ST. PHILOMENA'S COLLEGE (AUTONOMOUS)

Affiliated to University of Mysore
Accredited by NAAC with 'B^{++}' Grade
Bannimantap, Mysore, Karnataka,
India-570015

DEPARTMENT OF BIOTECHNOLOGY

The Board of Studies in Biotechnology which met on 27/08/24 has

Approved the syllabus and pattern of examination for

Semester III, IV ,V,VI for the

Academic Year 2024-25

BOS COMMITTEE MEMBERS

Sl. No.	Name	Designation
1	Naziya Habeeb M.	Chairperson
2	Dr.Ramachandra Kini	University Nominee
3	Dr.Rekha N.D	Member
4	Dr.Shwetha S.	Member
5	Milagris Antonius	Member

Course Content for B.Sc. Biotechnology as Major

Semester III & IV

Semester	Course code	Course Category	Theory/ Practical	Credits	Paper Title	Marks	
						S.A	I.A
3.	**BTC: 103**	DSC- 3	Theory	3	Biomolecules	60	40
			Practical	2	Biomolecules	25	25
		OE- 3	Theory	3	Nutrition and Health	60	40
4.	**BTC:104**	DSC- 4	Theory	3	Molecular Biology	60	40
			Practical	2	Molecular Biology	25	25
		OE- 4	Theory	3	Intellectual Property Rights	60	40

Program Name	**BSc Biotechnology**		Semester	**Third Sem**
Course Title	**Biomolecules**			
Course No.	**BTC: 301**	**DSC -3T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2.5 Hours**
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Objectives: students will be able to

1. Define and classify the structure of carbohydrates, proteins, lipids, and nucleic acids, as well as the role of these biomolecules in biological systems.
2. Explain the stereochemistry of carbohydrates, including epimers, enantiomers, anomers, and isomers, and describe the biological functions of DNA, RNA, and proteins like hemoglobin and collagen.

Course Outcomes (COs): At the end of the course the student should be able to:

1. Acquire knowledge about types of biomolecules, structure, and their functions
2. Will be able to demonstrate the skills to perform bioanalytical techniques
3. Apply comprehensive innovations and skills of biomolecules to biotechnology field

Content	**Hrs**
Unit–I	**14**
Carbohydrates: Introduction, sources, classification of carbohydrates. Structure, function and properties of carbohydrates. Monosaccharides – Isomerism and ring structure, Sugar derivatives – amino sugars and ascorbic acid Disaccharides – Maltose, Lactose and Sucrose Polysaccharides – Classification as homo and heteropolysaccharides, Homopolysaccharides - storage polysaccharides (starch and glycogen- structure, reaction, properties), structural polysaccharides (cellulose and chitin-structure, properties), Heteropolysaccharides - glycoproteins and proteoglycans. Metabolism: Glycolysis and gluconeogenesis, Kreb's cycle, ETC- oxidative phosphorylation. **Amino Acids, Peptides and Proteins:** Introduction, classification and structure of amino acids; Zwitterion, isoelectric point, pK values. Essential and nonessential amino acids. Peptide bond and peptide, Structural organization of proteins - primary, secondary (α helix, β sheets) tertiary and quaternary. Fibrous and globular proteins, Denaturation and renaturation of proteins. General aspects of amino acid metabolism: Transamination, deamination, decarboxylation and urea cycle.	

Unit –II	**14**

Lipids: Classification and function of lipids, Saturated and unsaturated fatty acids, properties (saponification value, acid value, iodine number, rancidity), Hydrogenation of fats and oils. General structure and biological functions of phospholipids, sphingolipids, glycolipids, lipoproteins, prostaglandins, cholesterol, ergosterol. Metabolism: β oxidation of fatty acids. Biosynthesis of palmitate. **Enzymes:** Introduction, nomenclature and classification, enzyme kinetics, factors influencing enzyme activity, metalloenzymes, activation energy and transition state, enzyme activity, specific activity. Coenzymes, cofactors and their functions (one reaction involving TPP, FAD, NAD). Enzyme inhibition- Irreversible and reversible (competitive, non-competitive and uncompetitive inhibition with an example each) Zymogens (trypsinogen, chymotrypsinogen and pepsinogen), Isozymes (LDH, Creatine kinase and their clinical significance).	

Unit –III **Vitamins:**Water and fat soluble vitamins, dietary source and biological role of vitamins Deficiency manifestation of vitamin A, B, C, D, E and K **Nucleic acids:** Structure of nucleosides, nucleotides in DNA and RNA. Structure and functions of DNA and RNA, Watson and Crick model of DNA and other forms of DNA (A and Z). Types of RNA (rRNA, tRNA, mRNA, snRNA, hnRNA, miRNA), ribozymes. Metabolism- Overview of biosynthesis and degradation of purine and pyrimidine, salvage pathway. **Hormones:** Classification of hormones based on chemical nature and mechanism of action. Chemical structure and functions of the following hormones: Glucagon, insulin, Epinephrine, Testosterone and Estradiol.	**14**
Unit –IV - Bioanalytical tools : **Electrophoresis:** Principle, procedure and applications of electrophoresis (paper electrophoresis, gel electrophoresis -PAGE, SDS- PAGE & agarose electrophoresis) and isoelectric focusing. **Spectroscopy:** Colorimetry**,** UV-Vis spectrophotometry, Spectrofluorimetry, IR and NMR spectroscopy, atomic absorption spectroscopy, mass spectroscopy **Radioisotope techniques:** Radioactivity, half life, radioisotopes, GM counter, scintillating counting, autoradiography, applications, biosafety	14

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes(POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Acquire knowledge about types of biomolecules, structure, and their functions	✓				✓							✓
Will be able to demonstrate the skills to perform bioanalytical techniques			✓								✓	✓
Apply comprehensive innovations and skills of biomolecules to biotechnology field	✓				✓							✓

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	Weightage in Marks
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	60 marks + 40 marks = 100 marks

Course Title	**Biomolecules**		Practical Credits	**2**
Course No.	**BTC:301**	**DSC-3P**	Contact hours	48 h

Content

1. Introduction to basic instruments (Principle, standard operating procedure) with demonstration.
2. Definitions and calculations: Molarity, Molality, Normality, Mass percent (w/w), Percent by volume (v/v), parts per million (ppm), parts per billion (ppb), Dilution of concentrated solutions. Standard solutions, stock solution, solution of acids. Reagent bottle label reading and precautions.
3. Preparation of standard buffers by Hendersen-Hasselbach equation – Acetate, phosphate, Tris and determination of pH of solution using pH meter.
4. Estimation of maltose by DNS method
5. Determination of α-amylase activity by DNS method
6. Determination of effect of pH on enzyme activity
7. Estimation of proteins by Biuret method
8. Estimation of Urea.
9. Extraction of protein from soaked/sprouted green gram by salting out method
10. Separation of amino acids by circular paper chromatography
11. Demonstration of Agarose Gel electrophoresis.
12. Determination of iodine number of lipids

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	
Record	5	25	**50**
Test	10		
Attendance	5		
Performance	5		
Total	**25**	**25**	

References	
1	An Introduction to Practical Biochemistry, 3rd Edition, (2001), David Plummer; Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India
2	Biochemical Methods,1st Edition, (1995), S.Sadashivam, A.Manickam; New Age International Publishers, India
3	Introductory Practical biochemistry, S. K. Sawhney&Randhir Singh (eds) Narosa Publishing. House, New Delhi, ISBN 81-7319-302-9
4	Experimental Biochemistry: A Student Companion, BeeduSasidharRao& Vijay Despande(ed).I.K International Pvt. LTD, NewDelhi. ISBN 81-88237-41-8
5	Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067

Program Name	**BSc Biotechnology**		Semester	**Third Sem**
Course Title	**Nutrition and Health**			
Course Code		**OE-3**	No. of Theory Credits	**3**
Contact hours	**Lecture**	42 h	Duration of ESA/Exam	**2.5 Hours**
	Practical	-		
Formative Assessment Marks	40		Summative Assessment Marks	60

Course Pre-requisite(s):	
Course Outcomes (COs): At the end of the course the student should be able to: 1. Study the concepts of food, nutrition, diet and health 2. To apply the best practices of food intake and dietary requirements 3. Acquire knowledge about various sources of nutrients and good cooking practices	
Content	**42 Hrs**
Unit–I – Introduction	**14 Hrs**
Concepts of nutrition and health. Definition of Food, Diet and nutrition, Food groups. Food pyramids. Functions of food. Balanced diet. Meal planning. Eat right concept. Functional foods, Prebiotics, Probiotics, and antioxidants	
Unit -II – Nutrients	**14 Hrs**
Macro and Micronutrients - Sources, functions and deficiency. Carbohydrates, Proteins, Fats – Sources and calories. Minerals –Calcium, Iron, Iodine. Vitamins – Fat soluble vitamins –A, D, E & K. Water soluble vitamins – vitamin C, Thiamine, Riboflavin, Niacin. Water–Functions and water balance. Fibre –Functions and sources. Recommended Dietary Allowance, Body Mass Index and Basal Metabolic Rate.	
Unit -III – Nutrition and Health	**14 Hrs**
Methods of cooking affecting nutritional value. Advantages and disadvantages. Boiling, steaming, pressure cooking. Oil/Fat – Shallow frying, deep frying. Baking. Nutrition through lifecycle. Nutritional requirement, dietary guidelines: Adulthood, Pregnancy, Lactation, Infancy- Complementary feeding, Pre-school, Adolescence, geriatric. Nutrition related metabolic disorders- diabetes and cardiovascular disease.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	Weightage in Marks
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	60 marks + 40 marks = 100 marks

References	
1	Sri Lakshmi B, (2007), Dietetics. New Age International publishers. New Delhi
2	Sri Lakshmi B, (2002), Nutrition Science. New Age International publishers. New Delhi
3	Swaminathan M. (2002), Advanced text book on food and Nutrition. Volume I. Bappco
4	Gopalan.C., RamaSastry B.V., and S.C.Balasubramanian (2009), Nutritive value of Indian Foods.NIN.ICMR.Hyderabad.
5	Mudambi S R and Rajagopal M V, (2008), Fundamentals of Foods, Nutrition & diet therapy by New Age International Publishers, New Delhi

Program Name	**BSc Biotechnology**		Semester	**Fourth Sem**
Course Title	**Molecular Biology**			
Course No.	**BTC: 401**	**DSC -4T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2.5 Hours**
Formative Assessment Marks	40		Summative Assessment Marks	60

Course Objectives: students will be able to explain the core principles of molecular biology, including the structure and function of nucleic acids, the central dogma of molecular biology (DNA → RNA → Protein), and the mechanisms of gene expression and regulation.

Course Outcomes (COs): At the end of the course the student should be able to:

1. Study the advancements in molecular biology with latest trends.
2. Will acquire the knowledge of structure, functional relationship of proteins and nucleic acids.
3. Aware about the basic cellular processes such as transcription, translation, DNA replication and repair mechanisms.

Content	Hrs
Unit–I –	**14 Hrs**
DNA as genetic material, Replication and Repair: Experimental proof of DNA as genetic material (Griffith's, Avery-Mcleod-McCarty, Martha-Chase). Central dogma, Replication of DNA in prokaryotes and eukaryotes– semiconservative mode (Messelson and Stalh experiment), Theta, linear and rolling circle models. Enzymes and proteins involved in replication-DNA polymerases, helicases, gyrases, ligase, SSB proteins, RNAse H The replication complex: Pre-primming proteins, primosome, replisome, unique aspects of eukaryotic chromosome replication, Fidelity of replication. DNA damage and Repair mechanism: types of damage, photo reactivation, excision repair, mismatch repair and SOS repair	
Unit -II –	**14 Hrs**
Transcription and RNA processing: Transcription in prokaryotes- RNA polymerase, sigma factor, promoter, initiation, elongation and termination. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance, elongation and termination. RNA processing of pre-mRNA: 5' cap formation, polyadenylation, splicing. Processing of rRNA and tRNA.	
Unit -III –	14 Hrs
Translation: Genetic code and its characteristics, Wobble hypothesis. Translation- in prokaryotes and eukaryotes- ribosomes, enzymes and factors involved in translation. Activation of amino acids, aminoacyl tRNA synthetases. Mechanism of translation- initiation, elongation and termination of polypeptide chain. Fidelity of translation, Inhibitors of translation. Post translational modifications of proteins. lysosomes.	
Unit –IV –	14 Hrs
Regulation of gene expression: Prokaryotic gene regulation- operon concept- regulation of *lac* operon and *trp* operon, attenuation control. Eukaryotic gene regulation- Activators, repressors binding to enhancers, coordinated control (tissue specific gene expression), DNA methylation, chromatin remodeling, Translational control of gene expression-ferritin mRNA regulation, RNAi- miRNA and siRNA.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes(POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Study the advancements in molecular biology with latest trends	✓				✓							✓
Will acquire the knowledge of structure, functional relationship of proteins and nucleic acids					✓	✓						✓
Aware about the basic cellular processes such as transcription, translation, DNA replication and repair mechanisms	✓				✓				✓			✓

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	Weightage in Marks
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	60 marks + 40 marks = 100 marks

Course Title	**Molecular Biology**		Practical Credits	**2**
Course No.	**BTC: 401**	**DSC-4P**	Contact hours	48
Content				
1. Preparation of DNA model 2. Estimation of DNA by DPA method 3. Estimation of RNA by Orcinol method 4. DNA isolation from plant/ animal/ microbial sources 5. Concentration and purity of isolated DNA samples 6. Melting temperature of DNA 7. Agarose gel electrophoresis of DNA 8. Charts on- DNA replication, transcription, translation, Types of DNA, RNA				

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	
Record	5	25	**50**
Test	10		
Attendance	5		
Performance	5		
Total	**25**	**25**	

References	
1	Glick, B.R and Pasternak J.J (1998) Molecular biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press
2	Howe. C. (1995) Gene cloning and manipulation, Cambridge University Press, USA
3	Lewin, B., Gene VI New York, Oxford University Press
4	Rigby, P.W.J. (1987) Genetic Engineering Academic Press Inc. Florida, USA
5	Sambrook et al (2000) Molecular cloning Volumes I, II & III, Cold spring Harbor Laboratory Press New York, USA
6	Walker J. M. and Ging old, E.B. (1983) Molecular Biology & Biotechnology (Indian Edition) Royal Society of Chemistry U.K
7	Karp. G (2002) Cell & Molecular Biology, 3rdEdition, John Wiley & Sons; I

Program Name	**BSc Biotechnology**		Semester	**Fourth Sem**
Course Title	**Intellectual Property Rights**			
Course Code		**OE-4**	No. of Theory Credits	**3**
Contact hours	**Lecture**	42 h	Duration of ESA/Exam	**2.5 Hours**
	Practical	-		
Formative Assessment Marks	40		Summative Assessment Marks	60

Course objectives: Students will be able to explain the key concepts and types of intellectual property rights, including patents, copyrights, trademarks, trade secrets, and design rights. They will understand the principles and importance of IPR in protecting innovations and creative works.

Course Outcomes (COs): At the end of the course the student should be able to:

1. Knowledge about need and scope of Intellectual property rights
2. Acquire knowledge about filing patents, process, and infringement
3. Knowledge about trademarks, industrial designs, and copyright

Content	42 Hrs
Unit–I - Introduction to Intellectual property rights (IPR): Genesis and scope. Types of Intellectual property rights - Patent, Trademarks, Copyright, Design, Trade secret, Geographical indicators, Plant variety protection. National and International agencies – WIPO, World Trade Organization (WTO), Trade-Related Aspects of Intellectual Property Rights (TRIPS), General Agreement on Tariffs and Trade (GATT).	**14 Hrs**
Unit -II - Patenting, process, and infringement Basics of patents - Types of patents; Patentable and Non-Patentable inventions, Process and Product patent. Indian Patent Act 1970; Recent amendments; Patent Cooperation Treaty (PCT) and implications. Process of patenting. Types of patent applications: Provisional and complete specifications; Concept of "prior art", patent databases (USPTO, EPO, India). Financial assistance, schemes, and grants for patenting. Patent infringement- Case studies on patents (Basmati rice)	**14 Hrs**
Unit -III - Trademarks, Copy right, industrial Designs Trademarks- types, Purpose and function of trademarks, trademark registration, Protection of trademark. Copy right- Fundamentals of copyright law, Originality of material, rights of reproduction, industrial Designs: Protection, Kind of protection provided by industrial design.	**14 Hrs**

Pedagogy

Summative assessment = 60 marks theory paper, End semester Exam duration: 2.5 hours	
Formative Assessment Occasion / type	Weightage in Marks
Assignment	10
Seminar	10
Case studies	10
Test	10
Total	40 marks

References

1	Manish Arora. 2007. Universal's Guide to Patents Law (English) 4th Edition) -Publisher: Universal Law Publishing House
2	Kalyan C. Kankanala. 2012. Fundamentals of Intellectual Property. Asia Law House
3	Ganguli, P. 2001. Intellectual Property Rights: Unleashing the knowledge economy. New Delhi: Tata McGraw-Hill Pub
4	World trade organization - http://www.wto.org

5	World Intellectual Property organization – www.wipo.intOffice of the controller general of Patents, Design & Trademarks - www.ipindia.nic.in

Semester V B.Sc (Biotechnology)
Core Course Content

Course Title: **Genetic Engineering(Paper – V)**	Course Credits: **4**
Course Code: **DSC –A9 (T)**	L-T-P per week: 4-0-4
Total Contact Hours**: 60 hrs**	
Formative Assessment Marks:40	Summative Assessment Marks:60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment Occasion	**Assessment type**	**Weightage in Marks**
C1 First component	Test-40 marks test for 90 minutes	10
C1 Second Component	Assignment	10
C2 First component		10
C2 Second Component		10
Total		**40**

Note: Any two different activities for C2 First component and C2 Second component can be selected from the below

Quiz/Project/Class room exercise/Practice exercise/Educational (industry/ institutes/ NGOs) visit/ field trip/ Field work/Viva voce/Role Play/Charts/ Models/Case study/Group discussion/Crosswords/ Presentation/seminar/Review – movie / Book/Research articles/e – content preparation

Course Objectives

1. Understand the fundamental principles and techniques of genetic engineering.
2. Explore the applications of genetic engineering in agriculture, medicine, biotechnology,and environmental science.
3. Develop practical skills in genetic engineering techniques and laboratory procedures.
4. Gain knowledge of gene expression regulation and genetic modification methods.
5. Enhance critical thinking and problem-solving skills through discussions and case studies.
6. Stay updated on emerging trends and advancements in genetic engineering.

Course Outcomes:

1. Demonstrate a thorough understanding of the fundamental principles and techniques of genetic engineering.
2. Apply the knowledge of genetic engineering to diverse applications in

agriculture, medicine, biotechnology, and environmental science.

3. Perform laboratory procedures and develop practical skills in genetic engineering techniques.
4. Explain gene expression regulation mechanisms and apply genetic modification methods effectively.
5. Evaluate genetic engineering's ethical, social, and legal implications and propose responsible solutions.
6. Stay updated with recent advancements in genetic engineering, critically evaluate emerging trends, and assess their potential impact on various fields.

Genetic Engineering - Content of Theory	60 hrs
Unit I- Fundamentals of Genetic Engineering	**15**
Definition, scope, and historical overview of genetic engineering. Importance and applications in various fields. **DNA Structure and Manipulation** - Techniques for DNA isolation and purification. Methods for quantification and characterization of DNA samples. **RNA Analysis and Gene Expression**- Methods for RNA isolation and purification. Analysis of gene expression. **Recombinant DNA technology** – Introduction to molecular cloning. Overview of cloning vectors. Plasmids, phage, cosmid, BAC, and YAC. Features and applications of cloning vectors in genetic engineering. Enzymes used in recombinant DNA technology: Restriction endonucleases, Polymerases, Ligase, kinases, and phosphatases.	
Unit II- Practices in Genetic Engineering	**15**
Recombinant Protein Expression and Purification, affinity tags. Techniques for expressing recombinant proteins using bacterial, animal, and plant expression systems. Strategies for protein purification and characterization. Hybridization techniques, Southern, Northern, Western, FISH, Polymerase Chain Reaction (PCR) and its types, molecular probes, DNA sequencing- Sanger's, Next Generation Sequencing **Gene Manipulation Techniques** - Methods of gene delivery. Physical, chemical, and biological methods. Transformation, transfection, Electroporation and micro-injection. Gene knockout techniques in bacterial and eukaryotic organisms. **Genome Editing** - Introduction to genome editing techniques- Principles and applications of genome editing techniques. CRISPR-Cas9.	
Unit III- Applications of Genetic Engineering	**15**
Introduction to Applications. Overview of the diverse applications of genetic engineering. Gene therapy and its potential in treating genetic disorders. Strategies for gene delivery in therapeutic applications. Diagnostic Applications. DNA fingerprinting and its applications in forensics. Molecular diagnostic techniques and their role in disease diagnosis. Use of genetic engineering in the development of therapeutics and vaccines.	
Unit IV- Advances in Genetic Engineering and Ethics	**15**
Industrial Applications. Industrial applications of genetic engineering, such as enzyme production, biofuel production, and bioremediation. Scale-up techniques and process optimization in industrial settings. Introduction to synthetic biology and its integration with genetic engineering. Design and construction of artificial biological systems **Ethical and Regulatory Considerations** - Discussion of ethical implications associated with genetic engineering.	

Course Title	**Genetic Engineering**	Practical Credits	**02**
Course Code:	**DSC–A10 (P)**	Contact hours	**60 hrs**

Practical Content

1. **Introduction to Laboratory Techniques -** Safety guidelines and laboratory protocols Aseptic techniques and proper handling of materials. Basic equipment and instrument operation Preparation of reagents and media
2. **Nucleic Acid Extraction and Quantification-** DNA extraction from different sources (e.g., bacteria, plant, animal). RNA extraction and purification methods. Quality assessment and quantification of nucleic acids (spectrophotometry, gel electrophoresis).
3. **Polymerase Chain Reaction (PCR)**
   Primer design and optimization PCR setup and cycling conditions
   Agarose gel electrophoresis for PCR product analysis
4. **Cloning and Plasmid Manipulation**
   Isolation of Plasmid
   Restriction enzyme digestion
   Ligation reactions
   Transformation of bacterial cells with recombinant plasmids
   Colony selection and screening for successful cloning
5. **Gel Electrophoresis and DNA Analysis**
   Agarose gel electrophoresis for DNA fragment separation and analysis DNA size determination using molecular weight markers
   DNA band visualization techniques (e.g., Ethidium bromide staining, DNA intercalating dyes)

Practical Assessment

Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exams**	
C1 Test	10	25	**50**
C2 Test	10		
Record & Attendance	05		
Total	**25**	**25**	

References

1. Principles of Gene Manipulation and Genomics (2016) 8th ed., Primrose, SB, and Twyman, R,Wiley Blackwell, ISBN: 978-1405156660.
2. Gene Cloning and DNA Analysis: An Introduction (2019) 7th ed., Brown, TA, WileyBlackwell, ISBN: 978-1119072560.
3. Genome 4 (2017) 4th ed., Brown, TA, Garland Science, ISBN: 978-0815345084.
4. Introduction to Genomics (2015) 2nd ed., Lesk, AM, Oxford University Press India, ISBN:978-0198745891.
5. Genomics and Personalized Medicine: What Everyone Needs to Know (2016) 1st ed., Snyder,M, OUP-USA, ISBN: 978-0190234768.
6. Molecular Biology of the Gene (2014) 7th ed., Watson, JD, Baker, TA, Bell, SP, Gann, A,Levine, M, and Losick, R, Pearson, ISBN: 978-0321762436.

Semester V BSc (Biotechnology)
Core Course Content

Course Title: Plant Biotechnology and Animal Biotechnology (Paper-VI)	Course Credits: **4**
Course Code: **DSC-A11 (T)**	L-T-P per week: 4-0-4
Total Contact Hours**: 60 hrs**	
Formative Assessment Marks:40	Summative Assessment Marks:60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment Occasion	**Assessment type**	**Weightage in Marks**
C1 First component	Test-40 marks test for 90 minutes	10
C1 Second Component	Assignment	10
C2 First component		10
C2 Second Component		10
Total		**40**

Note: Any two different activities for C2 First component and C2 Second component can be selected from the below

Quiz/Project/Class room exercise/Practice exercise/Educational (industry/ institutes/ NGOs) visit/ field trip/ Field work/Viva voce/Role Play/Charts/ Models/Case study/Group discussion/Crosswords/ Presentation/seminar/Review – movie / Book/Research articles/e – content preparation

Course Objectives

1. To understand the fundamental aspects of plant and animal biotechnology.
2. Learn about biotechnological tools and techniques used in plant and animal research.
3. Explore methods of introducing foreign genes into plants and animals through transformation techniques.
4. Gain practical skills in plant tissue culture and animal cell culture for improvement.
5. Design strategies for plant genetic manipulation against biotic and abiotic stressors.
6. Hypothesize strategies to increase plant yield and fruit/seed quality.
7. Apply knowledge to real-world challenges in agriculture, veterinary medicine, conservation, and biomedical research
8. Understand the need for animal biotechnology for human welfare.

Course Outcomes:
After completing this course, the student is expected to learn the following:

1. Demonstrate a comprehensive understanding of plant biology, physiology, genetics, and Molecular biology.
2. Apply biotechnological tools and techniques used in plant research and agriculture, such explant tissue culture, genetic engineering and transgenics.
3. Execute plant tissue culture techniques for callus induction, somatic embryogenesis, and Micropropagation, and apply them in plant breeding and propagation.
4. Perform plant transformation methods and demonstrate the ability to introduce foreign genes into plants using different techniques.
5. Apply knowledge about ethical considerations and regulatory frameworks associated with plant biotechnology and genetically modified crops.
6. Understand the biology and characterization of cultured cells, including their adhesion, proliferation, differentiation, morphology, and identification.
7. Gain practical skills in basic mammalian cell culture techniques, measuring growth parameters, assessing cell viability, and understanding cytotoxicity.
8. Learn about germplasm conservation techniques and the establishment of gene banks, along with large-scale culture methods for cell lines.
9. Explore organ and histotypic culture techniques, biotransformation, 3D cultures, whole embryo culture, somatic cell cloning, and the ethical considerations surrounding stem cells and their applications.

Plant and Animal Biotechnology - Content of Theory	60 hrs
Unit–I – Plant Tissue culture methods	**15**
Introduction, history, definition, hypothesis, and concept of totipotency. Principles of plant tissue culture,media and laboratory organization, types of culture, morphogenesis, differentiation, callus, direct, indirect organogenesis, and somatic embryogenesis,synthetic seeds. Micropropagation, Seed culture, embryo culture, Meristem culture, limitations and applications. Secondary metabolites, In vitro secondary metabolite production, Suspension cultures, cell cultures,growth vs secondary metabolite production.	
Unit -II Transgenic Plants and biosafety	**15**
Overview of transgenic plants and their significance in agriculture. - Techniques for introducing foreigngenes into plants: Agrobacterium-mediated transformation, Biolistics, and other methods.. Applications of Transgenic Plants - Improved crop traits throughgenetic engineering: pest resistance, herbicide tolerance, disease resistance, and abiotic stress tolerance. Biosafety assessment of transgenic plants: potential risks and benefits. International regulatoryframeworks for releasing and commercializing genetically modified organisms (GMOs). Ethical and socio-economic impacts of transgenic crops.	
Unit–III Animal Cell culture methods	**15**
History and laboratory Organisation, Media. Cell types and culture characters. Pluripotency, Multipotency, Differentiation, Trans differentiation Reprogramming, Biology and characterization of cultured cells- cell adhesion, proliferation, differentiation, morphology of cells, and identification. The basic technique of mammalian cell culture in vitro, Measuring parameters of growth in cultured cells, cell viability, and cytotoxicity. Organ and histotypic culture**:** Technique, advantages, limitations, applications. Stem cells: types (embryonic, adult, induced pluripotent).	
Unit -IV Gene transfer in animals and applications	**15**
Gene constructs promoter/ enhancer sequences for transgene expression in animals. Selectable markers for animal cells- thymidine kinase. Transfection of animal cells- calcium phosphate co-precipitation, Electroporation, lipofection, peptides, direct DNA transfer, viral vectors, Retrovirus, Microinjection. Transgene identification methods. Manipulation of animal reproduction and characterization of animal genes, Embryo transfer in cattle and applications. Somatic cell cloning - cloning of Dolly. Ethical issues. Production of recombinant Vaccines.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments. Case studies highlight successful applications and challenges in transgenic crop development.

Course Title	Plant and Animal Biotechnology	Practical Credits	2
Course Code	DSC-A-12 (P)	Contact hours	60 hrs

Content of Practical

1. Laboratory organization of basic and commercial plant tissue culture
2. Media preparation (MS, B5), solid media preparation, and Liquid media preparation
3. Explant preparation – Leaf, bud, rhizome, and meristem
4. Synthetic seed production
5. Callus culture- Initiation and establishment of different types of callus cultures
6. Micropropagation with a suitable example – Stage 0. 1, 2, 3, and 4
7. Preparation of cell culture media: Preparation of basic cell culture media, such as Dulbecco's Modified Eagle Medium (DMEM), supplemented with fetal bovine serum (FBS), antibiotics, and other required additives.
8. Aseptic techniques and sterile handling: Practicing aseptic techniques, including properly handling tools and equipment, working in a laminar flow hood, and maintaining sterility throughout the cell culture process.
9. Filter sterilization: Practice filter sterilization for sensitive media ingredients.
10. Cell counting and viability assessment: Count cells using a hemocytometer or automated cell counter, and perform viability assays (e.g., trypan blue exclusion) to determine the percentage of viable cells.
11. Experimental design and data analysis: Students can design and execute simple experiments, record and analyze data, and interpret the results based on their observations and measurements.

Practical Assessment			
Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/ Type	**Weightage in Marks**	**Practical Exams**	
C1 Test	10	25	**50**
C2 Test	10		
Record & Attendance	05		
Total	**25**	**25**	

References:

1. Bhojwani, S.S., and Razdan, M.K. (2004). Plant Tissue Culture: Theory and Practice. Amsterdam: Elsevier Science.
2. Brown, T.A. (2010). Gene Cloning and DNA Analysis: An Introduction. 7th edition. Oxford: Wiley-Blackwell.
3. Gardner, E.J., Simmons, M.J., and Snustad, D.P. (2008). Principles of Genetics. 10th edition. Hoboken, NJ: John Wiley & Sons.
4. Glick, B.R., and Pasternak, J.J. (2018). Molecular Biotechnology: Principles and Applications of Recombinant DNA. 5th edition. Washington, DC: ASM Press.

5. Raven, P.H., Johnson, G.B., Losos, J.B., and Singer, S.R. (2013). Biology. 10th edition. New York, NY: McGraw-Hill Education.
6. Reinert, J., and Bajaj, Y.P.S. (1997). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Berlin: Springer.
7. Russell, P.J. (2013). Genetics: A Molecular Approach. 3rd edition. Boston, MA: Benjamin Cummings.
8. Slater, A., Scott, N.W., and Fowler, M.R. (2008). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
9. Smith, R. (2012). Plant Tissue Culture: Techniques and Experiments. 3rd edition. San Diego, CA: Academic Press.
10. Taiz, L., and Zeiger, E. (2014). Plant Physiology. 5th edition. Sunderland,MA: Sinauer Associates.

Program Name	**B.Sc. Biotechnology**	Semester	**5th Semester**
Course Title	**Biotechnology Skills and Analytical Techniques**		
Course No.	**SEC- 4**	**No. of Theory Credits**	**2+1 (Theory + Practical)**
Contact hours	**45 hrs**	Duration of ESA/Exam	**2 hrs**
Formative Assessment Marks	**20**	Summative AssessmentMarks	**30**

Course Outcomes (COs): At the end of the course the student should be able to:

1. Demonstrate skills as per National Occupational Standards (NOS) of the "Lab Technician/Assistant" Qualification Pack issued by the Life Sciences Sector Skill Development Council-LFS/Q0509.
2. Develop knowledge of laboratory safety procedures and protocols and acquire skills in handling and maintaining laboratory equipment and instruments.
3. Operate analytical equipment and instruments as per standard operating procedures (SOP)
4. Knowledge about major activities of the biotech industry, regulations and compliance, environment, health and safety (EHS), good laboratory practices (GLP), and Good Manufacturing Practices (GMP) as per the industry standards.
5. Demonstrate soft skills, such as decision-making, planning, organizing, problem-solving, analytical thinking, critical thinking, and documentation.

Biotechnology Skills and Analytical Techniques Content	30 Hrs
Unit-I Insights into the biotechnology industry and basic professional skills	**15**
Biotechnology Industry in Indian and Global Context- Organization in the context of large/medium/small enterprises, their structure, and benefits. **Industry-oriented professional skills:** Planning and organizing skills, decision-making, problem-solving skills, analytical thinking, critical thinking, team management, and risk assessment. Interpersonal skills: Writing skills, reading skills, oral communication, conflict resolution techniques, interpretation of research data, and troubleshooting in the workplace. **Digital skills:** Basic computer skills (MS Office, excel, power point, internet) for the workplace. Professional E-mail drafting skills and PowerPoint presentation skills. Overview of good manufacturing practices (GMP), Good Documentation practices (GDP), and good laboratory practices (GLP).	
Unit- II Basic laboratory skills and Analytical Techniques	**15**
Analytical skills in the laboratory: Preparations of solutions, molarity, molality, normality, mass percent % (w/w), percent by volume (%v/v), parts per million (ppm), parts per billion (ppb), dilution of concentrated solutions. Standard solutions, stock solution, and solution of acids. Reagent bottle label reading and precautions. **Analytical techniques:** Basic principle, operation, application, maintenance, calibration, validation, and troubleshooting of instruments- Microscope-Simple, compound, TEM, SEM, fluorescence. Centrifuge and different types, Hot air oven, pH meter, different types of pH electrodes Autoclave, Incubator, BOD, COD, cell counter, Laminar airflow. Spectroscopy- Colorimeter, UV-Visible spectroscopy. Electrophoresis- Agarose Gel electrophoresis, SDS-PAGE, PCR, Conductivity meter, and Potentiometer. Biosafety cabinets.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments

Course title	**Quality control methods in biology (Practical)**	**Practical credits-1**	**5th Semester**
Course No.	**SEC -4**	Contact hours	4hrs/week
Content			
Unit-1			
Methods and practices of cleaning and management of lab: Learning and Practice of Integratedclean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards, material requirementsfor cleaning specific areas, equipment, ventilation area, personal protective requirements Calibration of and use of micropipette.			
Unit-2			

Preparation of Standard Operating Procedure (SOP) for various equipment in the QC Lab, Best practices of using and storing chemicals: Knowledge and practice in handling chemicals, labeling, and stock maintenance. SOP and material handling. Procedures to maintain chemicals, labeling, storage, and disposal.

Handling and calibration of lab equipment- weighing balance, Autoclave, Hot air Oven, Incubator, Centrifuge, Water bath, Colony Counter, and stability chamber, Preparation of Normality, Molarity, and buffer solutions

Unit-3

Preparation of media: Maintenance and storage of purified water for media (plant tissue culture media, microbiological media, and animal cell culture media) preparation. Preparation and storage of concentrated stock solutions. Documentation and disposal of expired stocks. Collection ofindents of media requirement, preparation, and storage. Media coding, documentation, and purpose of usage.

Demonstration, handling, and troubleshooting of High-Performance Liquid Chromatography and Gas chromatography.

Demonstration of Polymerase Chain Reaction (PCR), Hands-on training on colorimeter and spectrophotometer, Industry visit, or analytical laboratory visit.

Note: Semester end examination is only in the theory component; questions from thepractical part could be included, if any.

References:

1. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch (2017). "Principles ofInstrumental Analysis". Cengage Learning.
2. J. Perry Gustafson (2017). "Analytical Methods and Techniques for Advanced Sciences".CRC Press.
3. Dean F. Martin, William M. Ritchey, and Michael W. Wood (2017). "Laboratory Manual forPrinciples of General Chemistry". Wiley.
4. Michael Lufaso (2016). "Laboratory Skills for Science and Medicine: An Introduction". CRCPress.
5. David J. Livingstone and Christopher H. Amonette (2016). "Analytical Techniques inEnvironmental Chemistry: Applications to Air, Water and Soil". CRC Press.
6. Colin A. Ramsden (2014). "Analytical Molecular Biology". Oxford University Press.
7. John M. Walker and Ralph Rapley (2014). "Molecular Biomethods Handbook". HumanaPress.
8. Gary D. Christian, Purnendu K. Dasgupta, and Kevin A. Schug (2013). "AnalyticalChemistry". Wiley.
9. Roger L. Lundblad and Fiona M. Macdonald (2010). "Handbook of Biochemistry andMolecular Biology". CRC Press.

Semester VI
BSc/ (Biotechnology)
Core Course Content

Course Title: **Immunology(Paper-7)**	Course Credits: **4**
Course Code: **DSC-A13(T)**	L-T-P per week: 4-0-4
Total Contact Hours**: 60**	
Formative Assessment Marks:40	Summative Assessment Marks:60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment Occasion	**Assessment type**	**Weightage in Marks**
C1 First component	Test-40 marks test for 90 minutes	10
C1 Second Component	Assignment	10
C2 First component		10
C2 Second Component		10
Total		**40**

Note: Any two different activities for C2 First component and C2 Second component can be selected from the below

Quiz/Project/Class room exercise/Practice exercise/Educational (industry/ institutes/ NGOs) visit/ field trip/ Field work/Viva voce/Role Play/Charts/ Models/Case study/Group discussion/Crosswords/ Presentation/seminar/Review – movie / Book/Research articles/e – content preparation

Course Objectives:

1. To understand the various aspects of immunity, elicitation of immune responses, factors determining the outcome of immune responses and major players of immunity, relevance between nutritional support andimmunity, and immunological techniques.
2. To provide knowledge on essential features of antigens and antibodies and their types and different theories of Antibody formation.
3. To acquire knowledge on types of immunity, phagocytosis, interferons, and the complement system.
4. To explain the concept of hypersensitivity, autoimmunity, and transplantation.
5. To provide knowledge on immune deficiencies and several immunological techniques

Course Outcomes:

At the end of the course, the student should be able to:

1. Demonstrate comprehension of the underlying structure and function of the Immune system and related disorders.
2. Demonstrate an understanding of the role of cells and molecules in immune reactions and responses
3. Demonstrate technical skills in immunological tools and techniques
4. Apply the domain-specific knowledge and skills acquired in immunology for innovative therapies and Immunotechnologies
5. Understand the fundamental concepts of immunity, and the contributions of the organs and cells in immune responses.
6. Realize how the MHC molecule's function and host encounters an immune insult.
7. Understand the antibodies and complement system
8. Understand the mechanisms involved in the initiation of specific immune responses
9. Differentiate the humoral and cell-mediated immune mechanisms
10. Comprehend the overreaction by our immune system leading to hypersensitiveconditions and its consequences
11. Understand unique properties of cancer cells, immune recognition of tumors, immune evasion of cancers.

Immunology - Content of Theory	
Unit–I Cells and Organs of the Immune System	15
Introduction to the Immune System: History of Immunology, Types of Immunity: first and second line of defense, innate and acquired/adaptive immunity.Cells of the immune system: Antigen-presenting cells (APCs), Role of B and T-lymphocytes in Humoral immunity and cell-mediated immunity, primary and secondary immune response, Immunization, memory. Organs of the Immune system: Thymus, bone marrow, spleen, Lymph Node, peripheral lymphoid organs	
Unit -II Molecules of the Immune System	**15**
Antigens and Haptens : Properties (foreignness, molecular size, heterogeneity). Adjuvants. Antigenicity and Immunogenicity. Affinity and Avidity. B and T cell epitopes, superantigens Immunoglobulins: Classification, structure, and function. Antibody diversity, Monoclonal andpolyclonal antibodies. Major histocompatibility complexes: Classification, structure, and function. Antigen processing pathways – Cytosolic and Endocytic, Complement Pathways, Cytokines: Classification and function, Hypersensitivity: Reactions – Types I, II, and III. Delayed Type Hypersensitive Response.	
Unit -III Immunotechniques and vaccines	**15**
Structure and properties of antigens- iso- and allo-antigens, antigen specificity, Cross-reactivity, Precipitation, Immunodiffusion reactions: Radial immunodiffusion, Ouchterlony double diffusion, Immunoelectrophoresis. Agglutination: Agglutination reactions. ELISA. Vaccines: Conventional, peptide vaccines, subunit, DNA vaccines. Toxoids, antisera, ediblevaccines, plantibodies.	
Unit – IV	**15**
Transplantation immunology: Phases in graft rejection and immuno-suppressors. Autoimmune Disorders: Systemic and Organ-specific Autoimmune disorders with examples Immunodeficiencies: Primary and secondary immunodeficiencies; acquired immunodeficiency syndrome Cancer and the immune system – immune surveillance, immunological escape, cancer antigens,cancer immunotherapy Microbial diseases in humans**:** Mode of infection, symptoms, epidemiology and control measures of diseases caused by Viruses (Hepatits-B), Bacteria (Typhoid), Fungi (Aspergillosis), Protozoa (Malaria).	

Practical Assessment			
Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exams**	
C1 Test	10		

Course Title	**Immunology (Practical)**	Practical Credits	**02**
Course No.	**DSC-A14 (P)**	Contact hours	**60 hrs**

Content of Practical

1. Hemagglutination of ABO Blood groups
2. Determination of Rh factor
3. Whole Count of WBC using Hemocytometer
4. Cells of the Immune System
5. Radial immunodiffusion
6. Ouchterlony double diffusion
7. ELISA – Demonstrate
8. Serum Immunoelectrophoresis
9. Western Blotting

C2 Test	10		
Record & Attendance	05		
Total	**25**	**25**	

References:

1. Textbook of Immunology, Paul Ajoy, Books and Allied (P) Ltd., 2016
2. Cellular and Molecular Immunology. Abbas, A.K. et al., Elsevier Saunders Co., 2015
3. Essential Immunology. Riott, I.M., Blackwell Scientific Publications, 1994
4. Handbook of Experimental Immunology, Vol. 1 & 2, Weir D.M., Wiley, 1997
5. Immunology. Riott, I.M., Brostoff J., Male, D. Mosby Pub., 2017
6. Immunobiology. Janeway C.A. and Travers, P. Churchill Livingstone Pub., 2016
7. Practical Immunology. Hudson L. and Hay F.C., Blackwell Scientific Pub., 1989
9. Instant Notes in Immunology. Lydyard PM et al. Viva Books Pvt. Ltd., 2011
10. Abbas AK, Lichtman AH, and Pillai S. (2019). Basic Immunology- Functions and Disorders of theImmune System. Elsevier,

Semester VI BSc (Biotechnology)
Core Course Content

Course Title: **Bioprocess and Environmental Biotechnology(Paper-VIII)**	Course Credits: **4**
Course Code: **DSC-A15 (T)**	L-T-P per week: 4-0-4
Total Contact Hours**: 60**	
Formative Assessment Marks:40	Summative Assessment Marks:60

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment Occasion	**Assessment type**	**Weightage in Marks**
C1 First component	Test-40 marks test for 90 minutes	10
C1 Second Component	Assignment	10
C2 First component		10
C2 Second Component		10
Total		**40**

Note: Any two different activities for C2 First component and C2 Second component can be selected from the below

Quiz/Project/Class room exercise/Practice exercise/Educational (industry/ institutes/ NGOs) visit/ field trip/ Field work/Viva voce/Role Play/Charts/ Models/Case study/Group discussion/Crosswords/
Presentation/seminar/Review – movie / Book/Research articles/e – content preparation

Course Objectives:

1. Perform simulations of microbial growth and metabolism
2. Design bioreactors for the production of various products.
3. Present knowledge about major metabolic pathways and those related

to biofuel production from microbes.

4. Understand the fundamental concepts and principles of environmental biotechnology and explore the interrelationship between biotechnology and the environment.
5. Gain knowledge of the various applications of biotechnology in environmentalconservation, pollution control, and sustainability.
6. Learn about microbial processes and their role in environmental biotechnology.
7. Understand the principles of bioremediation and its application in the clean-up ofenvironmental pollutants.
8. Explore the potential of bio-energy production and waste management throughbiotechnological approaches.
9. Identify and characterize the most important contaminants in the Bioprocess and otherindustrial wastes.
10. Reuse/recycle the biological waste to clean technology such as energy, biofuel, biofertilizer through bioremediation

Course out comes:

1. Exploitation of microorganisms for industrial use and their improvement, and formulation of media for efficient growth and production of microbial orcell-based products.
2. The design, operation, and specific applications of various bioreactors.
3. Demonstrate a comprehensive understanding of the fundamental conceptsand principles of environmental biotechnology.
4. Apply knowledge of biotechnological techniques to address environmental challenges, such as pollution control and waste management.
5. Analyze and evaluate environmental biotechnology case studies, researchfindings, and real-world applications.
6. Design and implement biotechnological approaches for environmental remediation, utilizing microbial processes andbiodegradation principles.
7. Evaluate the ethical and sustainable aspects of environmental biotechnologypractices and make informed decisions regarding their application in environmental conservation.
8. Communicate scientific concepts and research findings related toenvironmental biotechnology effectively, both in written and oral forms, to diverse audiences.

Bioprocess and Environmental Biotechnology – Content of Theory	60 hrs.
UNIT- I – Introduction to bioprocess technology	**15**
Basic principle components of fermentation technology. Strain improvement of industrially important microorganisms. Types of microbial culture and its growth kinetics– Batch, Fed-batch, and Continuous culture. Principles of upstream processing – Media preparation, Inocula development, and sterilization.	
UNIT- II-Bioreactors and downstream processing	**15**
Bioreactors- Significance of Impeller, Baffles, Sparger; Specialized bioreactors- design and their functions: airlift bioreactor, tubular bioreactors, membrane bioreactors, tower bioreactors, fluidized bed reactor, packed bed reactors Downstream processing- cell disruption, precipitation methods, solid-liquid separation, liquid-liquid extraction, filtration, centrifugation, chromatography, drying devices (Lyophilization and spray dry technology), crystallization, biosensors-construction and applications, Microbial production of Ethanol and amylase.	
Unit III- Fundamentals of Environmental Biotechnology	**15**
Introduction to Environmental Biotechnology- Principles of Environmental Science. Role of Biotechnology in Environmental Conservation. Microbial Processes in Environmental Biotechnology. Pollution and Biotechnology – Major issues in environmental pollution and the role of biotechnology in addressing them. Biotechnological Methods of Pollution Detection-General bioassay methods for pollution detection. Cell biological methods for assessing pollution levels. Use of biosensors in pollution monitoring. Biotechnological Methods in Pollution Abatement-Reduction of CO2 emission using biotechnological approaches. Addressing eutrophication through biotechnological interventions. Application of cell immobilization techniques in pollution abatement.	
Unit IV- Bioremediation and Waste Management	**15**
Importance of bioremediation in environmental cleanup. Types of contaminants suitable for bioremediation. Microorganisms used in bioremediation. *In-situ* Bioremediation Methods. – Bioaugmentation. Biostimulation. Bioventing. Phytoremediation. *Ex-situ* Bioremediation Methods –Composting, Land farming, Biopile and bioslurry systems. Xenobiotics. Bio metallurgy and bio-mining. Waste water Management. Waste water Characterization and Composition. Biological Processes in Waste water Treatment. Activated Sludge Process and Biological Nutrient Removal, Anaerobic Digestion and Biogas Production. Solid Waste Management.	

Course Title	**Bioprocess and Environmental Biotechnology (Practical)**	Practical Credits	**02**
Course No.	**DSC-A16 (P)**	Contact hours	**60 hrs**

Content of Practical

1. Bacterial growth curve.
2. Calculation of the thermal death point (TDP) of a microbial sample.
3. Study of fermentor- Demonstration.
4. Production of wine.
5. Estimation of the percentage of alcohol, total acidity & volatile acidity in wine.
6. Production and analysis of ethanol.
7. Production and analysis of amylase.
8. Production and analysis of lactic acid.
9. Isolation of industrially important microorganisms from natural resources.
10. Standard analysis of Water.

Practical Assessment

Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exams**	
C1 Test	10	25	**50**
C2 Test	10		
Record & Attendance	05		
Total	**25**	**25**	

References:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (3rd Edn.).2022
6. Cambridge University Press. 2002.

Internship for Graduate Programme

Course title	**Internship Discipline specific**
No of contact hours	**90**
No credits	**2**
Method of evaluation	**Presentations/Report submission/Both**

Project Assessment			
Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/type	**Weightage in Marks**	**Practical Exams**	
Data maintenance	10	Presentation/Report/Both **25**	**50**
Assessment	10		
Attendance	05		
Total	**25**	**25**	

- Internship shall be Discipline Specific of 90 hours (2 credits) with duration 4-6 weeks.
- Internship may be full-time/part-time (full-time during semester holidays and part-time in theacademic session)
- The student should submit the final internship report (90 hours of Internship) to the mentor forcompletion of the internship.
- The detailed guidelines and formats shall be formulated by the universities separately asprescribed in accordance to UGC and AICTE guidelines.

Model Theory Question Paper

B.Sc., Biotechnology (Basic /Hons.)

Semester: III & IV (DSC and OE)

(Formative Assessment Marks: 40; Summative Assessment Marks: 60)

Month and Year:
Subject: Biotechnology

Title of the Paper:

Duration: 2.5 Hrs Max marks: 60

Instruction to the candidates: .....

Q. No	Questions	Marks allotted
1	**Define/Explain any Five of the Following:**	5 × 2=10
a.		
b.		
c.		
d.		
e.		
f.		
g.		
	Write a note on any Five of the Following:	5 × 6=30
2		
3		
4		
5		
6		
7		
8		
	Section C: Answer any TWO questions	2 × 10=20
10		
11		
12		
13		

******

Model Theory Question Paper

B.Sc., Biotechnology (Basic /Hons.)
Semester: V (Paper -5 and Paper 6)
(Formative Assessment Marks: 40; Summative Assessment Marks: 60)

Month and Year:
Subject: Biotechnology

Title of the Paper:

Duration: 2.5 Hrs Max marks: 60

Instruction to the candidates: .....

Q. No	Questions	Marks allotted
1	**Define/Explain any Five of the Following:**	5 × 2=10
a.		
b.		
c.		
d.		
e.		
f.		
g.		
	Write a note on any Five of the Following:	5 × 6=30
2		
3		
4		
5		
6		
7		
8		
	Section C: Answer any TWO questions	2 × 10=20
10		
11		
12		
13		

Model Theory Question Paper

B.Sc., Biotechnology (Basic /Hons.)
Semester: VI (Paper -7 and Paper 8)
(Formative Assessment Marks: 40; Summative Assessment Marks: 60)

Month and Year:
Subject: Biotechnology

Title of the Paper:

Duration: 2.5 Hrs Max marks: 60

Instruction to the candidates: .....

Q. No	Questions	Marks allotted
1	**Define/Explain any Five of the Following:**	5 × 2=10
a.		
b.		
c.		
d.		
e.		
f.		
g.		
	Write a note on any Five of the Following:	5 × 6=30
2		
3		
4		
5		
6		
7		
8		
	Section C: Answer any TWO questions	2 × 10=20
10		
11		
12		
13		

*****

PRACTICAL: DSC-3P, BTC 301 III-SEMESTER (Biomolecules)

(Formative Assessment Marks: 25; Summative Assessment Marks: 25)

Time: 3 Hrs **Max Marks: 25**

Q1. you are given two tubes A & B. Estimate the activity of salivary amylase and report which tube contains activity.

Or

You ar given tubes A ,B, & C containing buffers of different pH . Estimate the activity of salivary amylase and report in which tube the Maximum activity is obtained

12Marks

Scheme of Valuation

Principle and procedure-2M

Conducting experiment -6M

Calculation/Tabular column /observation -2M

Result-2M

Q2. Estimation of Protein by Biuret Method

Or

Estimation of Maltose by DNS method **08M**

Scheme of Valuation

Principle and procedure-2M

Conducting experiment -4M

Report -2M

Q3. Viva **05M**

B.Sc., Biotechnology (Basic /Hons.)

PRACTICAL: DSC-4P, BTC 401

IV-SEMESTER (Molecular Biology)

(Formative Assessment Marks: 25; Summative Assessment Marks: 25)

Time: 3 Hrs Max Marks: 25

Q1. Any one of the following colorimetric estimations**: 12 M**

a. DNA by DPA method

b. RNA by Orcinol method

Scheme of Valuation

Principle and procedure-2M

Conducting experiment -6M

Calculation/Tabular column /observation -2M

Result-2M

Q2. Comment on A, B, C and D - ---------- **08M**

Q3. Viva 05M

B.Sc., Biotechnology (Basic / Hons.)
PRACTICAL: DSC–A10 (P)
V-SEMESTER (Genetic Engineering)
Paper-V

Time: 3 Hrs **Max Marks: 25**

Q1. Conduct any one of the following experiments. 12 M

a. Isolation of DNA from the given sample (Plant/Animal/ Bacteria)

b. Quantification of DNA

c. Quantification of RNA

Scheme of Valuation

Principle and procedure-2M

Conducting experiment -6M

Calculation/Tabulation/observation -2M

Result-2M

Q2. Comment on A, B, C and D 08M

1.Laminar air flow Hood
2.colorimeter
3.PCR
4.Agarose Gel electrophoresis
5.Spectrophtometer

Q3.Viva 05M

PRACTICAL: DSC-A-12 (P)
V-SEMESTER (Plant and Animal Biotechnology)
Paper-VI

Time: 3 Hrs **Max Marks: 25**

Q1. Conduct any one of the following experiments 12 M

a. Preparation of explant

b. Synthetic Seed preparation/Initiation of Suspension culture

c. Determination of Cell viability using Trypan Blue Exclusion method

Scheme of Valuation

Principle and procedure - 2M

Conducting experiment - 6M

Calculation/Tabulation/observation - 2M

Result - 2M

Q2.Comment on A, B, C and D 08M

1.Callus culture
2.Growth hormones
3.Micropropogation stages
4 . Dulbecco's Modified Eagle Medium (DMEM)
5.Fetal Bovine serum albumin
5.Laminar Airflow Hood
6.MS media

Q3.Viva 05M

Practical Examination Scheme

B.Sc., Biotechnology (Basic /Hons.)
PRACTICAL: DSC
VI-SEMESTER (Immunology)

Time: 3Hrs **Max Marks: 25**

Q1.conduct any one of the following experiments 12M

a. ABO blood typing
b.ODD
c. WBC counting using Haemocytometer

Scheme of Valuation:

- Principle and Procedure- 2M
- Conducting experiment-6M
- Calculation/Tabulation/Observation-2M
- Result-2M

Q2. Comment on A,B 08M

Identification- 1 M
Description - 3 M

1.Radial immunodiffusion technique

2.cells of the immune system

2.ELISA

4.Westren blotting

Q3.Viva 05M

Practical Examination Scheme

B.Sc., Biotechnology (Basic /Hons.)
PRACTICAL: DSC
VI-SEMESTER (Bioprocess and Environmental Biotechnology)

Time: 3Hrs **Max Marks: 25**

Q1.conduct any one of the following experiments 12M

a. Estimation of percentage of alcohol.
b. Estimation of amylase activity
c. Estimation of BOD in the given water sample

Scheme of Valuation:

- Principle and Procedure- 2M
- Conducting experiment-6M
- Calculation/Tabulation/Observation-2M
- Result-2M

Q2. Comment on A,B 08M

Identification- 1 M
Description - 3 M

1. Bacterial growth curve
2. Fermentor
3. Wine
4. Industrially important microorganisms

Q3.Viva 05M

****