**
	MODULE I Historical developments in the field of genetics. Overview of Mendelian genetics- Mendel's experimental design, monohybrid, di-hybrid and tri-hybrid crosses, Mendel's Laws of Inheritance, Law of segregation & Principle of independent assortment., test cross, back cross, Chromosomal theory of inheritance. Allelic interactions: Concept of dominance, recessive, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple alleles, iso-alleles pseudo-allele, multiple genes, essential and lethal genes, penetrance and expressivity. Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes, Hypostasis. Sex determination and sex linkage - Sex determination in Drosophila, Insects, Honeybee, Bonelia, Turtle, Birds and Man. Barr bodies, dosage compensation, genetic balance theory, sex influenced dominance, sex limited gene expression, sex linked inheritance.	**15**
	MODULE II Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, repetitive transposed sequences, repetitive multiple copy genes, non-coding DNA. Genetic organization of prokaryotic genome. Concept of euchromatin and heterochromatin. Packaging of DNA molecule into chromosomes, chromosome morphology, chromosome banding pattern, karyotype, giant chromosomes, one gene-one polypeptide hypothesis, concept of cistron, exons, introns.	**15**

	Extra chromosomal inheritance: Rules of extranuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance. Types of gene mutations, Types of chromosomal aberrations, Aneuploidy and Euploidy. spontaneous mutation and induced mutation, Types of mutagens physical, Chemical and Biological, Ames test for mutagenic agents	
	MODULE III Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. Eugenics, Pedigree construction and analysis -Inheritance pattern of sex linked, autosomal dominant and recessive traits. Evolution and population genetics- Inbreeding and outbreeding, applications and evolutionary significance. Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.	**15**
	PRACTICAL 1. Problems in Genetics through beads/seeds mixtures- Monohybrid ratios. 2. Problems in Genetics through beads / seeds mixtures- Dihybrid ratios. 3. Problems in Genetics on multiple alleles and Quantitative inheritance (multiple genes). 4. Study of ABO blood group and Rh factor in Humans. 5. Chromosome mapping using point test cross data. 6. Study of polyploidy in onion root tip by colchicine treatment. 7. Study of phenotypic characters in *Drosophila* (Body colour, Wing pattern and Eye colour). 8. Determination of sex by Barr body method. 9. Preparation of Polytene chromosome slide from *Chironomous* larva/*Drosophila* larva. 10. Study of inheritance of human traits- Brown eyes, polydactyl, Diabetes insipidus, sickle cell anaemia. 11. Karyotyping Analysis in Humans from Printed Material a. Normal male or female a. Klinefelter's Syndrome b. Turner's Syndrome c. Down's Syndrome d. Philadelphia syndrome e. Cri-du-chat (2 sessions) 12. Determination of allelic frequency of the following Mendelian Human traits: Rolling, Ear lobes, Widow's peak, clasping of hand, Thumb crossing pattern, Folding of arms, Hitch-hiker's thumb (2 sessions) 13. Pedigree charts of some common characteristics like blood group, Colour blindness, and PTC tasting.	**30**

Pedagogy:	Lectures, tutorials. Assignments, and use of ICT tools.
References/ Readings:	1. Fletcher H. and Hickey I. (2015). Genetics.IV Edition. GS, Taylor and Francis Group, New York and London 2. Gardner, E.J.,Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics.VIII Edition John Wiley &Sons. 3. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co. 4. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings 5. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings. 6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics.V Edition. John Wiley and Sons Inc. 7. Tamarin R. H. Principles of Genetics (2017) Edition 7, McGraw-Hill Higher Education.
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the principles of Mendelian genetics, gene interaction and the mechanism of sex determination in different organisms. 2. Comprehend the chromosome structure and the effect of various mutations. 3. Analyse the pattern of inheritance in the families and evaluate the role of population genetics in evolution 4. Apply genetic principles to solve genetic problems, construct pedigree, and determine allelic frequency.

Name of the Programme : B .Sc. Biotechnology
Course Code : GBT-301
Title of the Course : Bioanalytical Tools
Number of Credits : 04 (3T + 1P)
Effective from AY : 2025-2026

Pre-requisites for the Course	Basic knowledge of Cell Biology, Microbiology and Biochemistry.	
Course Objectives:	1. To understand the principle, working and applications of different types of bio-analytical tools. 2. To acquaint the students with basics of Microscopy, Chromatography & Electrophoresis. 3. To acquire practical skills in using various bio-analytical tools	
Content:		**No. of Hours**
	MODULE I **Microscopy:** Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), **Spectroscopy:** Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation: principle of centrifugation, centrifugal force and sedimentation rate, differential and density gradient centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.	**15**
	MODULE II **Chromatography:** Introduction to the principle of chromatography, types of chromatography (planar and column), paper chromatography, thin layer chromatography, column chromatography: Silica, gel filtration, affinity, ion exchange chromatography, GC and HPLC.	**15**
	MODULE III **Electrophoresis:** Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immunoelectrophoresis, isoelectric focusing, Southern Blotting, Northern Blotting and Western blotting.	**15**
	PRACTICAL 1. Column Chromatography. (2 sessions) 2. Isolation of nuclei from liver tissue using density gradient centrifugation. 3. Native gel electrophoresis of proteins. 4. Step-wise ammonium sulfate fractionation, dialysis, SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions, Determination of molecular weight of unknown protein. (4 sessions) 5. Immunoelectrophoresis.	**30**

	6. Southern Blotting (Demonstration). 7. Western Blotting (Demonstration). 8. DNA recovery from Agarose gel. 9. FT-IR (Demonstration). 10. HPLC (Demonstration). 11. Visit to an Instrumentation facility.	
Pedagogy:	Lectures, Tutorials, Assignments, Practical skill-based learning, Study tours	
References/ Readings:	1. L. Veera Kumari (2019) Bioinstrumentation, MJP Publisher. 2. Ghoshal, Sabari, Avasthi , Anupama Sharma (2018); Fundamentals of bioanalytical techniques and instrumentation. PHI learning pvt ltd. 3. Upadhyaya, A. (2009) Biophysical Chemistry, Himalaya Publishing House. 4. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley &Sons.Inc. 5. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology.8th edition. Lippincott Williams and Wilkins, Philadelphia. 6. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition.ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA. 7. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco. 8. Wilson, K. and Walker J. (2010) Principles and Techniques of Biochemistry and Molecular Biology.7th Edition. Cambridge University Press. 9. Wilson, K. and Walker J. (2000) Practical Biochemistry Principles and Techniques 5th Edition. Cambridge University Press. 10. Singh B.D., Biotechnology: Expanding horizons (2010), Kalyani publishers	
Course Outcomes:	At the end of the course, students will be able to: 1. State the principle, working of microscopy, spectroscopy, chromatographic techniques, and electrophoresis 2. Explain the instrumentation and applications of different bio-analytical tools. 3. Acquire hands-on-skills in handling various instruments. 4. Apply the specific tools to analyse and solve research problems	

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT- 302
Title of the Course : Immunology
Number of Credits : 04 (3T + 1P)
Effective from AY : 2025-26

Pre-requisites for the Course:	Basic understanding of cell biology and Biochemistry.	
Course Objectives:	1. Familiarising with concepts and different components of the immune system. 2. Understanding the molecular mechanisms involved in the immune cells. 3. Learning about the pathogen v/s host responses in fighting diseases. 4. Handling laboratory experiments in immunology.	
Content:		**No. of Hours**
	MODULE I **Introduction-** History of Immunology, Immune Response: Components of the mammalian immune system (Structure, functions & properties of cells & organs of the immune system). **Antigens:** Characteristics of antigen, Epitopes, Haptens. **Immunoglobulins:** Types and Molecular structure, Humoral & Cellular immune responses, T lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells). **Antigen-antibody Interactions:** Overview and properties of Ag-Ab interaction (Affinity, avidity, cross reactivity), Stages and factors, *In-vivo* interactions: Opsonins, Agglutinins, Precipitins, Lysins, Antitoxins, Complement fixation, neutralisation, immobilisation. Invitro interactions: ELISA, Radioimmunoassay (RIA), Western Blotting, Immuno-chromatography (ICT), Immunofluorescence.	**15**
	MODULE II **Genetic and Molecular basis-** T-cell receptors, B-Cell receptors, genome rearrangements during B-lymphocyte differentiation, Regulation of immunoglobulin gene expression – clonal selection theory, allotypes and idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line and somatic mutation).	**15**
	MODULE III **MHCs, Defense mechanisms and Vaccines-** Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing and presentation (Cytosolic & Endocytic pathways).	**15**

	Pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS. Types of Hypersensitivity. Vaccines & Vaccination – adjuvants, Types of vaccines with examples.	
	PRACTICAL (Each practical of 2 hours) 1. Preparation of blood serum. 2. Differential leucocyte count. 3. Total leucocyte count. 4. Total RBC count. 5. Total platelet count. 6. Haemagglutination inhibition assay. 7. Antibody titer using Double Immunodiffusion assay 8. Ouchterlony's Double Diffusion Test 9. Radial Immuno-diffusion. 10. Dot ELISA. 11. Rocket Immunoelectrophoresis. 12. Latex bead agglutination. 13. Counter-current Electrophoresis. 14. Rapid immune-diagnostic kit for human hormones. 15. Haemoglobin estimation by Sahli's haemometer.	**30**
Pedagogy:	Lectures, tutorials, practical, Use of ICT, activity-based learning.	
References/ Readings:	1. Ananthnarayanan, R and Jeyaram Panicker, C. K. (2010). Textbooks of Microbiology. Orient Longman. 17th edition. 2. Goldsby RA, Kindt TJ, Osborne BA.(2017) Kuby's Immunology, W.H. Freeman and Company, New York. 3. Rastogi V.B.,Genetics. (2018) S. Chand Publishers, New Delhi. 48 4. Roitt and Roitt,Essential Immunology. (2017) Wiley-Blackwell Scientific Publications, Oxford. 5. Weir D.M., (1986) Handbook of Experimental Immunology- VolI &II. Wiley Blackwell. 6. Hardeep Kaur H., Toteja R., Makhija. S., (2021) Textbook of Immunology Wiley Publisher. 7. Kannan (2021) Immunology. MJP Publishers. 8. Luttmann W., Bratke K., Kupper M., and Myrtek D (2009). Immunology. Academic Press.	
Course Outcomes:	At the end of the course, students will be able to: 1. To understand the history and fundamental principles of immunology. 2. Demonstrate the overlapping roles of innate and adaptive immunity in response to pathogens. 3. Differentiate between different components of the immune system. 4. Develop practical skills in immunology.	

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-303**
Title of the Course : **Research Methodology**
Number of Credits : **02 (Theory)**
Effective from AY : **2025-2026**

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To provide an overview of research methodology and ethics in research. 2. To acquaint the student with writing a research proposal, carrying out data collection and analysis. 3. To provide hands-on training to students for using softwares for statistical analysis and referencing. 4. To motivate students to communicate their research through various scientific communications.	
Content:		**No. of Hours**
	MODULE I **Basic concepts of research:** Good Laboratory Practices, Research definition, and types of research (Descriptive vs analytical; applied vs fundamental; Quantitative vs qualitative; conceptual vs empirical). Research methodology. Literature review, designing the objectives of research study, Library research; field research; laboratory research. Sampling Process. Characteristics and types of samples, Introduction of Biosafety and Bioethics in Research. **Data collection and documentation of observations:** Maintaining a laboratory record, Imaging of tissue specimens and application of scale bars, Geo-tagging pictures for scientific writing. Use of Statistical Software for data analysis.	**15**
	MODULE II **Scientific Writing and Presentation:** Writing a research proposal, IMRAD format of project report, Importance of communicating research, Ethical aspects in academic writing, Abbreviations, and terminology used in scientific writing. Writing references, in-text citations, using software for referencing. Oral and Poster presentation, Author information, Introduction to copyright - academic misconduct/plagiarism.	**15**
Pedagogy:	Lectures, tutorials, assignments.	
References/ Readings:	1. Alley, M., (1996) The Craft of Scientific Writing, Springer Science and Business Media. 2. Barbara Gastel and Day R.A. (2016) How to write and publish a scientific paper. Greenwood. 3. Cooray P.G. (1992). Guide to Scientific and Technical Writing. Hindagala,	

	4. Kothari, C.R. and Garg G. (2004) Research Methodology: Methods and Techniques. 5th Edition, New Age International Publishers, New Delhi. 5. Kumar, R. C., (2008) Research Methodology. APH Publ Corporation, New Delhi.
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the basic elements of scientific research. 2. Comprehend various research methods in biological sciences. 3. Plan and execute strategies and design research proposals. 4. Systematically report their research findings through various scientific communications.

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT- 321**
Title of the Course : **Biostatistics and Bioinformatics**
Number of Credits : **04 (3T+1P)**
Effective from AY : **2025-2026**

Pre-requisites for the Course:	Basic math skills & knowledge of molecular biology.	
Course Objectives:	1. To understand different types and methods of collection of data. 2. To Learn the basics of using different statistical methods. 3. To perform elementary predictions of protein structure and comparative genomic analysis through sequence alignment programmes. 4. Acquire practical knowledge to access and search the major public databases for data retrieval and facilitate the investigation of molecular biology and evolution.	
Content:		**No. of Hours**
	MODULE I Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis. Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.	**15**
	MODULE II Methods of sampling, confidence level, critical region, testing of hypothesis, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA), Correlation and Regression. Emphasis on examples from Biological Sciences.	**15**
	MODULE III Introduction and basics of Bioinformatics. The Concept of Analogy & Homology. Introduction to biological databases. Data Submission. Private and public data sources. Introduction to protein structure. Protein Data Bank (PDB) data file format and visualization of protein structure. Protein-Protein and Protein-Ligand interaction visualization. Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of Sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Multiple Sequence Alignment, Phylogenetic Analysis. Searching Databases: SRS, Entrez. Genome Annotation: Pattern and repeat finding, Gene identification tools. SNP (Single Nucleotide Polymorphism) and other mutation databases.	**15**

	PRACTICAL 1. Learning the components of Nucleotide web resources: EMBL, NCBI, GenBank and retrieval of sequences.(2 sessions) 2. To study and understand the components of Integrated search engine system: Entrez. 3. Protein sequence database: GenPept. 4. Nucleotide sequence databases: Unigene. 5. Protein web resources: Protein information resource (PIR). 6. Protein web resources: SWISSPROT. 7. Protein web resources: UniProt. 8. Protein web resources: TrEMBL. 9. Exploring Protein Data Bank (PDB). 10. Visualizing protein structures with RasMol. 11. Visualizing protein-protein and protein-ligand interaction using PyMOL. 12. Performing BLAST of query sequence and interpretation of results (BLASTn and BLASTp). 13. Alignment of sequences and determination of PAM and BLOSUM scoring matrix. 14. Multiple sequence alignment using the Clustal Omega program and construction of phylogenetic trees.	**30**
Pedagogy:	Lectures, Practical Assignments, ICT tools	
References/ Readings:	1. A. D. Baxevanis, G. D. Bader and D. S. Wishart, (2020) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins Wiley Publisher. 2. Arora P.N. and Malhan, P.K. (2006), Biostatistics. Himalaya Publishing House. 3. J. Pevsner, (2015) Bioinformatics and Functional Genomics, Wiley Blackwell Publication. 4. J. Xiong, (2007) Essential Bioinformatics, by Cambridge University Press, First edition. 5. Kothari, C. R.,(2013) Quantitative Techniques, Vikas Publishing House. 6. L. Arthur, (2019) Introduction to Bioinformatics. Oxford University Press. 7. Mahajan B.K., (2018), Methods in Biostatistics: for Medical Students and Research Worker. Jaype Brothers. 8. Rao K. Surya (2010), Biostatistics for Health and Life Sciences, Himalaya Publishing House. 9. Rastogi, V. B. (2009). Fundamentals of Biostatistics. Ane Books Pvt Ltd. 10. Samuels, JA Witmer (2016) Statistics for the Life Sciences. Prentice Hall 11. S. Ignacimuthus, (2013) Basic Bioinformatics, Alpha Science International Ltd.	
Course Outcomes:	At the end of the course, students will be able to: 1. Apply appropriate methods to classify data and employ graphical representations for data visualization.	

	2. Understand the fundamental principles of statistical methods and their application in biological sciences 3. Elaborate the sequence alignment data generated through various algorithms and its phylogenetic tree analysis. 4. Evaluate and analyze the biological sequence, protein structure, and comparative genomics through practical knowledge using bioinformatic databases and software.

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT-304
Title of the Course : Plant Tissue Culture
Number of Credits : 04 (3T+1P)
Effective from AY : 2025-2026

Pre-requisites for the Course:	Basic knowledge of Cell Biology and plant Physiology.	
Course Objectives:	1. To introduce the basic concepts of plant tissue culture, including chemicals, media, equipment, and aseptic techniques. 2. To learn how to regenerate plants using different techniques of plant tissue culture. 3. To provide an insight into the methods of *in vitro* haploid production, protoplast isolation, somatic hybridization, production of secondary metabolites, and the applications of tissue culture in plant sciences. 4. To acquire practical skills used in plant tissue culture.	
Content:		**No. of Hours**
	MODULE I History of plant tissue culture, Basic principles of plant tissue- Concept of Cellular totipotency of cells, differentiation, dedifferentiation, redifferentiation. Plant tissue culture laboratory- Design, equipment, Methodology - sterilization (physical and chemical methods), Laboratory contaminants- it's control and measures. Aseptic Techniques: Washing of Glassware, Media Sterilization, Aseptic Workstation, Precautions to maintain Aseptic Conditions. Plant tissue culture media- types, Nutritional requirements of the explants, phytohormones their *in-vitro* roles, Role of Micro and macro nutrients, Vitamins and carbon source in tissue culture, Media preparation- pH, Temperature, Solidifying agents, Slant Preparations etc. Explants- explant characteristics, types and surface sterilization. Explant selection, sterilization and inoculation. Establishment of in vitro cultures, Ideal conditions for incubation, Acclimatization.	**15**
	MODULE II Micropropagation through various explants (Leaf, Stem, Axillary bud, Tuber, Corms and Bulbils). Advantages and disadvantages of micro propagation. Callus culture, Characteristics of callus tissue; Callus subculture, maintenance, growth measurements, morphogenesis in callus culture – organogenesis, somatic embryogenesis. Cytogenic and organogenic differentiation. Cell suspension culture- Principle, isolation, growth patterns, batch and continuous culture, viability testing, applications. Meristem and shoot tip culture, bud culture, root tip culture, seed culture, Embryo culture	**15**

	Somaclonal variation- Nomenclature, methods, applications	
	MODULE III In vitro haploid production: Androgenic methods: Anther culture, Microspore culture androgenesis Significance and use of haploids, Ploidy level and chromosome doubling, diploidization, Gynogenic haploids, factors affecting gynogenesis, chromosome elimination techniques for production of haploids in cereals. Protoplast isolation- Principle, enzymes used in protoplast isolation; isolation of protoplasts (mechanical and enzymatic); checking viability; methods of protoplast culture, Protoplast development. Somatic hybridization/ protoplast fusion- Spontaneous and induced; identification and selection of hybrid protoplasts; Cybrids applications and Potential of somatic hybridization, limitations. Production of secondary metabolites using plant tissue culture. Applications of tissue culture in plant sciences: micropropagation, Gene conservation banks, forestry.	**15**
	PRACTICAL (Each practical of 2 hours) 1. Washing of glassware and its sterilization. 2. Preparation of full strength, half strength, stock solutions of nutrient medium 3. Preparation of simple growth medium (Knop's medium). 4. Preparation of Murashige & Skoog's medium 5. Sterilization and inoculation of leaf and nodal explants. 6. Callus induction using hypocotyl explant. 7. Callus induction using carrot cambial explants. 8. Regeneration of plantlets. 9. Setting up an *invitro* culture from seed embryos. 10. Setting up of single cell suspension culture and checking cell viability of cells in suspension. 11. Encapsulation of somatic/true embryos. 12. Enzymatic isolation of protoplasts from leaves. 13. Effect of hormones on callus induction. 14. Micropropagation. 15. Maintenance of cultures, Sub culturing at periodical intervals.	**30**
Pedagogy:	Lectures and tutorials. Assignments, presentations and use of ICT tools.	
References/ Readings:	1. B.D. Singh, Plant Biotechnology; (2015) Kalyani Publishers; 3rd edition. 2. Chawla H.S.; Introduction to Plant Biotechnology; (2002) CRC press, 3rd Edition. 3. Jha & Ghosh: Plant Tissue Culture; (2016) Platinum Publishers; 2nd Edition. 4. K.G.Ramawat, (2008) Plant Biotechnology; S.Chand & Company Ltd., NewDelhi,	

	5. Kalyan Kumar De: Plant Tissue Culture; (2008). New Central Book Agency; 1st edition Calcutta. 6. Kumar U; (2012) Methods in Plant Tissue Culture. Agrobios; 01 edition. 7. Prakash and Arora, (2005) Cell and Tissue Culture; 5th ed. Anmol Publications Pvt. Ltd., New Delhi. 8. S.P. Misra: Plant Tissue Culture; (2009) Ane Books Pvt.Ltd., New Delhi. 9. S.S. Purohit, (2009) Practical Plant Biotechnology,7th ed. Student Edition.
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the concepts of cellular totipotency and aseptic techniques in plant tissue culture. 2. Elaborate on the techniques of micropropagation, callus culture, cell suspension culture employed in plant tissue culture 3. Evaluate the *in vitro* methods and the applications of tissue culture in plant sciences. 4. Prepare media, inoculate, grow and maintain explants under aseptic conditions and perform micropropagation.

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT-305
Title of the Course : Animal Cell Culture
Number of Credits : 04 (Theory)
Effective from AY : 2025-2026

Prerequisites for theCourse:	Basic knowledge of Cell Biology.	
Course Objectives:	1. To learn about different requirements for animal cell culture technology 2. To understand the concept of culturing of cells. 3. To study direct and indirect methods of cell measurements. 4. To learn different applications of animal cell culture.	
Content:		**No. of Hours**
	MODULE I Introduction, history and scope of animal tissue culture, Requirements for animal cell culture technology (washing room, media preparation, sterilization room, inoculation and culture room, equipment, culture vessels for tissue culture, maintenance of aseptic conditions, contamination, types of contaminants). Growth media- Types of cell culture media (natural media, complex media, basal salt solution (BSS) and other constituents of basal media), Ingredients of media; Physicochemical properties; CO2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics, growth supplements; Fetal bovine serum; Serum free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.	**15**
	MODULE II Cell culture techniques- basic techniques (material source, isolation of cells), cell lines and maintenance (primary and established cell lines), types of culture (primary, secondary, organ culture, organotypic culture/histolytic culture), concept of monolayer and suspension culture, transformed and normal cells), Behaviour of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Cryopreservation; Common cell culture contaminants, Maintenance of stock cultures.	**15**
	MODULE III Cell growth (eukaryotic cell cycle, cell synchronization, apoptosis in cultured cells). Characterization and growth measurements of cultured cells: (Cytogenetics,	**15**

	Karyotyping, Isoenzymes, immunological tests), Direct methods (Particle counter, dye exclusion test cytotoxicity assay), Indirect method (MTT assay). Cell separation methods: Physical method of cell separation, separation based on cell size, cell density, cell surface charge, cell affinity. Separation by cytofluorometry. Animal Cell Culture: scale-up process, methods (scale up in monolayer culture and suspension culture, immobilized culture), factors affecting scale up, monitoring of scale up process.	
	MODULE IV Applications of cell culture: Engineered tissues (artificial skin, artificial cartilage), Stem cells and their application; Application of animal cell culture for in vitro testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and valuable pharmaceutical products and proteins (Factor VIII (blood clotting factor), Tissue plasminogen activator, Interferon, monoclonal antibodies, Insulin, Erythropoietin (EPO), human growth hormone).	**15**
Pedagogy:	Lectures, tutorials, assignments, use of ICT tools.	
References/ Readings:	1. Butterworth-Heinemann., (1993) *Invitro cultivation of animal cells;* Oxford publisher 2. Das H.K., (2007) Text book of Biotechnology, Wiley India, New Delhi 3. Freshney Ian., (2005) Animal Cell Biotechnology . Wiley, John & sons 4. Gupta P.K., - (2000) Elements of Biotechnology. Rastogi Publications. 5. Mathur Shivangi, (2009) Animal cell & tissue culture, , Agrobios (India), 6. Masters John., (2000) Animal cell culture- A practical approach. . Oxford publishers 7. Sudha Gangal, (2007) Principles and practice of animal tissue culture. Universities Press, India	
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the importance of maintaining sterile conditions and equipment for animal tissue culture. 2. Apply various cell culturing methods for different cell lines. 3. Identify physical cell separation methods and analyze challenges in scaling up cell culture techniques. 4. Evaluate potential applications in tissue engineering for animal cell culture.	

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT-306
Title of the Course : Molecular Biology and Genetic Engineering
Number of Credits : 04 (3T+1P)
Effective from AY : 2025-2026

Pre-requisites for the Course:	Basic knowledge in Microbiology, Genetics and Biochemistry.	
Course Objectives:	1. To understand the central dogma of molecular biology, the concept of the genome, and mechanisms of DNA replication. 2. To analyze the regulatory aspects of transcription, translation and gene expression in prokaryotes and eukaryotes. 3. To obtain the fundamental knowledge and importance of recombinant DNA (rDNA) technology. 4. To understand the basic tools, techniques and methods employed in gene cloning and gene expression strategies.	
Content:		**No. of Hours**
	MODULE I **DNA Replication-** DNA as genetic material, Replication of DNA in prokaryotes and eukaryotes: Semi conservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication. **DNA damage and repair-** causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translation synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.	**15**
	MODULE II **Transcription:** Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation. **RNA processing:** RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing. **Translation:** Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, amino acyl tRNA synthetases. Mechanism of initiation, elongation and termination of polypeptide. Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system).	**15**
	MODULE III	**15**

	Genetic engineering: Introduction to rDNA technology, Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR. Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants. DNA Sequencing by Maxam Gilbert's method, Sanger's Method, RAPD, RFLP, DNA microarray analysis. Introduction to genome editing techniques- Principles and applications of genome editing techniques. CRISPR-Cas9, site-directed mutagenesis, and other genome editing methods.	
	PRACTICAL 1. Isolation of chromosomal DNA from plant cells. 2. Isolation of chromosomal DNA from bacterial cells. 3. Quantification of isolated DNA by spectrophotometry. 4. Agarose gel electrophoresis. 5. UV survival curve for *E. coli.* 6. Preparation of Polytene chromosomes from Drosophila larva. 7. Titration of phage P1 and λ, studying plaque morphology. 8. Mutagenesis and Isolation of auxotrophic mutants (2 sessions) 9. Isolation of RNA from bacterial cells. 10. Isolation of RNA from plant cells. 11. Estimation of RNA by orcinol method. 12. Blue-white screening of recombinants. 13. Plasmid DNA isolation by alkaline lysis. 14. Restriction digestion and mapping.	**30**
Pedagogy:	Lectures, Practicals, Assignments, ICT tools.	
References/ Readings:	1. G. Karp, J. Iwasa and W. Marshall, (2016) *Karp's Cell and Molecular Biology: Concepts and Experiments*, (8 ed) Wiley Publisher. 2. J. D. Watson, T A Baker, S P Bell, A Gann, M Levine and R Losick (2014) *Molecular Biology of the Gene,* Cold Spring Harbor Laboratory Press, New York. 3. Lewin B. (2007) *Genes XI.* Jones and Bartlett Publishers. 4. M. J. Simmons and P. Snustad, (2015) *Principles of Genetics* (7 ed), Wiley Student Edition 5. M. Strickberger, (2015) *Genetics*, (3 ed) by Pearson publishers. 6. Nelson D.L. and CoxM.M. (2000) *Lehninger Principles of Biochemistry* (3rdEdition). Worth Publishers, New York, USA. 7. R. F. Weaver, (2012) *Molecular Biology* (5th ed) McGraw Hill Higher Education publisher.	

	8. Watson J.D.,Hopkins N.H.etal. (2008) *Molecular Biology of the Gene*. Garl and Publishing (Taylor & Franci Group), New York & London.
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the central dogma of molecular biology and DNA repair mechanisms. 2. Analyse the basic concepts of translation and transcription factors, gene expression regulation in prokaryotes and eukaryotes. 3. Elaborate on the techniques and vectors employed in recombinant DNA technology. 4. Apply theoretical knowledge to work experimentally with DNA and RNA from biological samples through molecular biology experiments.

Name of the Programme : B.Sc.Biotechnology
Course Code : GBT-322
Title of the Course : Food Biotechnology
Number of Credits : 04 (3T+1P)
Effective from AY : 2025-2026

Pre-requisites for the Course:	Basic knowledge of Microbiology and Biochemistry.	
Course Objectives:	1. To understand the factors in food spoilage and study the disease and s preventive measures associated with spoilt food. 2. To examine the methods used for detection of food spoilage and comprehend the concept of various preservation techniques. 3. To provide approaches in food safety and quality control in food industries. 4. To acquire practical skills in food biotechnology.	
Content:		**No. of Hours**
	MODULE I **Microbiology of food:** History of microorganisms in food, Role and significance of microorganisms in food. Intrinsic and extrinsic factors responsible for food spoilage, microorganisms involved in food spoilage: fruits, vegetables, meat eggs, bread, eggs, Milk. Food poisoning due to bacterial (Botulism) and fungal toxins (Aflatoxin). Salmonellosis and Gastroenteritis as food borne infections. Listeriosis and Scarlet fever as milk borne diseases, Grading of milk by dye reduction tests: MBRT and Resazurin.	**15**
	MODULE II **Detection of food spoilage and food preservation:** Methods to detect food spoilage: traditional approaches (SPC, Breed's count, identification of specific microorganisms by using selective and differential media) and new approaches (Use of gene probes, RDT, Bioluminescence). Preservation by: Drying (solar and mechanical drying, salting, smoking), high temperature: concept of TDP and TDT, Pasteurization (LTLT, HTST, UHT processes, phosphatase test, canning), low temperature (freezing), use of additives (acids, salts, sugars, antibiotics, Ethylene oxide, antioxidants), radiation (ionizing and non-ionizing) and other methods (Hurdle technology, Hydrostatic cooking, modified atmosphere).	**15**
	MODULE III **Food safety and quality assurance:** Definition, types of hazard-physical, chemical and biological, factors affecting Food Safety, Hazard Analysis Critical Control Point (HACCP) and its implementation. Quality Assurance: Theoretical and practical considerations, description of different systems: GAP, GMP, TQM, ISO. Indian food standards- Voluntary and Obligatory	**15**

	standards (PFA, FPO, MMPO,AGMARK etc.) Codex Alimentarius, Worldwide food safety issues. Role of FSSAI, FDA.	
	PRACTICAL (Each practical of 2 hours) 1. Quality of milk by dye reduction test (MBRT). 2. Quality of milk by dye reduction test (Resazurin). 3. Spread plate count 4. Breed's Count or DMC 5. Plating on selective media. 6. Efficiency of pasteurization: phosphatase test. 7. Determination of TDP 8. Determination of TDT. 9. Microbial examination of spoilt food on selective media. 10. MIC of sugar. 11. MIC of NaCl. 12. MIC of KMS. 13. MIC of sodium benzoate. 14. Estimation of shelf life of packaged food. 15. Field trip to a food processing/dairy industry.	**30**
Pedagogy:	Lectures, tutorials, assignments, Use of ICT tools	
References/ Readings:	1. Banwart, G; (2012) *Basic Food Microbiology*, Springer Science & Business Media 2. Bibek R; Bhunia, A; (2013) *Fundamental Food Microbiology*, CRC Press; 5th edition 3. Garg, Neelima, K. L. Garg, and Krishna G. Mukerji.(2020) *Laboratory manual of food microbiology*. IK International Pvt Ltd. 4. Jay, James M., Loessner, Martin J., Golden, David A., (2005) *Modern Food Microbiology.* 7th Edition. Springer, Business Media New York. 5. M. R. Adams, M. O. Moss, (2015) *Food Microbiology*, Royal Society of Chemistry; 1st revision of 4th New edition 6. Sivasankar B. (2009) *Food processing and preservation*, Prentice Hall of India Pvt.Ltd., New Delhi, 6th printing. 7. W.C .Frazier, D.C.Westhoff, V.M. Vanitha, (2017) *Food Microbiology.* 5th Edition. McGraw Hill Education.	
Course Outcomes:	At the end of the course, students will be able to: 1. Examine the quality of food based on the presence of microbes. 2. Use traditional and new approaches to detect food spoilage, preservation, and processing into different food products. 3. Apply the principles and methods of Quality Control and Assurance in foods. 4. Develop practical skills in qualitative and quantitative analysis of microorganisms in food, spoiled food and milk.	

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-400**
Title of the Course : **Industrial Biotechnology and Enzyme Technology**
Number of Credits : **04 (3T+1P)**
Effective from AY : **2026-2027**

Pre-requisites for the Course:	Basic understanding of Biochemistry, Microbiology	
Course Objectives:	1. To impart the basic knowledge of fermentation processes and fermentors. 2. To understand the preliminary aspects of industrial fermentation. 3. To study the interaction of substrates with enzymes, enzyme assay, and enzyme kinetics. 4. To acquire practical skills in industrial and enzyme technology.	
Content:		**No. of Hours**
	MODULE I Fermentation Equipment and its use: Definition of Fermentor/Bioreactors, Types of fermentation processes: batch, fed batch and continuous. Structure of Ideal Fermentor, Impellers and their types, Spargers and their types, Baffles, Headspace, Controls and Sensors (temperature, pH, antifoam, dissolved oxygen and carbon dioxide sensor), Types of reactors (Definition, description, diagram and uses), Stirred Tank reactors, Bubble columns, Airlift Bioreactors (internal and external loop), Fluidised bed and Packed Bed column. Steps in upstream processing, fermentation & downstream processing: Characteristics of an ideal Production media, Sterilization and contamination, Batch and continuous sterilisation, Inoculum preparation. Primary Screening- Definition and techniques: Crowded Plate, Auxanography, Enrichment, Indicator dye. Secondary Screening- Definition and features.	**15**
	MODULE II Downstream processing: Extraction & purification techniques. Detection and assay of fermentation products: Physical or chemical assay. i) Titration and gravimetric assay. ii) Turbidity analysis and cell determination. iii) Spectrophotometric assay. iv) Chromatographic partition assay, Biological Assay-Definition benefits and drawbacks. Diffusion assay, Turbidometric and growth assay, Enzymatic assay. Examples of industrially important products: Antibiotics, Ethanol, wine, Amylase, Lactic acid.	**15**
	MODULE III Immobilized Enzymes: Principles and techniques of immobilization-Physical and Chemical Techniques for Enzyme Immobilization – Adsorption, Matrix Entrapment, Encapsulation, Cross-Linking, Covalent Binding and Suitable	**15**

	Examples – Advantages and Disadvantages of immobilized enzymes. Production and purification of crude enzyme extracts from plant, animal and microbial sources. Commercial production of enzymes-amylases, proteases, cellulase, artificial enzymes, industrial applications, fermentation, enzyme modification, site directed mutagenesis. Immobilized enzymes in industrial processes. Large Scale Extraction and purification of enzymes: Extraction by chemical and physical method, isolation and purification of enzymes -Measurement and expression of enzyme activity – enzyme assays, enzyme structure-chemical modification, enzyme purification various chromatographic techniques. Industrial utilization of enzymes, food, detergents, energy, waste treatment, pharmaceuticals and medicine.	
	PRACTICAL 1. Bacterial growth curve (Batch fermentation). 2. Bacterial growth curve (Fed-batch fermentation). 3. Isolation and screening of antibiotic producers from the soil. 4. Isolation and screening of lactic acid producers from curd. 5. Production and analysis of lactic acid. 6. MIC of Streptomycin. 7. Bioassay of penicillin. 8. Production of alcohol from jaggery. 9. Estimate the alcohol by distillation and standard curve using dichromate method. 10. Estimation of total acidity and volatile acidity of Wine. 11. Extraction of Cellulase enzyme from commercially available mushrooms. 12. Partial purification of cellulase enzyme. 13. Quantitative assay of cellulase enzyme - DNSA method. 14. Immobilization of cellulase enzyme by entrapment method and determination of activity of immobilised enzyme. (2 sessions)	**30**
Pedagogy:	Lectures, Practicals, Assignments, ICT tools.	
References/ Readings:	1. A. Pandey., C.Webb., C.R. Soccol and C.Larroche (2006). *Enzyme Technology* Springer. 2. Casida LE. (1968). *Industrial Microbiology.* 1st edition. Wiley Eastern Limited. 3. Crueger W and Crueger A. (2000) *Biotechnology: A textbook of Industrial Microbiology*.2nd edition. Panima publishing Co. New Delhi. 4. Dr. S. Shanmugam, T. Sathish Kumar (2009). *Enzyme Technology,* K. International Pvt Ltd. 5. Trevor Palmer, (2001). *Enzymes Biochemistry, Biotechnology and Clinical Chemistry,* Published by Horwood Publishing Chichester, UK. 1800	

	6. K.Buchholz., V. Kasche and U. Bornscheuer Bioctalysts and Enzyme Technology WILEY-VCH (2005) 7. Principles of Biochemistry by Lehninger, Nelson and Cox (2005), W H Freeman and Company, New York, USA, 4th edition. 8. Patel AH. (2016) Industrial Microbiology. 2nd edition, Trinity Press, New Delhi. 9. S.C Prescott, C.G. Dunn, Agrobios (2009). Industrial Microbiology. 1st edition. 10. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Limited. 11. T .Devasena (2010) . Enzymology Oxford Press. 12. Wiseman, Alan. Hand Book Of Enzyme Biotechnology, 3rd Edn., Ellis Harwood (2006).
Course Outcomes:	At the end of the course, students will be able to: 1. Describe the principles underlying the design of fermenters, fermentation processes, downstream processing, and its applications. 2. Understand the general requirements of a fermentation media & process. 3. Design and sketch the purification of Enzymes. 4. Demonstrate immobilization of enzymes by entrapment methods.

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT-401
Title of the Course : Environmental Biotechnology
Number of Credits : 04 (3T + 1P)
Effective from AY : 2026-2027

Pre-requisites for the Course:	Basic knowledge of Microbiology and Biochemistry.	
Course Objectives:	1. To understand various aerobic and anaerobic processes of wastewater treatment and recent advances regarding wastewater treatment. 2. To comprehend the dye degradation and bioremediation of other organic and inorganic xenobiotic compounds in the environment. 3. To learn applications of bioplastics, biopesticides, bioreactors, bioleaching, biomining, and biosensors.	
Content:		**No. of Hours**
	MODULE I Wastewater treatment: Preliminary, Primary, secondary, and tertiary treatment. Aerobic process - activated sludge, oxidation ponds, trickling filter, towers, rotating discs, rotating drums, oxidation ditch. Anaerobic process - anaerobic digestion, anaerobic filters, up-flow anaerobic sludge blanket reactors, Centralized and Decentralized treatment process, Hybrid techniques of the wastewater treatment process, and sludge co-digestion, recent advances in wastewater treatment processes. Solid waste management.	**15**
	MODULE II Degradation of Xenobiotic compounds: Dye degradation, Organic (aliphatic and aromatic hydrocarbon, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants), and inorganic (metals, radionuclides, phosphates, nitrates). Bioremediation of xenobiotics in the environment - ecological consideration, decay behaviour, and degradative plasmids, molecular techniques in bioremediation. Recent research.	**15**
	MODULE III Applications of Biotechnology in Environment- Bioplastics, Biodiesel, Biogas, Biohydrogen, Biopesticides, bioreactors, bioleaching, biomining, biosensors, immobilized cells/enzymes in the treatment of toxic compounds, biotechniques for air pollution abatement and odour control. Construction of superbugs for bioremediation.	**15**
	PRACTICAL 1. Determination of Total Suspended Solids (TSS) of water samples. 2. Determination of Total Dissolved Solids (TDS) of water samples.	**30**

	3. Determination of Biochemical Oxygen Demand of water samples (2 sessions) 4. Determination of Chemical Oxygen Demand of water samples. 5. Testing portability of water: MPN, Coliform count (2 sessions) 6. Determination of total alkalinity of water. 7. Detection of chlorine in water. 8. Isolation of xenobiotic degrading bacteria. 9. Determination of acidity of water. 10. Determination of salinity of water. 11. Determination of nitrates in water. 12. Determination of calcium in water. 13. Determination of phosphorus in water.	
Pedagogy:	Lectures, Practicals, Assignments, and use of ICT tools.	
References/ Readings:	1. Agarwal S.K., Environmental Biotechnology. (2009). APH Publishing Corporation New Delhi. 2. Anjaneyula Y., Introduction to Environmental Science. (2005). BS publications. 3. B.D. Singh, Biotechnology. 4th ed, (2010). Kalyani Publishers. 4. Chatterji A.K., Introduction to Environmental Biotechnology. 3rd ed, (2011). Prentice Hall India Pvt. Ltd., New Delhi. 5. Indu Shekar Thakur, Environmental Biotechnology: Basic concepts and applications. (2011).1.K.International Pvt. Ltd. New Delhi. 6. Jogdand B.N., Environmental Biotechnology (IndustrialPollutionManagement) (2010), Himalaya Publishing House, Mumbai. 7. Murugesan A; G., Rajakumari C., Environmental science and Biotechnology: theory and techniques. (2006).M J P publishers, Chennai. 8. Santra S.C., Environmental Science (2011) New central book agency (P) ltd. Calcutta.	
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the various stages of wastewater treatment. 2. Differentiate between centralized and decentralized techniques of wastewater treatment. 3. Discuss bioremediation techniques for various xenobiotic compounds in the environment. 4. Develop hands-on skills in water testing methods and evaluate water quality using various parameters.	

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-402**
Title of the Course : **Forensic Science and Toxicology**
Number of Credits : **04 (3T+1P)**
Effective from AY : **2026-2027**

Pre-requisites for the Course:	Basic understanding of Molecular Biology, Genetics, Immunology and Biochemistry.	
Course Objectives:	1. To introduce the students to the history & development of forensic science in criminal investigation. 2. To familiarize the students with the basic principles and methods of forensic science, including crime scene management, evidence collection, analysis, and interpretation. 3. To expose the students to the various disciplines and branches of forensic science, such as forensic biology, chemistry, toxicology, ballistics, fingerprinting, document examination, etc. 4. To demonstrate the application of biotechnology tools and techniques in forensic science, such as DNA profiling, PCR, electrophoresis, etc.	
Content:		**No. of Hours**
	MODULE I Introduction to Forensic science- Definition of Forensic Science. Courts in India and their powers: Supreme Court, High Court, Sessions Court, Additional Sessions Court, Magistrate's Courts. Court procedures: Summons, conduct money, oath, affirmation, perjury, types of witnesses, recording of evidence, conduct of doctor in witness box. Medical certification and medico-legal reports including dying declaration. Death: Definition, types; somatic, cellular and brain-death, Sudden natural and unnatural deaths, Suspended animation. Forensic pathology. Changes after death: Immediate changes, cooling of body, lividity, rigor mortis, cadaveric spasm, cold stiffening and heat stiffening, Putrefaction, mummification, adipocere and maceration. Postmortem artifacts. Inquest: Inquest by police, magistrate. Identification: Definition, Identification of unknown person, dead bodies and remains of a person by age, sex, stature, dental examination, scars, moles, tattoos, dactylography, DNA typing and personal belongings including photographs. Exhumation.	**15**
	MODULE II Medico-legal autopsies- Definitions of medico-legal and clinical/pathological autopsies. Objectives, procedures, formalities of medico-legal autopsies. Preservation of articles of importance, during autopsy. Preservation of body fluids & viscera in suspected poisoning.	**15**

	Types of injuries and Modes of death. Definition, classification of mechanical injuries; description of blunt force, sharp force and firearm injuries. Medico-legal aspects of injuries, differences between antemortem and post-mortem injuries, estimation of age of different types of injuries, suicidal/accidental/homicidal injuries; causes of death by mechanical injuries. Identification of injuries by torture. Regional injuries: Injuries to Head, Neck, Thorax, Abdomen, Pelvis, Genitalia, Vertebral column and Bones. Injuries due to physical agents and their medico-legal importance; cold, heat, electricity and lightning, explosions and radioactive substances. Asphyxial deaths: Definition, causes, types, post-mortem appearances and medico-legal significance of hanging, strangulation, suffocation and drowning.	
	MODULE III Introduction to Toxicology- General aspects of poisoning: Principles of general toxicology. Duties of doctor in cases of poisoning, medico-legal autopsy in poisoning, preservation and dispatch of viscera for chemical analysis. Role of Forensic Science Laboratory in brief. Types of poisons, diagnosis, principles of therapy and medico-legal aspects of: a) Corrosive poisons: strong mineral acids and organic acids. b) Metallic poisons: Lead, Arsenic, Mercury and Copper. c) Animal poisons: Snake and scorpion bites. d) Deliriants: Dhatura, Cannabis and Cocaine. e) Somniferous agents: Opium Morphine and other opiods. f) Inebriants: Methyl and ethyl alcohol. g) Asphyxiant poisons: Carbon monoxide, Carbon dioxide, Methane and cyanides. Poisoning - Cardiac poisons: Cerbera thevetia and Nerium odorum. Cerbera odollam. Miscellaneous: Aspirin, paracetamol, barbiturates, diazepam, antihistaminics, antidepressants and kerosene oil; Insecticides: Organophosphorus compounds, Carbamates and Organochloro compounds, Aluminum phosphide. Food poisoning. Drug abuse and dependence**.**	**15**
	PRACTICAL 1. Search methods for the Identification of physical evidence. 2. Documentation of a crime scene by photography, sketching and field notes. 3. Simulation of a crime scene for training. 4. To lift footprints from crime scenes. 5. Case studies to depict different types of injuries and death. 6. Separation of nitro compounds (explosives) and ink samples by thin-layer chromatography (2). 7. Lift fingerprints by dusting method and develop fingerprints by Iodine crystals.	**30**

	8. Morphological Examination of Human Hair, Animal hair & Fibres. 9. Serological Test- Blood analysis from the crime scene. 10. Identification tests from bodily fluids - 11. TLC of insecticide/ drug. 12. Detection of alcohol in blood. 13. Visit the cyber-crime cell for E-Mail Investigation, E-Mail Recovery, and Recovering deleted evidence. 14. Visit to a Forensic Science Laboratory.	
Pedagogy:	Lectures, tutorials, Use of ICT tools, activity-based learning.	
References/ Readings:	1. V.V. Pillay, (2014). *Text book of Forensic Medicine and Toxicology*, 15th Edition, Paras Medical Publishing, Hyderabad. 2. R. Basu, (2019) *Fundamentals of Forensic Medicine and Toxicology,* 4th edition. Publishers Books and Allied (P) Ltd, Kolkata. 3. P.V. Guharaj, (2003), Guharaj Forensic Medicine, 2nd Edition Edited by M.R. Chandran, Orient Longman, Hyderabad. 4. Knight's Forensic Pathology, 3rd Edition, Edited by Pekka Saukko and Bernard Knight, Arnold Publication, London, Co-published by Oxford Publications, USA.	
Course Outcomes:	At the end of the course, students will be able to: 1. Explain the significance of Forensic Sciences to the Criminal Justice System. 2. Understand the Importance of biological evidence encountered in crime scene investigation. 3. Emphasise the investigation techniques, requirements, and analysis of digital evidence in solving crime scenes. 4. Develop basic skills needed for crime scene investigation.	

Name of the Programme : B.Sc. Biotechnology
Course code : GBT-403
Title of the Course : Biotechnology in Healthcare
Number of Credits : 04 (Theory)
Effective from AY : 2026-2027

Pre-requisites of the course:	Basic knowledge of Microbiology, Genetics & Immunology	
Course Objectives:	1. To familiarise the students with red Biotechnology, host-pathogen interactions and ethical considerations in biotechnology. 2. To understand prenatal diagnosis and applications of genetic engineering. 3. To imbibe therapeutic approaches and the applications of genomics in personalized medicine. 4. To understand different clinical guidelines under clinical research studies.	
Content:		**No. of Hours**
	MODULE I Red Biotechnology; Role of Biotechnology in Healthcare; Status of the worldwide market; Normal microflora of the human body and its importance, normal microflora of skin, throat, gastrointestinal tract, Genito-urinary tract; medical and ethical issues in biotechnology. Epidemiology: theory, modelling tools, rates and risks, Epidemiological statistics relating exposure and disease; healthcare and ethical issues in Biotechnology.	**15**
	MODULE II **Techniques for diagnosing human disorders-** Prenatal diagnosis - Invasive techniques – Amniocentesis, Chorionic Villi Sampling (CVS); Non-invasive techniques – Ultrasonography; *in situ* hybridization DNA/RNA based diagnosis for HBV, HIV; Use of genetic engineering- in production of human insulin, growth hormones, factor VIII, plasminogen active protein, interferon and cytokines; therapeutic antibodies; phage therapy.	**15**
	MODULE III **Therapeutic approaches in treating human diseases-** Gene therapy – *ex vivo* and *in vivo* gene therapy; somatic and germline gene therapy; Strategies of gene therapy: gene augmentation – ADA deficiency; Cystic Fibrosis & Familial hypercholesterolemia; gene therapy for HIV; Encapsulation technology and therapeutics-Diabetes; DNA-based vaccines (peptide, minicells, attenuated, rDNA), subunit vaccines, vector vaccines; Basic concept of Nutrigenomics and Pharmacogenomics; Application of Nanobiotechnology in medicine.	**15**

	MODULE IV **Introduction to clinical research-** History & background of origin of clinical research; Drug development process: Preclinical trial, Human Pharmacology (Phase-I), Therapeutic Exploratory trail (Phase-II), Therapeutic Confirmatory Trial (Phase-III) and Post marketing surveillance (Phase-IV). Guidelines in Clinical Research-International Conference on Harmonization (ICH), Guidelines for Good Clinical Practice, ICMR guidelines for Biomedical Research on Human Subjects, Regulation in Clinical Research- Drug and cosmetic act, FDA, Schedule-Y- Ethics Committee. Other Regulatory authorities- EMEA, MHRA, PhRMA. Concept of Clinical Trial Management.	**15**
Pedagogy:	Lectures, tutorials, assignments, Use of ICT tools	
References/ Readings:	1. Meinert, C. L; (2012), C*linical Trials Handbook: Design and Conduct*, Publisher Wiley 2. Friedman, LM; Furberg, CD; Demets, DL; (2015). *Fundamentals of clinical trials*, ISBN 978-1- 4419-1585-6, Publisher Springer. 3. Strachen T. and A P Read, (2018). *Human Molecular Genetics*, Garland Science. 4. Kanungo R. (2022); *Ananthanarayan and Paniker's Textbook of Microbiology.* University Press. 5. S.N. Jogdand; (2008), *Medical Biotechnology* Himalaya Publishing House. 6. Nallari, P; V. Venugopal-Rao (2010), *Medical Biotechnology;* Oxford Press 7. Riedel, S., Hobden, J.A., Miller, S., Morse, S.A., Mietzner, T.A. et al. (2019). *Jawetz, Melnick, & Adelberg's Medical Microbiology,* McGrawHill Education. 8. Struthers, J.K. and Westran, R.P., (2003) *Clinical Bacteriology*. CRC Press.	
Course Outcomes:	At the end of the course, students will be able to: 1. Identify and understand the basic concepts and principles used in healthcare biotechnology. 2. Apply various diagnostics techniques involved in diagnosing human disorders. 3. Categorize and evaluate different therapeutic approaches in the treatment of disorders 4. Discuss various clinical guidelines under clinical research.	

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-411**
Title of the Course : **Developmental Biology**
Number of Credits : **04 (Theory)**
Effective from AY : **2026-2027**

Pre-requisites for the Course:	Knowledge of cell biology and genetics.	
Course Objectives:	1. To introduce the students to the origin, basic concepts and principles of developmental biology. 2. To provide an outline of the early embryonic development of vertebrates and invertebrates. 3. To gain an insight on the metamorphosis and organogenesis in plant and animal model organisms. 4. To learn about postembryonic development and highlight the medical implications of developmental biology.	
Content:		**No. of Hours**
	MODULE I History and basic concepts: the origin of developmental biology- cell theory, mosaic and regulative development, discovery of induction, genetics and development; Principles of Developmental Biology- Potency, commitment, specification, induction, competence. Determination and differentiation; morphogenetic gradient, cell fate and cell lineages. Epigenetic regulation of developmentally relevant genes. Cell to cell communication during early development. Signal transduction cascades; Fibroblast growth factor and the RTK pathway; the Hedgehog family; the Wnt family; the TGF-β superfamily. Juxtracrine signalling; the Notch pathway; cross-talk between pathways.	**15**
	MODULE II Early embryonic development of vertebrates and invertebrates: structure and production of the gametes– the sperm, the egg; cell surface molecules in sperm-egg recognition, zygote formation cleavage blastula formation, embryonic fields and gastrulation; neural tube formation, cell migration, axes and germ layers. Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis.*	**15**
	MODULE III Metamorphosis and organogenesis in animal model organisms- *Drosophila:* Axis specification; origin of anterior posterior and dorsal- ventral patterning- role of maternal genes, patterning of early embryo by zygotic genes; segmentation genes- the gap genes, the pair– rule genes, the segment polarity genes, the	**15**

	homeotic selector genes- bithorax and antennapedia complex, HOX gene and their regulation. developmental mutations in Drosophila. *Caenorhabditis elegans*: Early development and vulva formation. *Xenopus:* Organizer formation, mesoderm specification. *Zebra fish:* Cell movement and signal during early development, Patterning, polarity and regionalization of nervous system. Development of chick limb- development and patterning of vertebrate limb, proximal- distal and dorso- ventral axis formation, homeobox genes in patterning, signalling in patterning of the limb.	
	MODULE IV Postembryonic development: growth- cell proliferation, growth hormones; aging- genes involved in alteration in timing of senescence; regeneration– epimorphic regeneration of reptile (salamander) limb, requirement of nerves for the proliferation of blastema cells. Medical implications of developmental biology: genetic errors of human development- inborn errors of nuclear RNA processing, inborn errors of translation; teratogenesis- environmental assaults on human development- teratogenic agents like alcohol, retinoic acid etc.	**15**
Pedagogy:	Lectures and tutorials. Assignments, seminar and use of ICT tools.	
References/ Readings:	1. J. M. W. Slack, (2009). Essential Developmental Biology. Germany: Wiley, Kalthoff, Analysis of Biological Development, McGraw-Hill Science, New Delhi, India. 2. L. Wolpert, (2011) Developmental Biology: A Very Short Introduction. OUP Oxford. 3. M. A. Subramanian, (2022). Developmental Biology. India: MJP Publisher. 4. S. F. Gilbert, (2010) Developmental biology. Sinauer Associates, Inc.	
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the molecular and cellular mechanisms that underlie the development of organisms. 2. Describe the main anatomical changes that occur during early developmental stages in vertebrates and invertebrates. 3. Identify the cellular behaviors that lead to morphological change during development in plant and animal systems. 4. Evaluate how errors in development lead to congenital defects.	

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT-404
Title of the Course : Pharmaceutical Biotechnology
Number of Credits : 04 (3T+1P)
Effective from AY : 2026-2027

Pre-requisites for the Course:	Basic knowledge of Biochemistry.	
Course Objectives:	1. To understand the scope, current status and future prospects of pharmaceutical biotechnology. 2. To learn about the process of extraction, screening and analysis of phytochemicals. 3. To provide an insight on the drug development and approval process. 4. To develop practical skills in the extraction and screening of pharmaceutically important products.	
Content:		**No. of Hours**
	MODULE I History of the pharmaceutical industry. Introduction to pharmaceutical products. Discovery of Biopharmaceuticals. Scope, current status and future prospects of Pharmaceutical Biotechnology. Sources of Biopharmaceuticals- microbial cells, plant cells and mammalian cell lines. Drug development process- Drug discovery, initial characterization, Delivery of biopharmaceuticals-oral, pulmonary, nasal, transmucosal and transdermal delivery systems. Economic and legal considerations in Pharmaceutical Biotechnology.	**15**
	MODULE II Biopharmaceutic considerations in drug product design and performance: Introduction, biopharmaceutic factors affecting drug bioavailability, physicochemical nature of the drug formulation, Factors affecting drug product performance, considerations in the design of a drug product. Bioavailability and Bioequivalence: purpose of bioavailability studies, relative and absolute availability. Methods for assessing bioavailability, bioequivalence studies, Clinical significance of bioequivalence studies, special concerns in bioavailability and bioequivalence studies. Proteins based drugs (Sources, Structure, Folding and Stability); Therapeutic Proteins, Pharmacokinetics and Pharmacodynamics of peptides and protein.	**15**
	MODULE III Extraction of phytochemicals, Phytochemical screening of medicinal plants. Bioassay guided fractionation methods-TLC,	**15**

	HPTLC, GC, and HPLC, Role of NMR and Mass spectrometry in drug discovery. Antibiotics -source, classification, mode of action, antimicrobial activity studies (antibacterial, antiviral, antifungal and antiparasitic activity), Antimicrobial resistance. Pharmacological Assays - *In-vitro* assays - chemical (anti-oxidant), Biological (anti-cancerous and assay system based on enzymes and cells), and immunological - *In vivo* assays (Anti-inflammatory and Anti-analgesic).	
	PRACTICAL 1. Extraction of phytochemicals from medicinal plants - Tulsi, Neem, Amla, Ginger, Aloe vera, Garlic. (6 sessions) 2. Qualitative phytochemical screening of the crude extracts for secondary metabolites. (2 sessions) 3. Determination of total phenolic content in the crude extracts. 4. Determination of antioxidant activity in the crude extracts. 5. Separation of medicinal plant extracts by Thin Layer Chromatography. (2 sessions) 6. Evaluation of the antibacterial activity of the phytochemical extracts by plate assay. (2 sessions) 7. Field trip to the pharmaceutical industry.	**30**
Pedagogy:	Lectures, tutorials., Assignments and use of ICT tools.	
References/ Readings:	1. Crommelin J. A., Robert, S.D. (2013) Pharmaceutical Biotechnology: Fundamentals and Applications, 4th edition, CRC Press. 2. Walsh, G; (2003) Biopharmaceuticals, Wiley John & Sons, Inc., 2nd edition. 3. Walsh, G. (2007) Pharmaceutical Biotechnology: Concepts and Applications, Wiley John & Sons, Inc., 1st edition 4. Satoskar R.S, Nirmala N. Rege, and Bhandarkar S. D, (2017) Pharmacology and Pharmacotherapeutics (Revised 23rd Edition), Popular Prakashan, Mumbai. 5. Shoba rani R Hiremath, (2011). Text book of industrial pharmacy, 1st edition, Orient Longman Pvt ltd. 6. Tripathy K. D, (2018). Essentials of Medical Pharmacology (6th edition), Jaypee publishers.	
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the basics and scope of pharmaceutical biotechnology. 2. Describe the types of pharmacological agents and their process of extraction, screening, and analysis. 3. Evaluate the drug development and approval process. 4. Demonstrate practical skills in the extraction and screening of phytochemical extracts.	

Name of the Programme : **B.Sc. Biotechnology**
Course Code : **GBT-405**
Title of the Course : **Agricultural Biotechnology**
Number of Credits : **04 (3T + 1P)**
Effective from AY : **2026-27**

Pre-requisites for the Course:	Basic knowledge of Plant physiology, Microbiology and Genetic engineering.	
Course Objectives:	1. To learn the physicochemical properties of the soil. 2. To understand the plant-microbe interactions in the soil in improving crop productivity 3. To familiarise the students with different genetic engineering techniques used for crop improvement. 4. To attain practical skills in agriculture biotechnology.	
Content:		**No. of Hours**
	MODULE I **Soil characteristics**- Types of soil, horizons, soil profile, Physico-Chemical (abiotic and biotic) characteristics; Organic matter decomposition – humus formation (humic and fulvic acids); Rhizosphere and endophytic microflora and their role; R:S ratio (Rhizosphere and bulk soil ratio), microbivory, Microbial associations in phytosphere: rhizosphere – phyllosphere and rhizoplane – spermosphere; Degradation of cellulose, hemicelluloses, lignin and pectin in soils.	**15**
	MODULE II **Plant-microbe interactions-** Beneficial interactions: *Rhizobium* (Nitrogenase, Nodulation, Hydrogenase); *Azolla*; *Frankia* (infection process, nodulation); Mycorrhiza (Types-ecto/endo, mechanism of symbiosis, VAM); biochemistry and genetics of nitrogen fixation; plant growth promoting bacteria as biofertilizers (direct and indirect mechanisms); Biopesticides. Harmful interactions: common plant pathogens, pathogenesis, symptoms and plant defense response (phytoalexins, anatomical changes and biochemical synthesis of toxins, alkaloids and other biocontrol molecules).	**15**

	MODULE III **Methods in crop management-** Steps in mass production of bacterial biofertilizers, quality guidelines for biofertilizers; methods of preparation and application- liquid and carrier based, mass production of blue green algae, *Azolla* and mycorrhiza. Achievements and current trends in improvement of cereals, vegetable crops, oil yielding plants and forest trees, Micropropagation of ornamental plants and orchids. Genetic engineering through Agrobacterium based vectors (disarmed Ti plasmids) - Cointegrate and Binary vectors. Transgenic plants for biotic and abiotic stress resistance, *In vitro* induced mutagenesis; role of antisense and RNAi in crop improvement; Genetically modified crops- definition, advantages, social and environmental aspects, Bt crops, Golden rice, salinity tolerance, cold temperature; Molecular pharming; Production of edible vaccines and other therapeutics; Integrated pest management, post-harvest management.	**15**
	PRACTICAL (Each practical of 2 hours) 1. Determination of soil organic carbon (Walkey's and Black's rapid titration method). 2. Isolation of microflora from different types of soil. 3. Detection of microbial enzymes – lipase, catalase, urease from various soils (sandy soil/garden soil). 4. Isolation of plant growth promoting bacteria from rhizosphere. 5. Isolation of mycorrhiza from rhizosphere soil samples. 6. Isolation & screening for phosphate solubilising bacteria using Pikovskaya's agar. 7. Screening for IAA production and Potassium mobilisation. 8. Checking for siderophore activity 9. Evaluation of seed vigour. 10. Seed priming & hardening. 11. Biofertilizer formulation. 12. Effect of biofertilizer on Mung beans. 13. Preparation of Neem based biopesticide. 14. Preparation of Citrus enzyme-based biopesticide. 15. Field visit to ICAR/ Ecofarm.	**30**
Pedagogy:	Lectures, tutorials, assignments, use of ICT tools.	
References/ Readings:	1. Altman A (1997) Agriculture Biotechnology, Marcel decker Inc. CRC Press. 2. B D Singh, (2016), Biotechnology, Kalyani Publishers. 3. Kumar, H. D., (2004) Modern Concepts of Microbiology, Vikas Publishing House Pvt. Ltd.	

	4. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H. and Stahl, D. A., (2017) Brock Biology of Microorganisms, Pearson Education Limited. 5. Mahendra K. Rai (2006) Hand Book of Microbial Biofertilizers,; The Haworth Press, Inc.New York. 6. Subba Rao, N.S., (2017) Biofertilizers in Agriculture and Forestry, International Science Publishers.
Course Outcomes:	1. Understand the physico-chemical properties and microbiome of the soil. 2. Discuss beneficial and harmful plant-microbe interactions in the soil. 3. Identify various mass production techniques in the formulation of biofertilizer. 4. Evaluate various genetic improvement techniques for crop productivity.

Name of the Programme : B.Sc. Biotechnology
Course Code : GBT- 406
Title of the Course : Nanobiotechnology
Number of Credits : 04 (3T+1P)
Effective from AY : 2026-27

Pre-requisites for the Course:	Basic knowledge of chemistry and biology.	
Course Objectives:	1. To understand the basic concepts and principles of the field of nanobiotechnology. 2. To learn the preparation and characterizations of the nanoparticles. 3. To explain various types of nanostructures. 4. To provide a scientific understanding of the application of nanomaterials and nanotechnology.	
Content:		**No. of Hours**
	MODULE I Functional Principles of Nanobiotechnology- Information - Driven Nanoassembly, Energetic and Chemical Transformation, Regulation- Traffic Across Membranes, Biomolecular Sensing, Self-Replication, Machine-Phase Nanobiotechnology, Self-assembling nanostructures- Self-Assembled Artificial Transmembrane Ion Channels-types, Methods, Self-Assembling Nanostructures from Coiled-Coil Peptides, Synthesis and Assembly using Bio-Derived Templates- Self-Assembling for Patterned Molecular Assembly.	**15**
	MODULE II Peptide and DNA-based Nanostructures- S-layers-Chemistry and structure, Assembly, recrystalisation, diagnosis- Engineered Nanopores- Methods of production, Supported bilayers and membrane arrays, Genetic Approaches, Microbial nanoparticles production- Magnetosomes, Bacteriorhodopsins, Nanoproteomics, DNA-based Nanostructures- DNA-protein nanostructures, Methods- Self-assembled DNA nanotubes — Nucleic acid Nanoparticles, DNA as a Biomolecular template-DNA branching-Metallization-Properties.	**15**
	MODULE III Pharmaceutically important nanomaterials - Drug Nanoparticles- Structure and Preparation, Liposomes, Cubosomes and Hexosomes, Lipid-based Nanoparticles, nanoparticles for drug delivery- concepts, optimization of nanoparticle properties for suitability of administration through various delivery routes, advantages. Nanoparticles for diagnostics and imaging; concepts of smart stimuli-responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.	**15**

	Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment. Fate of nanomaterials in different strata of the environment; Ecotoxicity models and assays; Life cycle assessment, containment.	
	PRACTICAL 1. Preparation of nanoparticles from Plant extract (Organic and aqueous), Crushing, grinding, maceration, homogenization, Filtration, Centrifugation, cold percolation extraction, hot extraction, using Soxhlet apparatus (4 sessions). 2. Preparation of metal nanoparticles using marine bacteria/fungi/plankton (2 sessions). 3. Synthesis of Ag nanoparticles using silver nitrate. 4. Characterization of metal nanoparticles using UV spectroscopy, XRD, FTIR (3 sessions) 5. Determination of colloidal Ag nanoparticle density using a specific gravity bottle (5 ml). 6. Measurements of conductivity of KCl solution at different concentrations. 7. Biological activity of nanoparticles – antimicrobial assay (2 sessions). 8. Antioxidant activity of the synthesized nanoparticles.	**30**
Pedagogy:	Lectures, tutorials, Assignments, Use of ICT tools	
References/ Readings:	1. Nicolini, C; (2009). Nanobiotechnology & Nanobiosciences Pan Stanford Publishing Pvt. Ltd. 2. C.M. Niemeyer and C.A. Mirkin, (2004) Nanobiotechnology, Concepts, Applications and perspectives, WILEY-VCH, Verlag Gmb H & Co. 3. S. D. Goodsell, (2004) Bionanotechnology, Lessons from Nature, Wiley-Liss, Inc. 4. Melgardt M.deVilliers, Pornanong Aramwit, Glen S.Kwon, (2009) Nanotechnology in Drug Delivery, Springer-American Association of Pharmaceutical Scientists Press. 5. Robert A. Freitas Jr. (2009) Nanomedicine, Volume I: Basic Capabilities, Landes Bioscience.	
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the basics of Nanoscience and differentiate between Nanomaterials and bulk materials. 2. Explain the concepts in Nanobiotechnology. 3. Critically analyze the applications of nanobiotechnology. 4. Learn the synthesis and characterization of the nanoparticles.	

Name of the Programme: Biotechnology
Course Code: GBT-407
Title of the Course: Stem Cell Biology and Tissue Engineering
Number of Credits: 04 (Theory)
Effective from AY: 2026-2027

Pre-requisites for the Course:	Knowledge of cell biology.	
Course Objectives:	1. To learn types of stem cells, their characterization of stem cells 2. To highlight the role of stem cells in regenerative process 3. To impart knowledge on the basics of tissue engineering, the interaction between cells, matrix and biomolecules 4. To comprehend the potential of development of tissue engineering strategies.	
Content:		**No. of Hours**
	MODULE I The biology of stem cells: Overview; different types of stem cells- embryonic Stem cells, fetal tissue stem cells, adult stem cells; nuclear transfer of stem cells. Stem Cells in Extraembryonic Lineages; Amniotic fluid derived Pluripotent Cells; Cord Blood Stem Cells; Hematopoietic Stem Cells; Multipotent Adult Progenitor Cells; Mesenchymal Stem. Generation of Induced Pluripotent Stem Cells; Characteristics of Pluripotent Stem Cells. Stem Cell Niches; Mechanisms of Stem Cell Self-Renewal.	**15**
	MODULE II Introduction to stem cell therapy; Optimal tissue sources of mesenchymal stem cells (MSC) for clinical applications; Clinical applications of stem cell therapy; in skin burns and ulcers neurodegenerative diseases- (Parkinson's disease, Alzheimers), spinal cord injury, diabetes, cardiomyopathy, muscular dystrophy. bone and tendon associated diseases, kidney failure, liver failure, hemophilia, lymphoma and leukemic malignancies requiring stem cell therapy. Ethics of human stem cells research.	**15**
	MODULE III Tissue Engineering- History, scope, challenges, Stem cells as building blocks. Dynamics of cell-ECM interactions, matrix molecules and their ligands, morphogenesis and tissue engineering; gene expression, cell determination and differentiation. Tissue development in vitro and *in vivo: In vitro* culture parameters used in tissue engineering. Biomaterials in Tissue engineering: Cell interaction with polymers; Matrix effects; Polymer scaffold fabrications; Biodegradable polymers; 3 D scaffolds; mechanical properties of biomaterials (tensile, shear, bending and time-dependent properties).	**15**

	MODULE IV Biomimetic devices and Organ Transplant. Bioartificial Tissue Construction: Types of Bioartificial Tissue Construction, Challenges. Tissue Engineering of Epidermal Structures- Repairing of Skin wounds and Burns: Acute wounds, Chronic wounds. Transplants to Regenerate the Cornea. Bioartificial Pancreas. Bioartificial Muscle, Articular Cartilage. Bioartificial blood Vessels. Transplantation, Biocompatibility and immune rejection: biomaterial/graft compatibility, host acceptance and rejection. Significance of acellular grafts in regeneration. Immunosuppressive therapy. Regulatory process from concept to market; Business Issues; Ethical Issues.	**15**
Pedagogy:	Lectures and tutorials. Assignments and use of ICT tools.	
References/ Readings:	1. A.D. Hoffman, (2006), *Stem Cell Transplantation*, Biology Process Therapy, Willy VCH. 2. J. Collins, (2017) Stem cells: From basic to advanced principles, Hayle Medical. 3. R. Lanza, (2013) Essential of Stem cell Biology, Elsevier publisher. 4. R. Lanza, (2014) Principle of Tissue Engineering, 4th Edition, AP publisher. 5. Ravi Birla, (2014) Introduction to Tissue Engineering: Applications and Challenges (IEEE Press Series on Biomedical Engineering) John Wiley & Sons, Inc.	
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the basics of stem cells and stem cell research. 2. Evaluate the role of stem cell therapy in the elevation of diseases. 3. Understand the concepts of engineering of cells. 4. Apply the basic principles of tissue engineering to develop strategies.	

Name of the Programme : B.Sc. Biotechnology
Course code : GBT-412
Title of the Course : Cancer Biology
Number of Credits : 04 (Theory)
Effective from AY : 2026-2027

Pre-requisites for the Course:	Basic knowledge of cell biology and biochemistry.	
Course Objectives:	1. To introduce the concepts of cancer initiation, progression, metastasis and therapy. 2. To understand the etiology of cancer and its interaction with the host. 3. To familiarise the students with mechanisms and concepts of molecular mechanisms. 4. To establish basic understanding regarding the detection and treatment approaches.	
Content:		**No. of Hours**
	MODULE I Introduction to cancer- Growth characteristics of cancer cells (morphological and biochemical changes); cell proliferation v/s differentiation; ultrastructural properties of cancer cells; Types of growth -hyperplasia, dysplasia, anaplasia and neoplasia. Classification of tumours. Differences between benign and malignant tumors; Hallmarks of cancer; Aberrant metabolism during cancer development; Warburg effect; Paraneoplastic syndromes; tumorigenesis, tumor progression; telomeres and immortality; cell-cell interactions, cell adhesion-invasion; Classic theory of tumor metastasis and its mechanism; angiogenesis; epidemiology of cancer.	**15**
	MODULE II Cancer etiology- Causes of Cancer- Carcinogenic agents and their cellular interactions: Chemical carcinogenesis- mechanism of chemical carcinogenesis and carcinogenic chemicals; Radiation carcinogenesis- UV rays, ionizing radiation, mechanism of radiation carcinogenesis; Viral carcinogenesis - DNA and RNA oncogenic viruses, mechanism of viral oncogenesis; Ames test; Host tumor interactions, host factors affecting tumor cell growth, host defense against tumors; free radicals, ageing and antioxidants in cancer; Cancer endocrinology.	**15**
	MODULE III Molecular basis of cancer and cancer cell regulation- Cell cycle regulation- Cyclin dependent protein kinases, CDK inhibitors and cyclins; growth factors; apoptosis in cancer- role of caspases; Death signaling pathways- mitochondrial and death	**15**

	receptor pathways; autophagy in cancer; angiopoietins; ephrins; angiogenesis inhibitors. Clinical aspects of cancer; Hereditary cancer; molecular basis of cancer: oncogenes, protooncogenes and its mechanism; Tumor suppressor genes p53, p21, Rb, BRCA1 and BRCA2; epigenetics- role of DNA methylation in gene silencing- epigenetic silencing; whole chromosome aneuploidy and cancer; metastatic genes and metastasis suppressor genes.	
	Module IV Diagnosis and cancer treatment- Principle of cancer screening, cancer screening program; Prediction of aggressiveness of cancer; Tumor markers (CEA, AFP); PET scan; Classical Therapy: Surgery, biopsy and its type, chemotherapy and, radiation therapy and cancer vaccines; resistance against anticancer drugs; Epigenetic therapy; New approaches of cancer therapy: Stem cell therapy, hormone therapy, phytomedicine in cancer, immunotherapy- Immune checkpoint therapy and CAR T-cell therapy; other treatment methods (cryosurgery, laser therapy, photodynamic therapy, hyperthermia); nutrition and cancer management; cancer drug discovery: genomics and proteomics approach; cancer stem cells.	**15**
Pedagogy:	Lectures, class discussions, Use of ICT tools, assignments and case studies.	
References/ Readings:	1. Becker W. M., Kleinsmith L.J. and Bertni G. P. (2009). The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco. 2. Cooper G. M. Hausman R. E. (2009). The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinnauer Academic Press. 3. De Robertis, E. D. P. and De Robertis R. E. (2009). Cell and Molecular Biology, 8thedition. Lippincott Williams and Wilkins, Philadelphia. 4. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. 6th Edition,John Wiley & Sons. Inc. 5. King R.J.B., (1996) Cancer Biology, Addison Wesley Longmann Ltd, U.K., 6. McKinnell, R.G., Parchment, R.E., Perantoni, A.O., Pierce, G.B., Damjanov, I (2006). The Biological Basis of Cancer, Cambridge University Press, Cambridge. 7. Robert Allan Weinberg, (2007) “The Biology of Cancer”, Garland Science 8. Ruddon.R.W, (2007) Cancer Biology, Oxford University Press, Oxford. 9. Weinberg, R.A. (2013) The Biology of Cancer, Garland Science, New York.	
Course Outcomes:	At the end of the course, students will be able to: 1. Understand the different types of cancers and define the properties of a cancerous cell. 2. Compare and contrast the agents causing cancer and predict the molecular mechanism of cancer.	

	3. Summarize the methods used for the detection and screening of cancer. 4. Elaborate on the treatment process and cancer therapy.