

**SYLLABI AND SCHEME OF
EXAMINATIONS
FOR
DISCIPLINE SPECIFIC COURSES
OF SINGLE MAJOR PROGRAMS
B.Sc. (Biotechnology)**

(Based on Curriculum and Credit Framework for UG Programs under NEP)



**WITH EFFECT FROM
THE
SESSION 2024-25**

**MAHARSHI DAYANAND UNIVERSITY
ROHTAK (HARYANA)**

Credit Structure for Undergraduate Programmes (Single Major) B.Sc. Biotechnology

Semester	Discipline-Specific Courses (DSC) / Major Course	Minor(MIC)/ Vocational (VOC)/ Skill Enhancement Courses (SEC)/ Internship	Multidisciplinary courses (MDC)	Ability Enhancement courses (AEC)	Dissertation	Value-Added Courses (VAC)	Total Credits
I	DSC - A1 @ 4 credits Basics of Biomolecules	MIC1 @ 4 credits To be chosen from the basket	MDC1 @ 3 credits To be chosen from the basket	AEC1 @ 2 credits Communication Skills from common pool	-----	VAC1 @ 2 credits	22
	DSC – A2 @ 4 credits Cell Biology	SEC1@ 3 credits Laboratory Techniques- 1				To be chosen from the courses floated by the University	
II	DSC – A3 @ 4 credits Basics of Microbiology	MIC2 @ 4 credits To be chosen from the basket	MDC2 @ 3 credits To be chosen from the basket	AEC2 @ 2 credits Communication Skills from common pool	-----	VAC2 @ 2 credits To be chosen from the courses floated by the University	22
	DSC – A4 @ 4 credits Basics of Biotechnology	SEC2@ 3 credits Laboratory Techniques –II					
Students exiting the programme after second semester and securing 48 credits including 4 credits of summer internship (24CBTS402IN01) will be awarded UG Certificate in Biotechnology							
III	DSC – A5 @ 4 credits Fundamentals of Molecular Biology	MIC3 @ 4 credits To be chosen from the basket	MDC3 @ 3 credits To be chosen from the basket	AEC3 @ 2 credits Communication Skills from common pool		VAC3 @ 2 credits To be chosen from the courses floated by the University	22
	DSC – A6 @ 4 credits Fundamentals of Immunology	SEC3@ 3 credits Laboratory Techniques –III					
IV	DSC – A7 @ 4 credits Metabolism	MIC4(VOC)@ 4 credits To be chosen from the basket	-----	AEC4 @ 2 credits Communication Skills from common pool	-----	VAC4 @ 2 credits To be chosen from the courses floated by the University	24
	DSC – A8 @ 4 credits Introduction to Bioinformatics						
	DSC – A9 @ 4 credits Genetics						
	DSC – A10 @ 4 credits Bioanalytical tools and Biostatistics						
Students exiting the programme after fourth semester and securing 94 credits including 4 credits of summer internship (25CBTS404IN01) will be awarded UG Diploma in Biotechnology							
V	DSC – A11 @ 4 credits Recombinant DNA Technology	MIC5(VOC)@ 4 credits To be chosen from the basket	-----	-----	-----	-----	24
	DSC – A12 @ 4 credits Plant and Animal Biotechnology						
	DSC – A13 @ 4 credits Fundamentals of Enzymology	Internship @ 4 credits# 26CBTS405IN01					

Syllabi and S.O.E. for Under Graduate Single Major Program(s) w.e.f. 2024-25 session

	DSC – A14 @ 4 credits Bioprocess Engineering						
VI	DSC – A15 @ 4 credits Microbial Technology	MIC6(VOC)@ 4 credits To be chosen from the basket	-----	-----	-----	-----	22
	DSC – A16 @ 4 credits Nano Biotechnology						
	DSC – A17 @ 4 credits Genomics & Proteomics	SEC4@ 2 credits Laboratory Techniques –IV					
	DSC – A18 @ 4 credits Medical Microbiology						
Students will be awarded 3-year UG Degree in Biotechnology upon securing 136 credits.							
VII	DSC – H1 @ 4 credits Cell Biology	SEC5 @ 4 credits Lab Course -I	-----	-----	-----	-----	24
	DSC – H2 @ 4 credits Biomolecules & Metabolism						
	DSC – H3 @ 4 credits Molecular Biology						
	DSC – H4 @ 4 credits Microbiology						
	DSC – H5 @ 4 credits Genetic Engineering						
VIII (4yr UG Hon.)	DSC – H6 @ 4 credits Immunology	SEC6 @ 4 credits Lab Course -II	-----	-----	-----	-----	24
	DSC – H7 @ 4 credits Bioinformatics						
	DSC – H8 @ 4 credits Plant Biotechnology						
	DSC – H9 @ 4 credits Diagnostics						
	DSC – H10 @ 4 credits Human Molecular Physiology and Development Biology						
VIII (4yr UG Hon. with Research)	DSC – H6@ 4 credits Immunology	SEC6 @ 4 credits Lab Course -II	-----	-----	Research project/ Dissertation @ 12 credits	-----	24
	DSC – H7@ 4 credits Bioinformatics					TOTAL CREDITS	184

Note:#Four credits of internship earned by a student during summer internship after 2nd semester or 4th semester will be counted in 5th semester of a student who pursue 3 year UG Programmes without taking exit option.

Syllabi and S.O.E. for Under Graduate Single Major Program(s) w.e.f. 2024-25 session

Discipline Specific Courses/ Major Course			Credits Distribution			Total Credits	Workload			Total Workload	Marks			
	Nomenclature of Course	Course Code	L	T	P		L	T	P		Theory	Practical	Total Marks	
Semester I (Session 2024-25)														
DSC - A1 @ 4 credits	Basics of Biomolecules	24CBTS401DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC – A2 @ 4 credits	Cell Biology	24CBTS401DS02	4	0	0	4	4	0	0	4	30	70	-	100
Semester II (Session 2024-25)														
DSC – A3 @ 4 credits	Basics of Microbiology	24CBTS402DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC – A4 @ 4 credits	Basics of Biotechnology	24CBTS402DS02	4	0	0	4	4	0	0	4	30	70	-	100
Semester III (Session 2025-26)														
DSC – A5 @ 4 credits	Fundamentals of Molecular Biology	25CBTS403DS01	4	0	0	4	4	0	0	4	30	70		100
DSC – A6 @ 4 credits	Fundamentals of Immunology	25CBTS403DS02	4	0	0	4	4	0	0	4	30	70	-	100
Semester IV (Session 2025-26)														
DSC – A7 @ 4 credits	Metabolism	25CBTS404DS01	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A8 @ 4 credits	Introduction to Bioinformatics	25CBTS404DS02	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A9 @ 4 credits	Genetics	25CBTS404DS03	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A10 @ 4 credits	Bioanalytical tools and Biostatistics	25CBTS404DS04	3	0	1	4	3	0	2	5	25	50	25	100
Semester V (Session 2026-27)														
DSC – A11 @ 4 credits	Recombinant DNA technology	26CBTS405DS01	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A12 @ 4 credits	Plant and Animal Biotechnology	26CBTS405DS02	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A13 @ 4 credits	Fundamentals of Enzymology	26CBTS405DS03	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A14 @ 4 credits	Bioprocess Engineering	26CBTS405DS04	3	0	1	4	3	0	2	5	25	50	25	100
Semester VI (Session 2026-27)														
DSC – A15 @ 4 credits	Microbial Technology	26CBTS406DS01	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A16 @ 4 credits	Nano Biotechnology	26CBTS406DS02	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A17 @ 4 credits	Genomics & Proteomics	26CBTS406DS03	4	0	0	4	4	0	0	4	30	70	-	100
DSC – A18 @ 4 credits	Medical Microbiology	26CBTS406DS04	4	0	0	4	4	0	0	4	30	70	-	100
Semester VII (Session 2027-28)														
DSC – H1 @ 4 credits	Cell Biology	24CBT201DS01	4	0	0	4	4	0	0	4	30	70	-	100

Syllabi and S.O.E. for Under Graduate Single Major Program(s) w.e.f. 2024-25 session

DSC – H2 @ 4 credits	Biomolecules & Metabolism	24CBT201DS02	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H3 @ 4 credits	Molecular Biology	24CBT201DS03	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H4 @ 4 credits	Microbiology	24CBT201DS04	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H5 @ 4 credits	Genetic Engineering	24CBT201DS05	4	0	0	4	4	0	0	4	30	70	-	100
Semester VIII (Session 2027-28)														
DSC – H6 @ 4 credits	Immunology	24CBT202DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H7 @ 4 credits	Bioinformatics	24CBT202DS02	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H8 @ 4 credits	Plant Biotechnology	24CBT202DS03	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H9 @ 4 credits	Diagnostics	24CBT202DS04	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H10 @ 4 credits	Human Molecular Physiology and Development Biology	24CBT202DS05	4	0	0	4	4	0	0	4	30	70	-	100

L: Lecture; T: Tutorial; P: Practical

Internship Evaluation:

After completion of internship, students need to prepare a comprehensive report highlighting their learning and takeaways during the internship period as per MDUR Internship Regulations 2025. The report shall be signed by the Internship Supervisor from respective UTD/Centre/College and Mentor from internship providing organizations. Evaluation of internship report and viva-voce will be jointly conducted by Internship Supervisor and Mentor on the time and date notified by the concerned HoDs/Directors/Principals. The mentor from host organization may participate in the evaluation through online/offline mode. In case of non-availability of respective mentor, the available relevant mentor as decided by the concerned HOD/Director/Principal may be utilized for the purpose of evaluation.

Suggested distribution of marks will be as below:

S. No.	Components	Employability-Oriented Internship	Research-Oriented Internship																
1	Assessment by Mentor <table border="1"><tr><td>S.No.</td><td>Details</td><td>Marks</td></tr><tr><td>1</td><td>Skills learned</td><td>15</td></tr><tr><td>2</td><td>Regularity</td><td>10</td></tr><tr><td>3</td><td>Conduct</td><td>5</td></tr><tr><td></td><td>Total (30)</td><td></td></tr></table>		S.No.	Details	Marks	1	Skills learned	15	2	Regularity	10	3	Conduct	5		Total (30)		30	30
			S.No.	Details	Marks														
			1	Skills learned	15														
			2	Regularity	10														
			3	Conduct	5														
				Total (30)															
2	Internship Report		40	40															
3	Viva-Voce		30	30															

EVALUATION OF PROJECT REPORT / DISSERTATION

In case of the Project reports/Dissertation/Research Project shall be accessed by the system of 70% external and 30% internal. External examiners shall be invited from amongst the panel of examiners (ordinarily not below the rank of Associate Professor) recommended by the concerned Board of Studies.

Syllabi and S.O.E. for Under Graduate Single Major Program(s) w.e.f. 2024-25 session
Syllabi for Under Graduate Programme in Biotechnology

Semester 1
 Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Basics of Biomolecules	Course Code	24CBTS401DS01
Hours per Week	4	Credits	4
Maximum Marks	100 (70EA+30IA)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1: Understand physical and chemical basis of biomolecules involved in life processes. CLO 2: Demonstrate the knowledge of chemical basis of biomolecules, Classify, define, draw structures and correlate to various properties, functions of carbohydrates. CLO 3: Classify, draw structures and correlate the chemical structures of lipids, amino acids, and nucleic acids to their organization, properties and functions. CLO 4: Gain fundamental knowledge of proteins biochemistry.			
Unit 1: Carbohydrates: Definition, classification, nomenclature of carbohydrates. Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Glycoproteins and their biological functions.			
Unit 2: Lipids: Classification, nomenclature and properties of fatty acids. Essential fatty acids. Structure and properties of phospholipids, sphingolipids, glycolipids, gangliosides, prostaglandins. Terpenoids and isoprenoids - definition and representative structures, steroids. Concept of acid value, saponification value and iodine value.			
Unit 3: Amino Acids and Proteins: Common structural features of amino acids. Classification by R group, Zwitter ion structures, acid-base properties and titration curves of amino acids. Essential amino acids. Physico-chemical properties of amino acids. Basic introduction to terms: domains & motifs. Forces that stabilize the protein's structure (electrostatic forces, hydrogen and disulfide bonds, hydrophobic associations). Primary, secondary, tertiary & quaternary structures of proteins.			
Unit 4: Nucleic acids: Chemical structure and base composition of nucleic acids, Chargaff's rules, Watson Crick Model (B-DNA) and other forms of DNA (A- and Z-DNA). Nucleosides & Nucleotides. Biologically important nucleotides. Types and structure of RNA. Denaturation and renaturation of DNA.			
References: 1. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox (2017) Maxmillan/Worth publishers/W.H. Freeman & Company 2. Biochemistry, 5th edition, by R.H. Garrett and C.M. Grisham (2012). Michal Sabat, University of Virginia. 3. Outlines of Biochemistry by E.E. Conn, P.K. Stump, G. Bruening and Ray H. Doi (1987), John Wiley 4. Biochemistry: International edition by Jeremy M Berg, John L Tymoczko and Lubert Stryer. (2015). W.H. Freeman & Co., N.Y. 5. Biochemistry by J.L. Jain, S. Chand & Co. 6. Essentials of Biochemistry, 5th edition by Satyanarayana and Chakrapani. (2019) Elsevier, India 7. Chemistry of Biomolecules: An Introduction, by R.J. Simmonds. Royal Society of Chemistry			

Syllabi for Under Graduate Programme in Biotechnology

Semester 1

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Cell Biology	Course Code	24CBTS401DS02
Hours per Week	4	Credits	4
Maximum Marks	100 (70EA+30IA)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1: Understand the structures and functions of basic components of plant and animal cell, especially macromolecules, membranes and organelles. CLO 2: Understand how these cellular components are synthesized and degraded in cells CLO 3: Explain the structure and function of prokaryotic cell & its components CLO 4: Describe the various models and solute transporter systems belonging to cell membrane and will explain cell cycle and apoptosis			
Unit 1: Basics of Cell Biology – Discovery of cell and Cell Theory; Comparison between plant and animal cells; Structure and function of Protoplasm, Cell wall, Plasma membrane, Cytoskeleton, Mitochondria, Chloroplast, ER, Golgi complex.			
Unit 2: Structure and function of Lysosome, endosome and microbodies, Ribosome, Centriole, Nucleus, Chromosomes, Biogenesis of Cellular organelles – Biogenesis of mitochondria, chloroplast, ER, Golgi complex, Biosynthetic process in ER and Golgi apparatus,			
Unit 3: Structure and function of Prokaryotic cell and its components - The Slime and the cell wall of bacteria containing peptidoglycan and related molecules; the outer membrane of Gram-negative bacteria, the cytoplasmic membrane. Water and ion transport, mesosomes, flagella, Pilus, fimbriae, ribosomes, carboxysomes, endospores, exospores, cysts.			
Unit 4: Membrane structure and transport – Models of membrane structure, Membrane lipids, proteins and carbohydrates; Solute transport by Simple diffusion, Facilitated diffusion and Active transport, Cell cycle - An overview of cell cycle, Components of cell cycle control system.			
References: 1. Molecular Biology of cell–Bruce Alberts et al, Garland publications 2. Animal Cytology & Evolution–MJD, White Cambridge University Publications 3. Molecular Cell Biology–Daniel, Scientific American Books. 4. Cell Biology–Jack D. Bruke, The William Twilkins Company. 5. Cell Biology–Ambrose & Dorothy M Easty, ELBS Publications. 6. Fundamentals of Cytology–Sharp, McGraw Hill Company 7. Cytology–Wilson & Marrison, Reform Publications 8. Molecular Biology–Smith Faber & Faber Publications 9. Cell Biology& Molecular Biology–EDPR oberties & EMFR oberties, Sauder College.			

Syllabi for Under Graduate Programme in Biotechnology

Semester II

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Basics of Microbiology	Course Code	24CBTS402DS01
Hours per Week	4	Credits	4
Maximum Marks	100 (70EA+30IA)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1: Illustrate the knowledge of history, scope, classification and various approaches of study of microbes. Compare and characterize prokaryotic and eukaryotic cells based on morphology, different groups of microorganisms based on their structures. CLO 2: Illustrate the knowledge of microbial growth, reproduction and exhibit skill of isolation, purification, and preservation of microbial cultures. CLO 3: Gain the knowledge of characteristics of viruses, their types and mode of multiplication. Also understand the various control measures of microbes CLO 4: Understand the role of micro-organisms in the environment, for making industrially important fermented foods and also gain the knowledge of spoilage of food and food borne diseases.			
Unit 1: History and evolution of microbiology with special reference to the contribution of the scientists: A. V. Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner and Alexander Fleming. Introduction to classification of microorganisms: Microbial taxonomy. Stains and staining procedures: Acidic, basic and neutral stains, Gram staining, Acid fast staining, Flagella staining, Endospore staining. Distribution and characterization: Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi and Protozoa.			
Unit 2: Cultivation and Maintenance of microorganisms: Nutritional requirements of microorganisms. Methods of isolation, purification and preservation of microorganisms. Microbial growth: Study of growth curve, generation time, quantitative measurement of growth and factors affecting growth of bacteria. Basic of Bacterial. Transformation, Transduction and Conjugation.			
Unit 3: Viruses: General characteristics of viruses, difference between virus and typical microbial cell, structure, different shapes and symmetries with one example of each type, classification of viruses on the basis of nucleic acids, phage and animal cell viruses, example of each and their importance. Brief idea of lytic cycle and lysogeny.			
Unit 4: Food and Water Microbiology: Microbial contamination of water, coli forms and non coliforms. Sewage composition and its disposal. Microbial spoilage of foods. Major food born infections and intoxications. Microbiology of fermented Foods. Microbial ecology: Microenvironment & Niche.			
References: - Alexopoulos CJ, Mims CW, and Blackwell M.(1996).IntroductoryMycology.4th edition. John and Sons, Inc. - Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology.7thedition, CBS Publishers and Distributors, Delhi, India. - Kumar HD.(1990).Introductory Phycology.2nd edition. Affiliated East Western Press. - MadiganMT,MartinkoJM andParkerJ.(2009).BrockBiologyof Microorganisms. 12th edition.Pearson/Benjamin Cummings. - Pelczar MJ, Chan ECS and Krieg NR.(1993). Microbiology. 5th edition. McGraw Hill Book Company. - Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan. - Tortora, G.J., Funke, B.R.and Case, C.L.(2016) Microbiology: An introduction, Pearson Education. - Wiley, J., Sherwood, L. and Woolverton, C.J. (2017 Prescott 'smicrobiology, McGraw-Hill Education			

Syllabi for Under Graduate Programme in Biotechnology

Semester II

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Basics of Biotechnology	Course Code	24CBTS402DS02
Hours per Week	4	Credits	4
Maximum Marks	100 (70EA+30IA)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1 Understand the concepts in biotechnology CLO 2: Gain the knowledge of tools of genetic engineering CLO 3: Gain the knowledge of scope and applications of plant and animal biotechnology CLO 4: Get an insight of scope and applications of biotechnology in environment, food and chemical industries			
Unit 1: Introduction to biotechnology – an interdisciplinary pursuit; Main areas of application of biotechnology; Biotechnology research in India and biotechnology in context of developing world; Public perception of biotechnological products; Brief account of safety guidelines, risk assessment and ethics in biotechnology; Very brief account of intellectual property rights.			
Unit 2: Introduction of genetic engineering, basics of cloning (PCR, restriction enzymes, vectors etc.) gene and genomes, proteins and proteome, history of genetic manipulations, DNA fingerprinting and forensic analysis. Potential laboratory biohazards of genetic engineering.			
Unit 3: Introduction of animal tissue culture (brief of history, culture media, substrate surfaces, culture procedures, primary cultures, cell lines, organ culture and tissue engineering etc.). Introduction of plant tissue culture (in brief history, culture media, explants, totipotency, dedifferentiation and types of cell & tissue culture etc.). Scope and applications of animal biotechnology and plant biotechnology.			
Unit 4: Environmental Biotechnology: An overview, scope and market of biological control of environment. Brief account on bioremediation and waste treatment biotechnology, microbial insecticides, biofertilizers, microbes in oil recovery and bioleaching.			
References: 1. Elements of Biotechnology- PK Gupta 2. Gene Biotechnology-S.N. Jogdand 3. Biotechnology 5th Edition (Cambridge)-John E. Smith 4. Biotechnology for beginners–Reinhard Renneberg Academic Press			

Syllabi for Under Graduate Programme in Biotechnology

Semester III

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Fundamentals of Molecular Biology	Course Code	25CBTS403DS01
Hours per Week	4	Credits	4
Maximum Marks	100 (70EA+30IA)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1: Acquire the knowledge and understanding of the fundamentals of molecular processes of life. CLO 2: Analyse architecture of the genomes, genes, and the flow of genetic information CLO 3: Exhibit knowledge of differences in fundamental molecular processes between prokaryotes and eukaryotes CLO 4: Understand basics of gene expression and regulation.			
Unit 1: DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bidirectional replication, DNA polymerases, The replication complex: prepriming proteins, primosome, replisome			
Unit 2: DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, Homologous recombination overview			
Unit 3: RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains, Transcription in eukaryotes: Eukaryotic RNA polymerases, mechanism of transcription initiation, promoter clearance and elongation			
Unit 4: Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides			
References: 1. Molecular Biology of the Cell, Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Garland Science Publishing (2008). 2. The world of the Cell, Becker, W.M., Klein smith, L.J. and Hal din, J., Seventh Edition, Pearson Education (2008). 3. The Cell - A Molecular Approach (sixth edition) Cooper, Geoffrey M. Sunderland (MA): Sinauer Associates, Inc.;2013 4. Cell and Molecular Biology: Concepts and Experiments, 5th Edition, Gerald Karp: Wiley 2007 5. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub. 6. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.			

Syllabi for Under Graduate Programme in Biotechnology

Semester III

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Fundamentals of Immunology	Course Code	25CBTS403DS02
Hours per Week	4	Credits	4
Maximum Marks	100 (70EA+30IA)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1: Conceptualize the basics of immune system and its role and responses to fight invading pathogens. CLO 2: Understand and describe antigen, antibodies and their interactions. CLO3: Know about the basic principles of immune cells responses. CLO 4: Learn about the diseases related to immune system, Immuno techniques and vaccines			
Unit 1: Introduction of immune system and immunology, Organs and cells in immune system, Primary and secondary lymphoid organs: thymus, bone marrow, spleen, lymph nodes and mucosa associated lymph tissues (MALT). Types of immunity (innate and adaptive immunity)			
Unit 2: Properties and structure of antigen, types of antigen: based on their origin and basis of immune response; antigen processing and presentation. General structure of antibodies, types of antibodies, properties and function. antigen-antibody interaction			
Unit 3: Immune response: cell mediated and its effector mechanism; humoral mediated and its effector mechanism; Non-specific immune response; Major Histocompatibility complex (MHC): Types and importance; MHC I and II structure, mechanism and Functions			
Unit 4: Hypersensitivity, types of hypersensitivity, autoimmune diseases: an overview and examples. Immuno techniques: Immuno-diffusion, immuno-electrophoresis, ELISA, RIA, fluorescence activated cell sorter (FACS), immuno blotting, Hybridoma technology, Vaccines and its types.			
References: 1. Benjamin E. Immunology – A short course 4th Edition, John Wiley, NewYork 2. Kuby J. Immunology, 8th Edition, W.H. Freeman & Co., NewYork 3. Roitt, I.M. Essential Immunology, 12th Edition, Oxford Black Well Science, London 4. Tizard I.R. Immunology – An introduction, 9th Edition, Philadelphia Saunders College press. 5. Gupta P.K. Biotechnology and Genomics, Rastogi Publications Meerut 6. Ommerville et al. Alcamo's Fundamentals of Microbiology, Jones and Bartlett Publishers.			

Syllabi for Under Graduate Programme in Biotechnology

Semester IV

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Metabolism	Course Code	25CBTS404DS01
Hours per Week	5 (3+2)	Credits	4 (3+1)
Maximum Marks	100 (75Theory (50 EA+25IA) +25Practical)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1: Acquire the knowledge of the energy transactions during metabolism. CLO 2: Gain insights of the metabolic pathways of carbohydrate metabolism CLO 3: Describe ETC and apply the concept of oxidative phosphorylation and oxidation of fatty acids. CLO4: Analyse how amino acid metabolism takes place in the body, understanding of the different pathways of nucleotide biosynthesis			
Unit 1: Bioenergetics: Basic principles of bioenergetics- Concept of free energy, standard free energy, relation between equilibrium constant and standard free energy change and coupled reactions. Biological oxidation-reduction reactions. High-energy compounds.			
Unit 2: Carbohydrate Metabolism: Glycolysis. Alcoholic and lactic acid fermentations. Feeder pathways. TCA cycle. Gluconeogenesis. Glycogenesis and glycogenolysis. Pentose phosphate pathway.			
Unit 3: Electron Transport Chain and Oxidative Phosphorylation: organization and sequence of electron carriers, sites of ATP production, Oxidative phosphorylation: chemiosmotic theory, structure of ATP synthase, Transport of reducing equivalents from cytosol into mitochondria. Lipid Metabolism: Introduction, hydrolysis of triacylglycerols, beta-oxidation of saturated fatty acids			
Unit 4: Amino acid Metabolism: General reactions of amino acid metabolism: transamination, oxidative and non-oxidative deamination and decarboxylation. Urea cycle. Nucleotide Metabolism: de novo and salvage pathway for purine and pyrimidine nucleotides synthesis.			
PRACTICAL 1. Preparation of solutions and buffers 2. Estimation of blood glucose. 3. Preparation of absorbance spectra for nucleic acids 4. Demonstration of Beer Lambert law 5. Titration curves for amino acids 6. Estimation of proteins, DNA, RNA, carbohydrates, ascorbic acid. 7. Preparation of starch from potato and determination of achromatic point by salivary amylase 8. Isolation of total lipids by Folch method and determine acid value. 9. Isolation of casein from milk and determination of isoelectric pH.			
References: 1. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox (2000) Maxmillan/Worth publishers. 2. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999). John Wiley & Sons, NY 3. Biochemistry, 2nd edition, by R.H. Garrett and C.M. Grisham (1999).Saunders College Publishing, NY. 4. Outlines of Biochemistry by E.E. Conn, P.K. Stump, G. Bruening and Ray H. Doi (1987). John Wiley & Sons, NY 5. Biochemistry, 2nd edition, by Laurence A. Moran, K.G. Scrimgeour, H. R. Horton, R.S. Ochs and J. David Rawn (1994), Neil Patterson Publishers Prentice Hall.			

Syllabi for Under Graduate Programme in Biotechnology

Semester IV

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Introduction to Bioinformatics	Course Code	25CBTS404DS02
Hours per Week	5 (3+2)	Credits	4 (3+1)
Maximum Marks	100 (75Theory (50 EA+25IA) +25Practical)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1: Understand the basic principles and concepts of bioinformatics CLO 2: Concept utilization in applying bioinformatics tools to solve biological problems. CLO 3: Understanding of various databases available to explicit research in Biology. CLO 4: To develop familiarity with various interfaces of Bioinformatics resources.			
Unit 1: Overview of bioinformatics: history, scope, and detailed applications. Introduction to biological databases and data types, Bioinformatics resources (GenBank, ENA, DDBJ, UniProt, PDB etc): Understanding the structure of each source and using it on the web. Detailed Overview of NCBI.			
Unit 2: Basic structural introduction of Biomolecules studied in Bioinformatics (polynucleotide, polypeptides, Gene, Protein). Format of Sequence databases, Introduction to Pairwise Sequence Analysis and Sequence alignment, Introduction and applications of Multiple sequence alignment.			
Unit 3: Basic introduction to following terms: Genomics, proteomics, transcriptomics, metabolomics, chemo informatics, pharmacogenomics, system Biology, homology modelling, In silico drug design. Phylogenetics: introduction and basic concepts			
Unit 4: Introduction to various biological data generating techniques- sequencing, microarray, RNA seq, mass spectroscopy etc. Human Genome Project objectives and applications. Introduction to Various Bioinformatics tools- Expasy, BLAST, Clustal omega, Prosite, InterPro			
PRACTICAL 1. Overview of NCBI homepage URL is: https://www.ncbi.nlm.nih.gov 2. Understanding and using on web: Genbank, Uniprot, PDB 3. Understanding and using tools at Expasy 4. Understanding and using on web: PDB 5. Visit PubMed database. Explore search based on various criteria and using Boolean Operators. 6. Using tools BLAST and interpretation of results 7. Multiple sequence alignment tool Clustal Omega			
References: 1. "Bioinformatics: Principles and Applications" by Zhumur Ghosh and Bibekan and Mallick. 2. "Introduction to Bioinformatics" by S. Jawahar and S.Arumugam. 3. "Bioinformatics: A Practical Handbook" by Rashmi S.Shenoyand Ajay S.Verma. 4. "Bioinformatics: Concepts, Skills, and Applications" by Rastogi S. C. 5. "Practical Bioinformatics" by B. Jayaramand R. K. Shyamasundar. 6. "Bioinformatics For Dummies" by Jean-Michel Claverie and Cedric Notredame. 7. "Introduction to Bioinformatics" by Arthur M. Lesk 8. "Understanding Bioinformatics" by Marketa J.Zvelebil and Jeremy O. Baum. 9. "Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools" by Supratim Choudhuri			

Syllabi for Under Graduate Programme in Biotechnology

Semester IV

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Genetics	Course Code	25CBTS404DS03
Hours per Week	5 (3+2)	Credits	4 (3+1)
Maximum Marks	100 (75Theory (50 EA+25IA) +25Practical)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1: Exhibit conceptual understanding of laws of inheritance, genetic basis of loci and their linkage. CLO 2: Develop critical understanding of allelic variation and cytoplasmic inheritance CLO 3: Comprehend the effect of chromosomal abnormalities leading to genetic disorders. CLO 4: Analyze the effect of mutations on gene functions, dosage and their interactions at population and evolutionary levels.			
Unit 1: Definition, history and Scope. Mendelian genetics: Mendel's work on transmission of traits, Principles of Inheritance, monohybrid, di-hybrid, and trihybrid crosses, Laws of Probability, test cross, backcross, Chromosome theory of inheritance (Sutton-Boveri) and its relation to cell division. Law of segregation & Principle of independent assortment. Extensions of Mendel's Principles: Allelic and Non-allelic interactions overview			
Unit 2: Chromosome and genomic organization: Organization of prokaryotic, viral, and eukaryotic nuclear genome, packaging of DNA molecule into chromosomes, chromosome morphology, chromosome types, concept of euchromatin and heterochromatin (Constitutive and facultative), Special types of chromosomes- Polytene chromosomes and Lampbrush Chromosomes. Chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns and genetic code			
Unit 3: Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents. Chromosomal aberrations: Structural aberrations (Deletions, Duplications, Inversions & Translocations-reciprocal and Robertsonian), position effects of gene expression; Numerical aberrations (Euploidy and Aneuploidy) Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and inheritance of Sex-linked, Sex-influenced, and Sex-limited characters.			
Unit 4: Linkage, Crossing Over and Molecular Mechanism Introduction to linkage and crossing over, Chromosome theory of Linkage, kinds of linkage, linkage groups, factors affecting and significance of linkage, types of Crossing over, Molecular mechanism of crossing over, Cytological basis of crossing over, Extra chromosomal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.			
PRACTICAL 1. Cell division: Permanent slides of animal and plant cells and Cell division 2. Mitotic and meiotic studies in grasshopper testes, onion root tips and flower buds. 3. Study of Mendelian traits: Straight hair, Curly hair, Widow's peak, Dimpled cheek, Hitchhiker's thumb, clasping of handstand Hypertrichosis, Attached ear lobe. 4. Simulation exercises using beads or seeds study the gene interactions:9:3:4, 12:3:1, 9:7, 9:3:3:1(Comb shapes in roosters), 15:1, 13:3. 5. Karyotyping with the help of photograph. 6. Simple genetic problems based on theory 7. Man-Normal and Abnormal-Down and Turner's Syndromes (with the help of slides)			
References: 1. Snustad, D. Peter, and Michael J. Simmons. Principles of genetics. John Wiley & Sons, 2015. 2. Primrose, Sandy B., and Richard Twyman. Principles of genome analysis and genomics. John Wiley & Sons, 2009. 3. Simmons, Michael J., and D. Peter Snustad. Principles of genetics. John Wiley & Sons, 2006. 4. Gupta, P. K. Genetics. Rastogi Publications, 2000. 5. P.K. Gupta; Cytology Genetics Evolution and Plant Breeding, Rastogi Publications, 2002 6. Klug, William S., Michael R. Cummings, Charlotte A. Spencer, and Michael A. Palladino. Concepts of genetics. Pearson, 2014.			

Syllabi and S.O.E. for Under Graduate Single Major Program(s) w.e.f. 2024-25 session

7. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
8. Carroll, Sean B., John Doebley, Anthony JF Griffiths, and Susan R. Wessler. Introduction to genetic analysis. WH Freeman, 2015.

Syllabi for Under Graduate Programme in Biotechnology

Semester IV

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Bioanalytical tools and Biostatistics	Course Code	25CBTS404DS04
Hours per Week	5 (3+2)	Credits	4 (3+1)
Maximum Marks	100 (75Theory (50 EA +25IA) +25Practical)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1: Acquire knowledge of basic analytical tools and techniques of biotechnology. CLO2: Understand the molecular separation and purification techniques essential for working in a biotechnological laboratory. CLO 3: Learn statistical methods to analyze summarize and present data. CLO 4: Demonstrate an understanding of the central concepts of modern statistical theory and their probabilistic foundation			
Unit 1: Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy, Principles and laws of absorption, fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques			
Unit 2: Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC, Introduction to electrophoresis. Agarose-gel electrophoresis, polyacrylamide gel (native and SDS-PAGE), Blotting techniques.			
Unit 3: Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data; Measurement of central tendency (mean, mode and range); Dispersion (standard error and standard deviation); Probability and distribution. Normal, Poisson and binomial distributions.			
Unit 4: Population and sampling test of significance. Test hypothesis; Student t-test for small samples. ANOVA: One-way and two-way, Chi ² test for analysis, correlation and regression; Emphasis on examples from Biological Sciences.			
PRACTICAL 1. Colorimetry estimation of biomolecules 2. Separation of amino acids by paper chromatography 3. Separation of lipids by TLC 4. Agarose gel electrophoresis 5. SDS-PAGE 6. Measurements and sampling 7. Calculation of mean, median and mode 8. Graphical representation of data: Bar Diagrams, Scatter pots, Pie charts in Excel 9. Calculation of one-way and two-way analysis of variance Chi² test for analysis			
References: 1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc. 2. Wilson, K., Hofmann, A., Walker, J.M. and Clokie, S. eds., 2018. Wilson and Walker's principles and techniques of biochemistry and molecular biology. Cambridge university press. 3. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia. 4. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA. 5. 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. 6. Introductory Biostatistics, 1st edition, (2003), Chap T. Le; John Wiley, USA.			

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7. Methods in Biostatistics, (2002), B. K. Mahajan –Jaypee Brothers.
8. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

Syllabi for Under Graduate Programme in Biotechnology

Semester V

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Recombinant DNA Technology	Course Code	26CBTS405DS01
Hours per Week	5 (3+2)	Credits	4 (3+1)
Maximum Marks	100 (75Theory (50 EA +25IA) +25Practical)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO1: Understand concept and scopes of Genetic Engineering and central role of recombinant DNA technology in all fields of Biotechnology. CLO2: Acquire the knowledge of basic concepts and different methodologies used for isolation, purification and manipulation of nucleic acids CLO3: Understand the concepts of various tools and techniques of genetic engineering and its uses in diverse fields of life sciences. CLO4: Learn about the applications of genetic engineering in human welfare			
Unit 1: Genetic Engineering Introduction, scope and applications, Isolation of genomic and plasmid DNA, Quantitative estimation of DNA and RNA, Primer Designing, Polymerase Chain reaction, RT-(Reverse transcription)PCR, Real time PCR, Nucleic acid blotting (Southern, Northern blotting) and hybridization techniques- In-situ hybridization, FISH.			
Unit 2: Nucleic acid Modifying Enzymes: DNA polymerase, Polynucleotide kinase, Alkaline phosphatase, Nucleases, Methylases, Terminal deoxynucleotidyl transferase, Reverse transcriptase, Restriction endonucleases (R.E.)- Nomenclature, types, Recognition sequence, blunt and sticky ends, applications, Ligases, Linker, Adaptor, Homopolymer tailing.			
Unit 3: Cloning Vectors; Types- Plasmid, bacterio phage, phagemid, cosmid. Plasmid Biology: Structural and Functional Organization of Plasmids, Stringent and Relaxed Plasmids, Incompatibility of Plasmid Maintenance, Artificial chromosomes (YAC, BAC, PAC), Genomic library, cDNA library.			
Unit 4: Production of Recombinant proteins in bacteria: Central role of <i>E. coli</i> in genetic engineering, Construction of recombinant DNA, Preparation of competent cell, Transformation, Selection and Screening of Recombinant clones by different screening strategies (Probes, Colony and plaque hybridization) and expression of the recombinant proteins in <i>E. coli</i> .			
PRACTICAL 1.To perform plasmid isolation from <i>E. coli</i> and its quality determination by agarose gel electrophoresis 2. Isolation of genomic DNA from bacteria and plants. 3. Designing primers for PCR. 4. To perform PCR with given template and primers. 5. Demonstrate about RT-PCR 6. To perform Restriction digestion of given DNA sample. 7. Performing ligation reaction of two DNA fragments. 8.Transformation of <i>E. coli</i> with foreign DNA.			
References: 1. Singh B.D. Biotechnology: Expanding Horizon (2010)3rd edition. Kalyani Publishers. 2. Gupta P.K. Biotechnology and Genomics (2013)1st Edition. Rastogi publishers 3. Clark D.V and Pazdernik, N. J Applying Genetic Revolution (2009) Academic Press 4. Gene cloning and DNA analysis–An Introduction (2015)7th edition, T.A Brown, Blackwell publisher. 5. Essential genes (2006), Benjamin Lewin, Pearson education international. 6. Genome-3(2007) T.A Brown. Garland science, Taylor & Francis, New York. 7. Principles of gene manipulation and Genomics (2006)7th edition, S.B Primose and R.M Twyman, Blackwell publishing. 8. Principles of Genetic Engineering (2009), Mousumi Debnath, pointer publisher, Jaipur. 9. Molecular Biotechnology-Principles and Applications of Recombinant DNA (2003) 3rd edition, Bernard R Glick and Jack J pasternak. ASM press, Washington.			

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10. Human Molecular Genetics (2004) 3rd edition, Tom Strachan & Andrew P Read, Garland science.
11. Molecular Biology of Gene (2008) 6th edition, Watson, Baker, Bell. Gann, Levine and Losick, Pearson education Inc.
12. Biotechnology-Appling the genetic Revolution(2009), Clark and Pazdernik, Academic Press
13. Molecular Cloning: A Laboratory Manual (2000), J. Sambrook, E. F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York
14. DNA Cloning: A Practical Approach (1995) , D.M. Glover and B.D. Hames, IRL Press, Oxford.

Syllabi for Under Graduate Programme in Biotechnology

Semester V
Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Plant and Animal Biotechnology	Course Code	26CBTS405DS02
Hours per Week	5 (3+2)	Credits	4 (3+1)
Maximum Marks	100 (75Theory (50 EA +25IA) +25Practical)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1: Students will understand the importance of Plant Tissue Culture in various aspects like ascetic culture conditions, culture media, organogenesis, somatic embryogenesis, micro-propagation CLO 2: Students will learn the applications of plant transformation for improving the productivity and performance of plants under biotic and abiotic stresses. CLO 3: To gain knowledge of animal cell culture fundamentals CLO 4: To apply principles of Biotechnology concepts in veterinary sciences i.e. production of Transgenic animals, Artificial insemination, <i>In vitro fertilization</i> , Embryo transfer technology.			
Unit 1: Introduction to in vitro plant culture methods, Use of growth regulators, Embryo culture, embryo rescue, wide hybridization and its applications, Introduction to Embryogenesis and Organogenesis: Principles and Practical Applications, Haploids production methods and their applications			
Unit 2: Agrobacterium-Mediated Gene Delivery, Direct Gene Transfer Methods: PEG-Mediated, Electroporation, and Particle Bombardment, Cointegrate and Binary Vectors: Structure and Applications, Screenable and selectable markers, Chloroplast Transformation, Transgenic plants and their applications.			
Unit 3: History of animal cell culture, culture media and equipments, primary and secondary culture, continuous cell line, suspension culture somatic cell cloning and hybridization, transfection and transformation of cell, commercial scale production of animal cell, application of animal cell culture.			
Unit 4: Structure of sperm and ovum, cryopreservation of sperm and ova of livestock, artificial insemination, superovulation, in-vitro fertilization, cryopreservation, Embryo transfer technology, Transgenic animals and their applications			
PRACTICAL 1. Preparation of stocks of macronutrients, micronutrients, vitamins and hormones for Murashige and Skoog medium. 2. Preparation of Murashige and Skoog medium, filter sterilization of hormones and antibiotics. 3. Surface-sterilization of seeds/explants using disinfectants like ethanol, sodium hypochlorite. 4. To extract genomic DNA from plant sample. 5. Extracting plasmid DNA from bacterial cultures for plant transformation experiments. 6. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization 7. Sources of contamination and decontamination measures. 8. Preparation of Hanks Balanced salt solution 9. Preparation of Minimal Essential Growth medium 10. Isolation of lymphocytes 11. DNA isolation from tissue and quantification			
References 1. Plant Tissue Culture: Theory and Practice. S.S. Bhojwani, M.K. Razdan Elsevier. 2. Plant Biotechnology: The genetic manipulation of plants, A. Slater, N. Scott and M. Fowler, Oxford University Press, 2008. 3. Plant Biotechnology- Principles And Applications, M. Z. Abdin: Springer, 2017 4. P. K. Gupta Plant Biotechnology, Rastogi Publication, Meerut, India. 5. epgp.inflibnet.ac.in 6. Singh B. D. Biotechnology: Expanding Horizon (2010) 3rd edition. Kalyani Publishers.			

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7. Gupta P.K. Biotechnology and Genomics (2013)1st Edition. Rastogi publishers
8. Freshney I. Culture of Animal Cells: A Manual of Basic Technique, 5th Edition Publisher: Wiley-Liss, 2005 ISBN: 0471453293
9. Nigel Jen, Animal Cell Biotechnology: Methods and protocols, Humana Press.
10. Portner R. 2007. Animal Cell Biotechnology. Humana Press.

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Semester V

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Fundamentals of Enzymology	Course Code	26CBTS405DS03
Hours per Week	5 (3+2)	Credits	4 (3+1)
Maximum Marks	100 (75Theory (50 EA +25IA) +25Practical)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO 1: Learn various characteristics of enzymes, classify them and elaborate the role of cofactors in enzyme catalysis. CLO 2: Understanding of mechanism of enzyme catalysis. CLO3: Exhibit the knowledge of enzyme kinetics, enzyme inhibition and enzyme regulation mechanisms CLO4: Learning applications of enzymes in industry and significance of enzymes			
Unit 1: Introduction to enzymes, nomenclature, classification of enzymes, structure of enzymes. Enzyme activity, units of enzyme activity, Factors affecting the enzyme activity (concentration, pH and temperature). Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, LB Plot, Turnover number, Kcat. Coenzymes and cofactors.			
Unit 2: Lock and key hypothesis, induced fit hypothesis, mechanism of enzyme catalysis - acid-base catalysis, covalent catalysis, metal ion catalysis. Reversible inhibition: competitive, non-competitive, uncompetitive, mixed, substrate, allosteric and product inhibition. Irreversible inhibition: suicide inhibition.			
Unit 3: Overview of enzyme regulation, including feedback inhibition, allosteric regulation, and covalent modification. The importance of enzyme regulation in cellular processes. The role of enzymes in metabolic pathways.			
Unit 4: Industrial enzymes (thermophilic enzymes, amylases, lipases, proteolytic enzymes in meat and leather industry, enzymes used in various fermentation processes, cellulose degrading enzymes, metal degrading enzymes), Clinical enzymes (Enzymes as thrombolytic agents, Anti-inflammatory agents, streptokinase, asparaginase, Isoenzymes like CK and LDH, Transaminases (AST, ALT), Amylases, Cholinesterases, Phosphatases).			
PRACTICAL 1. Estimation of protein by Biuret/Lowry method 2. Assay of acid/alkaline phosphatase activity from germinating mung bean seeds and calculation of activity of acid/alkaline phosphatase. 3. Effect of enzyme concentration on the rate of enzyme catalysed reaction. 4. Effect of substrate concentration on acid/alkaline phosphatase activity and determination of its Km value. 5. Effect of Temperature on Enzyme activity and determination of optimum temperature. 6. Partial purification of enzyme by change of pH, temperature, addition of organic solvents and ammonium sulphate fractionation technique and to determine the specific activity of the enzyme			
References: 1. Structure and mechanism in Protein Science, by Alan Fersht (2017). World Scientific. 2. Fundamentals of Enzymology, 3rd edition, by Nicholas C. Price and Lewis Stevens (2009) Oxford U. 3. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer, Philip Bonner (2008). East West Publishing. 4. The Chemical Kinetics of Enzyme action by K.J. Laidler and P.S. Bunting, Oxford University Press London. 5. An introduction to Practical Biochemistry, 3rd Edition, by David Plummer (2017). Tata Mc-Graw Hill 6. Introductory Practical Biochemistry by S.K. Sawhney & R. Singh (2014). Narosa Publishers 7. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002). Addison-Wesley Longman.			

Syllabi for Under Graduate Programme in Biotechnology

Semester V

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Bioprocess Engineering	Course Code	26CBTS405DS04
Hours per Week	5 (3+2)	Credits	4 (3+1)
Maximum Marks	100 (75Theory (50 EA +25IA) +25Practical)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): After completing this course, the learner will be able to: CLO 1: Understand the concepts in Bioprocess Engineering CLO 2: Gain the knowledge of scope of Bioprocess Engineering CLO 3: Get an insight into scope and applications of Bioprocess Engineering CLO 4: Learn the process of the formation of biotech products			
Unit 1: Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of fermentation: Batch, Fed-batch, Continuous and solid state culture			
Unit 2: Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inoculum development and sterilization			
Unit 3: Introduction to oxygen requirement in bioprocess; mass transfer of nutrients and oxygen, Form formation and control during fermentation, Bioprocess measurement and control system with special reference to computer-aided process control			
Unit 4: Introduction to downstream processing, product recovery (intracellular and extracellular) and purification. Effluent treatment- aerobic and anaerobic. Microbial production of ethanol, amylase, lactic acid, xanthan gum and Single Cell Proteins			
PRACTICAL 1. Preparation of culture media for bioprocess 2. Bacterial growth curve. 3. Calculation of the thermal death point (TDP) of a microbial sample. 4. Preservation of industrially important microbes 5. Inoculum development and preservation			
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.			

Syllabi for Under Graduate Programme in Biotechnology

Semester VI

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Microbial Technology	Course Code	26CBTS406DS01
Hours per Week	5 (3+2)	Credits	4 (3+1)
Maximum Marks	100 (75Theory (50 EA +25IA) +25Practical)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO1: Understand the concepts in Microbial Technology CLO2: Gain knowledge of the scope of industrial Microbiology CLO3: Get an insight into scope and applications of industrially important microorganisms CLO4: Learn the process of the formation of industrially important products			
Unit 1: Microbial Biotechnology: Scopes application and challenges. Biology of industrial micro-organisms: Industrial microorganisms, growth metabolism regulation, substrate assimilation/ product formation. Microbial preservations of industrial important strains.			
Unit 2: Primary and secondary metabolites and their overproduction. Media for industrial fermentations. Culture media sterilization formulation for industrial purpose. Strains improvement of industrially important microbes			
Unit 3: Industrial production and uses of alcoholic beverages, Bioethanol production, Food starter cultures; Bakery, Dairy and Meat industry			
Unit 4: Microbial transformation of steroids and sterols and their applications. Microbial production of biopolymers, bioplastics, healthcare products: antibiotics and antimicrobial. Microbial production of Single-cell protein (SCP). Vaccine, Therapeutic agents			
Practical 1. Preparation of culture media for industrial strains. 2. Production and analysis of amylase. 3. Production and analysis of lactic acid. 4. Isolation of industrially important microorganism from natural resources. 5. Isolation of antibiotic producing microorganisms 6. Wine production			
References: 1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited. 2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of I 3. ndustrial Microbiology.2nd edition. Panima Publishing Co. New Delhi. 4. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited. 5. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.			

Syllabi for Under Graduate Programme in Biotechnology

Semester VI

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Nano Biotechnology	Course Code	26CBTS406DS02
Hours per Week	5 (3+2)	Credits	4 (3+1)
Maximum Marks	100 (75Theory (50 EA +25IA) +25Practical)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO1: To understand the fundamentals of nanotechnology and its application in biology. CLO2: To explore the synthesis and characterization of nano materials used in bio-nanotechnology. CLO3: To examine the interactions between biological systems and nanoparticles. CLO4: To investigate the applications of nanotechnology in biology			
Unit 1: Introduction & Background: Introduction to Nanotechnology, Historical Background advances in nanotechnology, its future prospects & applications in different fields such as: agriculture, healthcare, instrumentation, textile, food industry, cosmetics etc. Ethical issues in nanotechnology.			
Unit 2: Synthesis & Characterization of Nanoparticles: Green & Chemical synthesis of nanoparticles of Gold, Silver, Zinc Oxide, Tin Oxide, Iron nanoparticles along with their characterization. Chemical Synthesis of Carbon Nanotubes: Single Walled & Multi Walled Carbon Nanotubes.			
Unit 3: Techniques used in Nanotechnology: UV-Visible Spectroscopy, Particle Size Analyzer, X-Ray Diffraction, Fourier Transform Infrared Spectroscopy, Scanning Electron Microscopy, Transmission Electron Microscopy			
Unit 4: Role of Nanotechnology in Disease diagnosis such as Cancer Detection. Nanotechnology in drug delivery systems. Nanoparticles in Biosensors.			
PRACTICAL 1. To synthesize nanoparticles by chemical reduction method 2. To synthesize nanoparticles from plant extract. 3. To characterize nanoparticles. 4. Applications of Nanotechnology in biology.			
References 1. Multilayer Thin Films; Decher G, Schlenoff JB, Wiley-VCH Verlag GmbH & Co. KGaA. 2. Bio-nanotechnology : Lessons from Nature; Goodsell DS, Wiley-Liss. 3. Nanotechnology - A Gentle Introduction to the Next Big Idea; Ratner and Ratner, Prentice Hall PTR			

Syllabi for Under Graduate Programme in Biotechnology

Semester VI

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Genomics & Proteomics	Course Code	26CBTS406DS03
Hours per Week	4	Credits	4
Maximum Marks	100 (70EA +30IA)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO1: Understand the gene and genome sequencing and its importance in biotechnology CLO2: Gain the basics of the genome and proteome analysis softwares. CLO3: Gain the knowledge of protein structure and protein analysis techniques. CLO4: Students will acquire the concept of genomics and proteomics tools and techniques			
Unit 1: Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam and Gilbert and Sangers method. Chain termination method, Pyrosequencing, Genome Sequencing methods: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.			
Unit 2: Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organismal Genomes and Databases.			
Unit 3: Introduction to protein structure, Characterization of protein- Sedimentation analysis, gel filtration, SDS-PAGE, Native PAGE, Edman degradation.			
Unit 4: Introduction to Proteomics, The proteome. Analysis of proteomes. 2D and 3D-PAGE. Mass spectrometry based methods for protein identification and applications			
References: 1. Voet D, Voet JG and Pratt CW, Fundamentals of Biochemistry, 2nd ed., Wiley, 2006 2. Brown TA, Genomes, 3rd ed., Garland Science, 2006 3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd ed. Benjamin Cummings 2007. 4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th ed, Blackwell, 2006			

Syllabi for Under Graduate Programme in Biotechnology

Semester VI

Session: 2024-25

Name of Program	B.Sc. Biotechnology	Program Code	USBOT4
Name of the Course	Medical Microbiology	Course Code	26CBTS406DS04
Hours per Week	4	Credits	4
Maximum Marks	100 (70EA+30IA)	Time of Examinations	3 Hours
Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.			
Course Learning Outcomes (CLO): CLO1: Understand the concepts in Medical Microbiology and analytical techniques CLO2: Gain the knowledge of scope of Medical Microbiology and analytical techniques CLO3: Students will understand the importance of human microflora CLO4: Students will understand the importance of diagnosis in the field of medical			
Unit 1: Introduction: Normal microflora of the human body, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interactions, Opportunistic infections, Nosocomial infections. Route of transmission of infection			
Unit 2: Sample collection, transport and diagnosis Collection and transport of clinical samples for diagnosis, principles of different diagnostic tests (ELISA, Immuno-fluorescence, Agglutination based tests, Complement fixation, Molecular Diagnosis DNA, RNA and protein. .			
Unit 3: Bacteria: mode of transmission, prophylaxis and control- <i>Streptococcus pyogenes</i> , <i>Haemophilus influenzae</i> , <i>Mycobacterium tuberculosis</i> , <i>Escherichia coli</i> , <i>Salmonella typhi</i> , <i>Clostridium tetani</i>			
Unit 4: Viral infections: Symptoms, mode of transmission, prophylaxis and control- Polio, Hepatitis, Rabies, Dengue, AIDS, Protozoan diseases and Symptoms, mode of transmission, prophylaxis and control- Malaria, Kala-azar. Fungal infections- symptoms and prevention- <i>Candida albicans</i> , <i>Mucormycosis</i>			
References: 1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication. 2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology.4th edition. Elsevier. . 3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education			