Session: 2024-25			
Part A - Introduction			
Subject	Biochemistry		
Semester	6		
Name of the Course	Immunology		
Course Code	B23-BCH-601		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-6/MCC-11		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 5th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn the basics of defense mechanisms in human body and various forms of immunity. 2. Comprehend the roles of various cells involved in immune response. 3. Gain insight into roles of major lymphoid organs. 4. Understand the roles of antigens and antibodies in immunological responses.		
	5*. Exhibit skills to isolate lymphocytes from blood/spleen, purification of immunoglobulins & blood typing and to perform various immunoassays such as Ouchterlony double immunodiffusion , ELISA for diagnosis of various diseases.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	45	30	75

Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Overview of Immune System:** First line of defense: Physical barriers to microbial entry; Innate immunity; General features of Innate immunity: Anatomical, Physiological, Phagocytic and Inflammatory barriers; Adaptive immunity: Specificity, memory, diversity and tolerance; Humoral and cell-mediated immunity; Active & passive immunity; Complement system.	11
II	**Cells involved in Immune response:** Granulocytes: Neutrophils, Basophils, Mast cells, Eosinophils; Myeloid antigen-presenting cells- Monocytes, Macrophages, and Dendritic cells; Cells of lymphoid system-B & T lymphocytes and NK cells; MHC- types and roles; Brief overview of cytokines.	11
III	**Organs of the Immune system:** Primary and secondary lymphoid organs: bone marrow, thymus, spleen, lymph nodes and tissues (MALT)- their architecture and role in immune response.	11
IV	**Antigens & antibodies:** Antigens and haptens, Immunogenicity versus antigenicity, factors influencing immunogenicity; Adjuvants; structure and functions of various classes of immunoglobulins; Antigen-antibody interactions: agglutination and precipitation reactions: ELISA.	12
V*	1. Isolation of lymphocytes from blood / spleen. 2. Purification of immunoglobulins. 3. Assays based on agglutination reactions - Blood typing. 4. Ouchterlony double immunodiffusion (DID) 5. Enzyme linked immunosorbent assay (ELISA).	30

Suggested Evaluation Methods	
Internal Assessment: 30 ➢ **Theory-20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum-10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination: 70** ➢ **Theory-50** ➢ **Practical-20**

Part C-Learning Resources (Books of latest edition)

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. Cellular and Molecular Immunology Cellular and Molecular Immunology. Elsevier Health Sciences.
2. Owen, J. A., Punt, J., Stranford, S. A., & Jones, P. P. Kuby immunology. New York: WH Freeman.
3. Parham, P. The Immune System: Fifth International Student Edition with Registration Card. WW Norton & company.
4. Runte, F., Renner IV, P., & Hoppe, M. Kuby immunology.
5. Murphy, K., & Weaver, C. Janeway immunologie. Springer-Verlag.
6. Flajnik, M. Paul's fundamental immunology. Lippincott Williams & Wilkins.

*Applicable for courses having practical component.

Session: 2024-25			
Part A - Introduction			
Subject	Biochemistry		
Semester	6		
Name of the Course	Recombinant DNA Technology		
Course Code	B23-BCH-602		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC-12		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 5th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Know about various enzymes used in the field of Recombinant DNA technology and modification of DNA fragments. 2. Learn the fundamentals of PCR, RT-PCR- their uses and methods of DNA sequencing. 3. Acquaint himself with the vectors used in cloning like plasmids, phage-based vectors and methods of cloning the DNA fragments in these vectors. 4. Learn the screening methods of recombinants. Understand the processes of library constructions and tools to identify the clones of interest.		
	5*. Perform Plasmid DNA isolation, primer designing, amplification of DNA by PCR and RFLP analysis.		
Credits	Theory	Practical	Total
	3	1	4

Contact Hours	45	30	75

Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Recombinant DNA Technology & It's Tools:** Basic introduction of RDT, Class II Restriction enzymes- their features. Isoschizomers, neoschizomers and isocaudomers. Ligases (T4 DNA ligase and T4 RNA ligase), polymerases (*E. coli* DNA polymerase I and III, Klenow polymerase, T7 and SP6 RNA polymerase), alkaline phosphatase, polynucleotide kinase, terminal deoxynucleotidyl transferase. DNAase I, BAL31 nuclease, S1 nuclease, Exonulease III and 3' phosphatase. Linkers and Adaptors.	11
II	**PCR:** Fundamentals of Polymerase Chain Reaction. RT-PCR and cDNA preparation. Brief account of Taq polymerase, Pfu polymerase and Reverse Transcriptase. Brief account of Real-Time PCR. **DNA sequencing:** Sanger's Method and Pyrosequencing.	11
III	**Gene cloning:** Vectors for cloning in prokaryotes: Plasmid vectors (pBR322, pUC, pGEM3Z and TA-cloning), Bacteriophage lambda and M13-based vectors, cosmids and phagemids. **Introduction of rDNA into cells:** Transformation methods & *In-vitro* packaging.	12

IV	**Selection of transformed cells & Identification of recombinant phages**- Insertional inactivation, Blue-White screening. **Library construction and clone identification:** Construction of Genomic and cDNA libraries, Identification of desired clones: Hybridization (Colony, Plaque) and Southern Blotting.	11
V*	1) Isolation of plasmid DNA from *E. coli*. 2) Designing primers for PCR. 3) Amplification of DNA by PCR. 4) Performing RFLP analysis.	30
Suggested Evaluation Methods		
Internal Assessment: 30 ➢ **Theory-20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum-10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:		**End Term Examination: 70** ➢ **Theory-50** ➢ **Practical-20**
Part C-Learning Resources (Books of latest edition)		
1. Brown, T. A. Gene cloning and DNA analysis: an introduction. John Wiley & Sons. 2. Primrose, S. B., & Twyman, R. Principles of gene manipulation and genomics. John Wiley & Sons. 3. Rapley, R., & Whitehouse, D. Molecular biology and biotechnology. Royal Society of Chemistry. 4. Nicholl, D. S. An introduction to genetic engineering. Cambridge University Press. 5. Reece, R. J. Analysis of genes and genomes. John Wiley & Sons. 6. Lodge, J., Lund, P., & Minchin, S. Gene cloning. Taylor & Francis.		

*Applicable for courses having practical component.

Session: 2024-25			
Part A - Introduction			
Subject	Biochemistry		
Semester	6		
Name of the Course	Molecular Basis of non-infectious Diseases		
Course Code	B23-BCH-603		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-4		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 5th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn about nutritional deficiency disorders of water- & fat-soluble vitamins. 2. Comprehend the biochemical basis of disorders related to unhealthy lifestyle. 3. Gain knowledge about diseases arising due to misfolding of proteins and blood related disorders. 4. Understand the molecular biology of cancer including the causative agents and molecular mechanisms of tumor formation.		
	5*. Perform tests for lipid profile, diabetes and estimation homocysteine and glycosylated hemoglobin in serum.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	45	30	75

Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Nutritional Disorders:** Nutritional deficiency disorders of water-soluble vitamins beriberi, pellagra, pernicious anemia and scurvy- their clinical symptoms and treatment: Marasmus and Kwashiorkor. Fat-soluble vitamin deficiency disorders such as night blindness xerophthalmia (Vitamin A deficiency), rickets and osteomalacia (vitamin D deficiency) and haemorrhage (Vitamin K deficiency); Hypervitaminosis.	11
II	**Lifestyle Disorders:** Diabetes mellitus, hypertension, obesity, hypothyroidism and stress; Cardiovascular disorders: pathogenesis, symptoms, causative factors of atherosclerosis; Irritable bowel syndrome- common symptoms, the influence of diet, stress and environment on the condition; Common eating disorders- anorexia nervosa and bulimia nervosa.	11
III	**Protein disorders and other diseases:** Introduction to protein folding; etiology and molecular basis for Alzheimer's disease, Parkinson’s disease, Prion diseases (mad cow), Huntington's Chorea, sickle cell anemia and Thalassemia.	12
IV	**Cancer:** Benign and malignant tumors; types of cancers; cancer causing agents- radiations, chemical compounds, DNA and RNA viruses; Characteristics of cancerous cells, Mechanism of carcinogenesis, proto-oncogenes and oncogenes, tumor suppressor genes; Promoter insertion, enhancer insertion, chromosomal translocation, gene amplification and point mutation as mechanism for activation of proto-oncogenes.	11

V*	1. Perform Lipid profile test. 2. Diagnostic test for Diabetes. 3. Estimation of SGOT & SGPT to detect myocardial infarction 4. Estimation of homocysteine levels in serum. 5. Estimation of glycosylated hemoglobin.	30
Suggested Evaluation Methods		
Internal Assessment: 30 ➢ **Theory-20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum-10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:		**End Term Examination: 70** ➢ **Theory-50** ➢ **Practical-20**
Part C-Learning Resources (Books of latest edition)		
1. Marshall, W. J., Lapsley, M., Day, A., & Ayling, R. Clinical biochemistry: metabolic and clinical aspects. Elsevier Health Sciences. 2. Peet, A. Marks' Basic Medical Biochemistry. Lippincott Williams & Wilkins. 3. Pecorino, L. Molecular biology of cancer: mechanisms, targets, and therapeutics. Oxford university press. 4. Weinberg, R. A. The biology of cancer/Robert A. Weinberg. New York, NY: Garland Science. 5. Pincus, M. R. Henry's clinical diagnosis and management by laboratory methods. Elsevier.		

*Applicable for courses having practical component.

Session: 2024-25			
Part A – Introduction			
Subject	Biochemistry		
Semester	6		
Name of the Course	Industrial Biochemistry		
Course Code	B23-BCH-604		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-4		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 5th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Introduce himself with the subject of industrial biochemistry and its objectives. He will learn about microbes & enzymes of industrial applications. 2. Understand the various kinds of fermentation employed in industry and in the production of beverages and metabolites. 3. Appreciate the goal of immobilized enzymes in biosensors and bioremediation. 4. Learn the applications of Biochemistry in food, diary, detergent, leather industries, and health sector.		
	5*. Perform amylase extraction & preparation of wine, vinegar and rose water.		
Credits	Theory	Practical	Total
	3	1	4

Contact Hours	45	30	75

Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Introduction to Industrial Biochemistry:** Objectives and scope of Industrial Biochemistry; characteristics and comparison of bioprocessing with chemical processing; Microbial growth, substrate degradation and product formation kinetics; Microbes and enzymes of industrial importance.	11
II	**Fermentation:** Basic principles of fermentation technology; Type of fermentation: solid state, submerged fermentation and continuous fermentation; Brief account of production of alcohol**,** alcoholic beverages, organic acids- lactic acid & citric acid and antibiotics.	11
III	**Immobilized Enzyme Reactions:** Techniques of enzyme immobilization-matrix entrapment, ionic and cross linking; Applications of immobilized enzymes- Bioremediation and biodiesel production; Enzyme biosensor and applications of biosensors in diagnostics.	12
IV	**Applications of Biochemistry in Industry:** Glucose production from starch, cellulose and dextran; Use of lactase in dairy industry; role of proteases in food industry; role of enzymes in detergent industry and leather industry; Production of biodegradable plastics.	11

V*	1. Extraction of amylase from apple. 2. Preparation of Fruit wine. 3. Preparation of vinegar. 4. Immobilization of Yeast cells. 5. Preparation of distilled rose water.	30

Suggested Evaluation Methods

Internal Assessment: 30 ➢ **Theory-20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum-10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination: 70** ➢ **Theory-50** ➢ **Practical-20**

Part C-Learning Resources (Books of latest edition)

1. Okafor, N., & Okeke, B. C. Modern industrial microbiology and biotechnology. CRC press.
2. Brahmachari, G. Biotechnology of microbial enzymes: production, biocatalysis and Industrial applications. Academic Press.
3. Wilson, D. B., Sahm, H., Stahmann, K. P., & Koffas, M. Industrial microbiology. John Wiley & Sons.
4. Verma, P. Industrial microbiology and biotechnology. Singapore: Springer.
5. Stanbury, P. F., Whitaker, A., & Hall, S. J. Principles of fermentation technology. Elsevier.
6. Brahmachari, G., Demain, A. L., & Adrio, J. L. Biotechnology of microbial enzymes: production, biocatalysis and Industrial applications. Academic Press.
7. Lee, S. Y., Nielsen, J., & Stephanopoulos, G. Industrial biotechnology: products and processes. John Wiley & Sons.
8. Baltz, R. H., Demain, A. L., & Davies, J. E. Manual of industrial microbiology and biotechnology. American Society for Microbiology Press.

*Applicable for courses having practical component.

Session: 2024-25			
Part A – Introduction			
Subject	Biochemistry		
Semester	6		
Name of the Course	Plant Physiology		
Course Code	B23-BCH-605		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-5		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 5th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Understand the role of light in controlling plant development and photoperiodism, and study plant water relations. 2. Gain knowledge of the roles of macronutrients & micronutrients essential for plant growth. They will also learn the physiological role of plant hormones. 3. Know the physiology of flowering, seed development and seed germination. 4. Acquaint themselves with the topics of senescence and stress biology.		
	5*. Perform experiments regarding plant water relations; determine the total chlorophyll content in leaves; study the α-amylase activity in germinating seeds and senescence in flowers.		
Credits	Theory	Practical	Total

	3	1	4
Contact Hours	45	30	75
Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**		**Time: T-3hrs.** **P-4hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Role of light in Plant development:** Skotomorphogenesis and photomorphogenesis, Phytochromes, Cryptochromes and Phototropins. Biological clocks. Photoperiodism and its significance. **Plant water relation:** Diffusion, osmosis**,** absorption and transport of water in plants, transpiration, and physiology of opening and closing of stomata.	11
II	**Mineral Nutrition:** Essential macro and micro elements and their role in plant growth. **Plant Growth Hormones:** Physiological roles of auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids, salicylic acid, strigolactones, nitric oxide and jasmonic acid.	11
III	**Physiology of Flowering:** Floral Induction and Development, Vernalization and hormonal control, ABCDE model of flower development. **Seed Development, Dormancy and Seed Germination:** Hormonal control of seed development, seed germination and seedling growth; Mobilization of food reserves during seed germination.	12
IV	**Senescence and Programmed Cell Death (PCD):** Senescence and its regulation; Hormonal and environmental control of senescence; PCD in the life cycle of plants; Differences and similarities in PCD and senescence.	11

	Stress physiology: Abiotic (water, temperature and salt) stresses; An introduction to responses of plants to biotic (pathogen and insects) stresses.	
V*	1. To find out the stomatal frequency and transpiration index of a leaf. 2. To determine the tonicity of solutions using *Rhoeo discolour*/*Tradescantia* leaves. 3. Leaf disc expansion and total chlorophyll content estimation under cytokinin treatment. 4. Induction of α-amylase activity in germinating seeds using Gibberellin treatment. 5. Delay of senescence in cut flowers using sucrose and kinetin.	30
Suggested Evaluation Methods		
Internal Assessment: 30 ➢ **Theory-20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum-10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:		**End Term Examination: 70** ➢ **Theory-50** ➢ **Practical-20**
Part C-Learning Resources (Books of latest edition)		
1. Buchanan BB, Gruissem,W and Jones RL. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA 2. Davies, Peter J. Plant Hormones: Physiology, Biochemistry and Molecular Biology. Kluwer Academic Publishers, The Netherlands 3. Noggle, GR and Fritz GJ. Introductory Plant Physiology, Prentice-Hall of India Pvt Ltd, New Delhi. 4. Salisbury, FB and Ross CW. Plant physiology. Wadsworth Publishing Co Belmont, California, USA 5. Taiz L and Zeiger, E. Plant Physiology. Sinauer Associates, Inc., Publishers, Massachusetts, USA. 6. Wilkins, MB. Advanced Plant Physiology, ELBS, Longman, England.		

*Applicable for courses having practical component.

Session: 2024-25			
Part A – Introduction			
Subject	Biochemistry		
Semester	6		
Name of the Course	Biopharmaceuticals		
Course Code	B23-BCH-606		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-5		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 5th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn about various classes of biopharmaceuticals available in the market. 2. Know about the biopharmaceuticals of animal, plant and microbial origins and mechanism of drug action. 3. Learn the processes of drug manufacturing and processing. 4. Understand the therapeutic uses of different types of biopharmaceuticals and nucleic acids in therapeutics.		
	5*. Study the pH effects on the solubility of aspirin, Preparations of drugs, estimation of major ofloxacin in saliva and identify bioactive compounds from plants.		
Credits	Theory	Practical	Total

	3	1	4
Contact Hours	45	30	75
Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**		**Time: T-3hrs.** **P-4hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Introduction to Biopharmaceuticals:** Definition, Overview of Specific biopharmaceutical products: Blood products (Blood clotting factors, Anticoagulants, Thrombolytic agents), Therapeutic enzymes, Recombinant therapeutic hormones, Haemopoietic growth factors, Interferons and interleukins and Recombinant vaccines.	11
II	**Drug action, metabolism and pharmacokinetics:** Pharmaceuticals of animal, plant origin and microbial origins. Mechanism of Drug Action; Physico-Chemical Principles of Drug Metabolism; Basics of Pharmacokinetics.	11
III	**Manufacture of drugs, process and applications:** Types of Reaction Process and Special Requirements for Bulk Drug Manufacture. Compressed Tablets; Dry and Wet Granulation; Slugging or Direct Compression; Tablet Presses; Coating of Tablets; Capsule Preparation; Oval Liquids-Vegetable Drugs-Topical Applications; Preservation of Drugs; Analytical Methods; Quality Management.	12
IV	**Biopharmaceutical categories:** Various Categories of Therapeutics like Vitamins, Laxatives, Analgesics,	11

	Contraceptives, Antibiotics, Hormones. Nucleic acid therapeutics (Gene therapy, Antisense technology).	
V*	1. To investigate how pH affects the solubility of a specific drug (e.g., aspirin). 2. Spectrophotometric estimation of Ofloxacin in saliva. 3. To prepare tablets using the wet granulation method. 4. To extract and identify bioactive compounds from a plant source (holy basil).	30
Suggested Evaluation Methods		
Internal Assessment: 30 ➢ **Theory-20** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 5 • Mid-Term Exam: 10 ➢ **Practicum-10** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:		**End Term Examination: 70** ➢ **Theory-50** ➢ **Practical-20**
Part C-Learning Resources (Books of latest edition)		
1. Klefenz, H. Industrial pharmaceutical biotechnology. Wiley-VCH Verlag GmbH. 2. Wu-Pong, S., & Rojanasakul, Y. Biopharmaceutical drug design and development. Springer Science & Business Media. 3. Walsh, G. Biopharmaceuticals: biochemistry and biotechnology. John Wiley & Sons. 4. Kirst, H. A., & Yeh, W. K. Enzyme technologies for pharmaceutical and biotechnological applications. CRC Press. 5. Bhise, S. B., Dias, R. J., Dhawale, S. C., & Mali, K. K. Laboratory Manual of Biopharmaceutics and Pharmacokinetics, Trinity Publishing House.		

*Applicable for courses having practical component.

Session: 2024-25			
Part A – Introduction			
Subject	Biochemistry		
Semester	3		
Name of the Course	Clinical Lab Testing		
Course Code	B23-VOC-310		
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	VOC-3		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 2nd semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Introduce themselves with various kinds of hematological tests. 2. Learn the methods utilized in analysis of urine sample. 3. Learn the clinical tests designed for detecting proper kidney functioning. 4. Get familiarized with the tests designed to ascertain proper functioning of liver, cardiac functioning and lipid profile.		
	5* Perform hemoglobin estimation, WBC counting, preparation of blood smears, detection urea in urine and measurement of Blood Pressure.		
Credits	Theory	Practical	Total
	2	2	4
Contact Hours	30	60	90

Max. Marks: 100 **Internal Assessment Marks: 30 (15T+15P)** **End Term Exam Marks: 70 (35T+35P)**	**Time: T-3hrs.** **P-4hrs.**

Part B-Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 7 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Haematology:** Introduction to Haematology; Normal constituents of Blood and their function; Collection of Blood samples; Anticoagulants used in Haematology; Normal values in Haematology-; Basic Haematological techniques- RBC Count, Haemoglobin estimation, Packed cell volume, WBC counts- Total and differential, Absolute eosinophil Count, Platelet count & Erythrocyte sedimentation rate (ESR).	7
II	**Urine Chemistry:** Normal Constituents of urine; Physical examination of urine- Colour, transparency; Chemical examination- Protein, reducing sugar, Ketone bodies, Bile pigment/salt, Creatinine, Blood, Microscopical examination- Cells (RBC, WBC, Epithelial), casts, crystals and bacteria.	8
III	**Kidney Function:** Introduction; Clearance tests- Creatinine clearance and Urea clearance tests, uric acid, Blood urea nitrogen, Micro albumin, Globulin, albumin-globulin ratio and Electrolytes in Urine, protein creatinine ratio, renal blood flow and filtration fraction.	8
IV	**Liver function tests:** Serum enzymes in liver disease- Alkaline Phosphatase, SGPT, SGOT, Gamma GT and Lactate dehydrogenase (LDH). **Cardiac function tests:** Blood pressure.	7

	Lipid profile: HDL-c, LDL-c, total cholesterol, triglycerides and electrolytes.	
V*	1. Hemoglobulin estimation by cyanmethemoglobin method. 2. Preparation of blood smears and staining with Leishman's stain. 3. Differential W.B.C Count. 4. Detection of urea in urine. 5. Measurement of Blood pressure and its interpretation.	60

Suggested Evaluation Methods

Internal Assessment: 30 ➢ **Theory-15** • Class Participation: 4 • Seminar/presentation/assignment/quiz/class test etc.: 4 • Mid-Term Exam: 7 ➢ **Practicum-15** • Class Participation: 5 • Seminar/Demonstration/Viva-voce/Lab records etc.: 10 • Mid-Term Exam:	**End Term Examination: 70** ➢ **Theory-35** ➢ **Practical-35**

Part C-Learning Resources (Books of latest edition)

1. Burtis CA, Ashwood ER and Bruns DE. Tietz Textbook of Clinical Chemistry and Molecular Diagnosis. William Heinmann, Medical Books Ltd. New Zealand
2. Mayne PD. Clinical Chemistry in Diagnosis and Treatment. Hodder Arnold Publications, London
3. Swaminathan R. Handbook of Clinical Biochemistry. Oxford University; Press, London.
4. Devlin T M. Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, New York.
5. Mukherjee KL. Medical Laboratory Technology-A procedure manual for routine Diagnostic tests -Volumes I, II, III. Tata McGraw Hill Publishing Company ltd. New Delhi.

*Applicable for courses having practical component.

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<tr><td>Subject</td><td colspan="3">Biochemistry</td></tr>
<tr><td>Semester</td><td colspan="3">3</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Cell culture</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-VOC-324</td></tr>
<tr><td>CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)</td><td colspan="3">VOC-3</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">200-299</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">Students appeared in B.Sc. 2nd semester</td></tr>
<tr><td rowspan="2">Course Learning Outcomes (CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Explain the fundamental concepts of cell culture, including the differences between animal and microbial cultures.
2. Understand various types of cell culture media, including essential components and supplements.
3. Clear concept related to cryopreservation, maintain cell lines, and manage contamination control using appropriate sterilization methods and safe disposal practices.
4. Understand practical applications of cell culture in various fields and troubleshoot common cell culture problems.</td></tr>
<tr><td colspan="3">5* Prepare various cell culture media and apply aseptic practices to prevent contamination; estimate cell numbers and assess the viability of cell lines.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>2</td><td>2</td><td>4</td></tr>
</table>

Contact Hours	30	60	90
Max. Marks: 100 **Internal Assessment Marks: 30 (15T+15P)** **End Term Exam Marks: 70 (35T+35P)**		**Time: T-3hrs.** **P-4hrs.**	

Part B-Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 7 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Introduction to Cell Culture:** Overview of Cell Culture (Animal and Microbial Cultures); Types of Cell Cultures **(**Primary Cultures, Secondary Cultures, and Cell Lines); Basic Cell Biology relevant to culture; Laboratory Safety and Aseptic Techniques **(**Best Practices for Safe and Sterile Work**).**	7
II	**Cell Culture Media and Reagents:** Types of Culture Media **(**Overview of Different Media for Cell Culture). Media Components: Essential Ingredients and Supplementation. Balanced Salt Solutions and Buffers **(**Roles and Preparation). Reagents for Cell Culture **(**Trypsinization, Cryopreservation, and General Media Preparation- plating; broth).	8
III	**Cell Culture Techniques and Equipment:** Subculturing and Passaging: Techniques for Maintaining Cell Lines. Cell Counting and Viability: Methods Including Cell Viability Stains and MTT Assay. Cryopreservation: Techniques for Freezing and Thawing Cells. Contamination Control: Sterilization Methods and Safe Disposal Practices.	8
IV	**Applications and Troubleshooting in Cell Culture:** Common Applications: Practical Uses of Cell Culture in Various Fields; Troubleshooting: Identifying and Solving Common Cell Culture Problems; Documentation and Quality Control: Keeping Accurate Records and Ensuring Quality; Ethical Considerations: Understanding the Ethical Implications of Cell Culture Work.	7

<table>
<tr><td>V*</td><td>1. To demonstrate the use of essential instruments required for cell culture.
2. To understand and practice the aseptic technique to prevent contamination in cell culture.
3. Preparation of various types of cell culture media used for animal and microbial cells.
4. To estimate cell number using a hemocytometer.
5. To assess cell viability and metabolic activity using the MTT assay.
6. To learn the process of cryopreserving cell lines (using animal cells) and reviving them for continued culture.</td><td>60</td></tr>
<tr><td colspan="3">Suggested Evaluation Methods</td></tr>
<tr><td colspan="2">Internal Assessment: 30
➢ Theory-15
• Class Participation: 4
• Seminar/presentation/assignment/quiz/class test etc.: 4
• Mid-Term Exam: 7
➢ Practicum-15
• Class Participation: 5
• Seminar/Demonstration/Viva-voce/Lab records etc.: 10
• Mid-Term Exam:</td><td>End Term Examination: 70
➢ Theory-35
➢ Practical-35</td></tr>
<tr><td colspan="3">Part C-Learning Resources (Books of latest edition)</td></tr>
<tr><td colspan="3">• Cell culture basics Handbook- Invitrogen
• Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications by R. Ian Freshney
• Animal Cell Culture by John RW Masters
• Basic techniques and limitations in establishing a cell culture: a mini review by Priyabrat Swain, Pramod Kumar Nanda, Sukanta Kumar Nayak, Sudhansu Sekhar Mishra.</td></tr>
</table>

*Applicable for courses having practical component.

Session: 2024-25			
Part A – Introduction			
Subject	Biochemistry		
Semester	7		
Name of the Course	Gene Regulation		
Course Code	B23-BCH-701		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H1		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 6th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn the different gene regulation strategies employed in bacteria like positive & negative regulation, transcriptional and translational attenuation & quorum sensing. 2. Gain insight into various kinds of regulatory RNAs in bacterial and eukaryotic system like cis & trans-sRNA, CRISPER Cas9, riboswitches, miRNA & SiRNA. 3. Learn the role of transcription factors, response elements, enhancers, silencers, insulators in gene regulation. 4. Comprehend short term & long-term regulation in eukaryotes and histone modifications. Post-transcriptional levels of gene regulation will also be learned.		
Credits	Theory	Practical	Total
	4	0	4

Contact Hours	60	0	60
Max. Marks: 100 **Internal Assessment Marks: 30** **End Term Exam Marks: 70**		**Time: T-3hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 14 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Bacterial Gene Regulation Strategies:** Concept of operon and its significance in Bacterial genomes, *lac* operon and *trp* operon. Positive and negative regulations in operons, induction and repression. Catbolite repression (*lac* operon) and transcriptional attenuation (*trp* operon). Regulon: SOS regulon in *E. coli*. Translational attenuation (*pyrC* strategy), Alternate sigma factors and anti-sigma factors. Brief account of Two-component regulatory systems and Quorum sensing in bacteria.	15
II	**Regulatory RNAs in Bacteria:** tmRNA (transfer messenger RNA) and mechanism of trans-translation. Regulation of gene expression by small RNAs (sRNA): cis-sRNA and trans-sRNA. CRISPR-Cas9 in bacterial immune defense, Riboswitches. **Regulatory RNAs in Eukaryotes:** microRNA (miRNA) and small interfering RNA or silencing RNA (siRNA): discovery, mechanisms of action, RNA induced silencing complex (RISC) and Dicer.	15
III	**Eukaryotic Gene Regulation Basics:** Transcription initiation at RNA polymerase II promoter, the main features of eukaryotic promoter, Regulation of transcriptional initiation by phosphorylation status of RNA polymerase II. General transcription factors, response elements and response factors,	15

	The Britten and Davidson model for the coordinate regulation of unlinked genes. Role of enhancers, silencers, Locus control regions (LCR) and insulators in gene regulation. DNase I sensitive and hypersensitive sites. Brief account of nucleosome displacement and nucleosome remodeling.	
IV	**Eukaryotic Gene Regulation strategies:** Brief account of Short-term regulation (Hormone responses and Heat-shock responses) and Long-term regulation (organ development and differentiation, genomic imprinting and X-chromosome inactivation). DNA methylation and Histone modifications (acetylation, phosphorylation, ubiquitination and methylation). Histone code. Gene regulation at post-transcriptional levels like RNA splicing, RNA transport and RNA stability levels. Translational control of gene regulation.	15
Suggested Evaluation Methods		
Internal Assessment: 30 • **Class Participation: 5** • **Seminar/presentation/assignment/quiz/class test etc.: 10** • **Mid-Term Exam: 15**		**End Term Examination: 70 (T)**
Part C-Learning Resources (Books of latest edition)		
1. Microbial Physiology; Moat et al. Wiley-Liss, Inc., New York. 2. Eukaryotic transcription factors; Latchman, Academic Press, Elsevier. 3. Gene control; Latchman, Garland Science. 4. Epigenetics; Allis et al, Cold Spring Harbor Laboratory Press. 5. Molecular Biology; Zlatanova, CRC Press. 6. Molecular Genetics of Bacteria; Dale and Park, John Wiley & Sons, Ltd. 7. Molecular Genetics of Bacteria; Snyder & Champness, Henkin and Peters, Wiley.		

Session: 2024-25			
Part A – Introduction			
Subject	Biochemistry		
Semester	7		
Name of the Course	Animal Cell Culture		
Course Code	B23-BCH-702		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H2		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 6th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Understand the history, importance, and basic techniques of animal cell culture, including primary, secondary, and continuous cell lines. 2. Identify and apply various cell culture media, growth supplements, and reagents for culturing different tissues. 3. Explain cell behavior, growth patterns, and metabolism in culture, and accurately estimate cell numbers. 4. Develop, characterize, and maintain cell lines, including stem cells, and manage cryopreservation and contamination issues.		
Credits	Theory	Practical	Total
	4	0	4

Contact Hours	60	0	60

Max. Marks: 100 **Internal Assessment Marks: 30** **End Term Exam Marks: 70**	**Time: T-3hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 14 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Introduction to Animal Cell Culture:** Introduction, importance, history of cell culture development, basic techniques in animal cell culture including primary and secondary culture, continuous cell lines, suspension and adherence culture, organ culture.	15
II	**Animal Cell Culture Media and Reagents:** Different types of cell culture media (natural and synthetic), growth supplements, serum free media, balanced salt solution, other cell culture reagents, culture for different tissues and its applications.	15
III	**Animal Cell Behavior in Culture Conditions:** Behavior of cells in culture conditions, cell division, growth pattern of cultured cell, metabolism of cultured cells, estimation of cell number, factors affecting cell behavior in culture.	15
IV	**Development and Maintenance of Cell Lines:** Development of cell lines, characterization and maintenance of cell lines, stem cells in culture, cryopreservation of cell lines, common cell culture contaminants.	15

Suggested Evaluation Methods

Internal Assessment: 30 • **Class Participation: 5** • **Seminar/presentation/assignment/quiz/class test etc.: 10** • **Mid-Term Exam: 15**	**End Term Examination: 70 (T)**

Part C-Learning Resources (Books of latest edition)

1. Culture of animal cells by R. Ian Freshney.
2. Principles of Animal Cell Culture by Basant Kumar Sinha & Rinesh Kumar.
3. Applications of Cell Culture Studies in Pharmaceutical Technology by Seyma Hande Tekarslan Sahin, Burcu Mesut, Yildiz Ozsoy.
4. Basic techniques and limitations in establishing a cell culture: a mini review by Priyabrat Swain, Pramod Kumar Nanda, Sukanta Kumar Nayak, Sudhansu Sekhar Mishra.
5. Animal cell culture by John RW Masters
6. Standards for cell line authentication and beyond by Almeida, J. L., Cole, K. D., & Plant, A. L. PLoS biology, 14(6), e1002476.

Session: 2024-25			
Part A – Introduction			
Subject	Biochemistry		
Semester	7		
Name of the Course	Protein Purification		
Course Code	B23-BCH-703		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H3		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 6th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn about the various methods of soluble & membrane bound protein extraction, precipitation and purification through gel filtration. 2. Understand the techniques of ion exchange chromatography, affinity chromatography and HPLC in protein purification. 3. Gain insight into the electrophoretic means of protein separation using NATIVE, SDS PAGE & Isoelectric focusing. The methods of protein purity monitoring will also learn. 4. Know the means to determine primary structure of proteins.		
Credits	Theory	Practical	Total
	4	0	4

Contact Hours	60	0	60
Max. Marks: 100 **Internal Assessment Marks: 30** **End Term Exam Marks: 70**		**Time: T-3hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 14 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Protein extraction:** Methods of extraction of soluble and membrane-bound proteins. Homogenization methods and extraction medium (pH and ionic strength of buffer, detergents and chaotropic agents, reducing agents, chelators and proteolytic inhibitors). Salting in and salting out phenomena; Organic precipitation and Dialysis. **Chromatographic techniques (Size and Shape-based):** Size Exclusion Chromatography-Concepts of fractionation range of bead material, void volume, bed volume and elution volume Molecular weight determination of proteins.	15
II	**Chromatographic techniques (Charge-based):** Ion-exchange Chromatography-Cation and Anion exchangers (materials and use in purification). **Chromatographic techniques (Affinity-based):** Affinity and Immunoaffinity chromatography. Applications and use in separation of recombinant proteins. Role of Hydrophobic interaction chromatography and High-performance liquid chromatography (HPLC) in protein purification.	15
III	**Electrophoretic techniques for protein purification:** Native PAGE for purity analysis; SDS PAGE for molecular weight and subunits analysis; Isoelectric focusing; Detection and quantification of proteins in gels.	15

	Methods for monitoring the purity of protein solutions: Factors to ascertain the purity of a given enzymatic protein-specific activity, fold purification, total activity and percentage yield.	
IV	**Protein sequence determination:** Steps involved: N-and C-terminus identification, reduction of disulfide bonds, role of endopeptidases, Cyanogen bromide, ordering the peptide fragments. Determination of Post-Translational Modifications in a protein (In Brief).	15
Suggested Evaluation Methods		
Internal Assessment: 30 • **Class Participation: 5** • **Seminar/presentation/assignment/quiz/class test etc.: 10** • **Mid-Term Exam: 15**		**End Term Examination: 70 (T)**
Part C-Learning Resources (Books of latest edition)		
1. Methods in Enzymology Guide to Protein Purification. (Burgess and Deutscher). Academic Press. 2. Protein Purification (Bonner). Taylor & Francis Group. 3. Principles and Reactions of Protein Extraction, Purification, and Characterization (Hafiz Ahmed). CRC Press. 4. Biochemistry (Voet and Voet). John Wiley & Sons, Inc. 5. Protein Purification- Principles, High Resolution Methods, and Applications (Jan-Christer Janson). John Wiley & Sons, Inc.		

<table>
<tr><td colspan="4">Session: 2024-25</td></tr>
<tr><td colspan="4">Part A - Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Biochemistry</td></tr>
<tr><td>Semester</td><td colspan="3">7</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Clinical trials & Management</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-BCH-704</td></tr>
<tr><td>Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)</td><td colspan="3">DSE-H1</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">400-499</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">Students appeared in B.Sc. 6th semester</td></tr>
<tr><td>Course Learning Outcomes (CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Learn the criteria involved in conducting clinical trials.
2. Understand the protocols of clinical trials, approval process and challenges involved in this process.
3. Garner knowledge about randomized controlled trials & its distinct features.
4. Know about the methods of collecting & evaluating the data originating from clinical trials and their proper management.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>4</td><td>0</td><td>4</td></tr>
<tr><td>Contact Hours</td><td>60</td><td>0</td><td>60</td></tr>
<tr><td colspan="2">Max. Marks: 100
Internal Assessment Marks: 30
End Term Exam Marks: 70</td><td colspan="2">Time: T-3hrs.</td></tr>
</table>

Part B- Contents of the Course		
Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 14 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Basics of Clinical Trials:** Clinical Research, Healthy Volunteer, Inclusion/Exclusion Criteria, Informed Consent, Patient Volunteer, Phases of Clinical Trials, Placebo, Protocol, Principal Investigator, Randomization, Single- or Double-Blind Studies, Types of Clinical Trials- Diagnostic trials, Prevention trials, Quality of life trials, Screening trials and Treatment trials.	15
II	**Clinical Trial Protocol and its components:** Clinical trial application filing, documents required / information required for filing a trial; clinical trial approval process; Indian clinical trial regulations; Challenges in Indian clinical trials.	15
III	**Randomized controlled trial (RCT):** Basics of randomized controlled trial and their reasons, Features of RCT; designe and its conduct; Random allocation, Allocation concealment, Blinding, Outcome ascertainment, Sample size, report on outcome of RCT; Randomization and masking, Overview of clinical study design.	15
IV	**Clinical trials metrics collection, Clinical data management, Data processing-** Database management and its benefits- types of data: data collection methods, raw, physical collection, models, images etc. –Data entry - File naming- Data assurance: quality control and assurance of data, medical coding, dictionary management and maintenance of quality documents.	15
Suggested Evaluation Methods		

Internal Assessment: 30 • **Class Participation: 5** • **Seminar/presentation/assignment/quiz/class test etc.: 10** • **Mid-Term Exam: 15**	**End Term Examination: 70 (T)**

Part C-Learning Resources (Books of latest edition)

1. Leon Gordis. Epidemiology. Elsevier.
2. Lawrence MF, Curt DF, David LD. Fundamentals of clinical trials.
3. Tom Brody. Clinical trials. Elsevier.
4. KPR Chowdary. A Textbook of Clinical Research and Pharmacovigilance. PharmaMed Press.
5. Machin, D, Day, S, Green, S. Textbook of clinical trials. John Wiley & Sons.
6. World Health Organization. Handbook for good clinical research practice (GCP): guidance for implementation.

Session: 2024-25			
Part A – Introduction			
Subject	Biochemistry		
Semester	7		
Name of the Course	Bioinformatics		
Course Code	B23-BCH-705		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-H1		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 6th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn about biological databases; data retrieval methods and database similarity searching tools- BLAST, FASTA. 2. Understand the concept of local & global alignment and their respective algorithms; perform multiple sequence alignment. 3. Learn various methods of construction of phylogenetic trees. 4. Analyze the domain architecture, secondary structure, hydropathic profile of proteins using different tools. Applications of bioinformatics in various fields of biology will be understood.		
Credits	Theory	Practical	Total
	4	0	4

Contact Hours	60	0	60
Max. Marks: 100 **Internal Assessment Marks: 30** **End Term Exam Marks: 70**		**Time: T-3hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 14 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Introduction to Bioinformatics:** Biological databases and their applications, Primary, secondary and specialized databases. Biological sequence data formats (FASTA and GenBank), single letter code of amino acids, symbols used to represent nucleotides. Data retrieval- Entrez and SRS. **Database similarity searching:** FASTA and BLAST programs, outline of search methodology, types of BLAST search. Statistical significance of alignment score.	15
II	**Pairwise Sequence alignment:** Local and Global alignment concepts. Dot plot. Dynamic programming methodology: Needleman-Wunsch algorithm and Smith-Waterman algorithm. Substitution matrices- PAM and BLOSUM. **Multiple Sequence alignment:** Progressive, iterative and block-based alignment. Alignment procedure in Clustal. Brief account of Alignment editors.	15
III	**Phylogenetic Trees:** Evolutionary analysis: Cladistic and Phenetic trees, Basics of construction of Neighbor-Joining (NJ), Maximum Parsimony (MP) and Maximum Likelihood (ML) trees.	15

	Tree evaluation methods: Bootstrapping and Jackknifing.	
IV	**Structure prediction:** Domain architecture and secondary structure prediction tools for proteins (SMART, Pfam). Hydropathy plot of proteins. Predicting protein secondary structure using tools like PSIPRED and SOPMA. Introduction to structural classification of proteins (SCOP and CATH databases). **Application of bioinformatics** in various fields of biology.	15
Suggested Evaluation Methods		
Internal Assessment: 30 • **Class Participation: 5** • **Seminar/presentation/assignment/quiz/class test etc.: 10** • **Mid-Term Exam: 15**		**End Term Examination: 70 (T)**
Part C-Learning Resources (Books of latest edition)		
1. Essential Bioinformatics (Jin Xiong). Cambridge University Press. 2. Introduction to Bioinformatics (Arthur M. Lesk). Oxford University Press. 3. Bioinformaics (Baxevanis et al.). Wiley. 4. Bioinformatics Genes, Proteins and Computers (Orengo et al.). BIOS Scientific Publishers Limited. 5. Molecular Evolution: A Phylogenetic Approach (Page et al.). Blackwell Publishing Ltd. 6. Understanding Bioinformatics (Zvelebil et al.). Garland Science.		

<table>
<tr><td colspan="4">Session: 2024-25</td></tr>
<tr><td colspan="4">Part A – Introduction</td></tr>
<tr><td>Subject</td><td colspan="3">Biochemistry</td></tr>
<tr><td>Semester</td><td colspan="3">7</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Practical Based on B23-BCH-701 TO 704/705</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-BCH-706</td></tr>
<tr><td>Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)</td><td colspan="3">CC-H1</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">400-499</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">Students appeared in B.Sc. 6th semester</td></tr>
<tr><td>Course Learning Outcomes (CLO):</td><td colspan="3">After completing this course, the learner will be able to:
1. Learn methods of RNA isolation from different types of tissues, histone protein separation and in-silico promoter analysis of plant & animal genes.
2. Demonstrate proficiency in cell culture techniques, like media preparation & sterilization; estimation of cell numbers and their viability.
3. Perform SDS-PAGE and affinity chromatography.
4. Demonstrate the randomization concept, placebo effect and analyze a published clinical trial study.
OR
Execute BLAST searches, identify domain architecture & secondary structures in protein sequences, create multiple sequence alignment and phylogenetic tree construction.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>0</td><td>4</td><td>4</td></tr>
</table>

Contact Hours	0	120	120
Max. Marks: 100 **Internal Assessment Marks: 30** **End Term Exam Marks: 70**		**Time: T-8hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter:

Unit	Topics	Contact Hours
I	1. Isolation of Histone proteins from dark-grown wheat coleoptile tissue and separating them using SDS PAGE. 2. RNA isolation from several developmental stages of rice seed using Guanidinium Hydrochloride method. 3. Studying differential gene expression of some candidate genes using semi-quantitative PCR among different floral components of rice flower. 4. RNA isolation from blood sample. 5. Analysis of Promoter sequences from plant and animal genes and identifying various response elements and core elements in the promoter using in silico methods.	30
II	1. To demonstrate the use of essential instruments required for animal cell culture. 2. To understand and practice the aseptic technique to prevent contamination in cell culture. 3. To estimate cell number using a hemocytometer. 4. To assess cell viability and metabolic activity using the MTT assay. 5. To learn the process of cryopreserving cell lines and reviving them for continued culture.	30
III	1. Isolate chloroplasts proteins from spinach leaves and quantitate them using dot blot assay, 2. Demonstration of Gel Filtration Chromatography. 3. Performing Affinity chromatography. 4. Resolve chloroplast proteins by SDS-PAGE to identify Rubisco and other major proteins.	30

	5. Isolate mitochondria from cauliflower and demonstrate the activity of its marker enzyme, succinate dehydrogenase.	
IV	1. To demonstrate the perceptions of healthy volunteers regarding participation in clinical trials. 2. To create a mock clinical trial protocol for a hypothetical study. 3. To demonstrate the concept of randomization in clinical trials. 4. To investigate the placebo effect in a controlled setting. 5. To analyze and discuss a published clinical trial study. **OR** 1. To perform BLAST search in NCBI database. 2. Visualization of protein 3-D structure using Swiss PDB viewer. 3. To perform multiple sequence alignment using ClustalX. 4. To construct Phylogenetic tree with a given alignment. 5. Prediction of Domain architecture of a protein sequence using SMART tool. 6. Determination of secondary structural elements in a protein sequence.	30
Suggested Evaluation Methods		
Internal Assessment: 30 • **Class Participation: 5** • **Seminar/presentation/assignment/quiz/class test etc.: 10** • **Mid-Term Exam: 15**		**End Term Examination: 70 (P)**
Part C-Learning Resources (Books of latest edition)		

1. Molecular Cloning: A Laboratory Manual. Sambrook and Russell Vol. I to III, Cold Spring Harbor Laboratory Press.
2. Methods in Molecular Biology. PCR protocols, Bartlett and Stirling, Humana Press.
3. Cell culture basics Handbook- Invitrogen
4. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications by R. Ian Freshney
5. Animal Cell Culture by John RW Masters
6. Basic techniques and limitations in establishing a cell culture: a mini review by Priyabrat Swain, Pramod Kumar Nanda, Sukanta Kumar Nayak, Sudhansu Sekhar Mishra.
7. General techniques of cell culture by Maureen A. Harrison and Ian R Rae
8. Animal Cell Culture and Technology by Michael Butler.
9. Animal Cell Culture: Essential Methods by John M. Davis
10. Basic Cell Culture Protocols by Cheryl D. Helgason and Cindy L. Miller.
11. Protein Purification (Bonner). Taylor & Francis Group.
12. Principles and Reactions of Protein Extraction, Purification, and Characterization (Hafiz Ahmed). CRC Press.
13. World Health Organization. Handbook for good clinical research practice (GCP): guidance for implementation.
14. Essential Bioinformatics by Jin Xiong. Cambridge University Press.
15. Introduction to Bioinformatics by Arthur M. Lesk. Oxford University Press.
16. Bioinformaics by Baxevanis et al. Wiley.

Session: 2024-25			
Part A – Introduction			
Subject	Biochemistry		
Semester	8		
Name of the Course	Research Methods & Documentation		
Course Code	B23-BCH-801		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H4		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 7th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn the various aspects of defining a research problem and addressing it. 2. Acquaint themselves with several methods of literature survey, documentation and data collection. 3. Assimilate the skills of research paper, dissertation, thesis, review article writing and presenting research work in conference. 4. Learn about plagiarism in scientific work and functions of various research funding agencies in India.		
Credits	Theory	Practical	Total
	4	0	4

Contact Hours	60	0	60
Max. Marks: 100 **Internal Assessment Marks: 30** **End Term Exam Marks: 70**		**Time: T-3hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 14 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Fundamentals of research**: Meaning and objective (including definition and significance) of research, types of research (basic, applied and patent oriented), research problem (identifying and formulation), research process (Steps involved in conducting research and designing a research plan), research proposal/synopsis- Key components and structure of a successful research proposal.	15
II	**Literature survey and documentation:** Methods of literature survey, use of library, books, journals, e-journals, thesis, chemical abstracts and patent database, importance of documentation, documentation techniques, use of computer programs/packages (online resources such as-scientific search engines and online servers) in literature survey and documentation. **Data collection:** Classification of data, methods of data collection, sample size, sampling procedure and methods. Data processing and graphical representation of data.	15
III	**Technical writing and reporting of research:** Types of research report: Dissertation and thesis, research paper, review article, short communication, conference presentation, meeting report etc. Structure and organization of research reports: Title, abstract, key words, introduction, methodology, results, discussion, conclusion, acknowledgement, references,	15

	footnotes, tables and illustrations. Use of reference managing software (such as-MENDELEY, ENDNOTE). Impact factor, rating, indexing and citation of journals.	
IV	**Plagiarism:** Basic concept of plagiarism and its impact on research/thesis; Plagiarism detection softwares and their uses. **Funding agencies and research grants:** Introduction to various research funding agencies such as-DST, DBT, AICTE, UGC, CSIR, ICMR, AAYUSH, and DRDO along with their functions in India.	15
Suggested Evaluation Methods		
Internal Assessment: 30 • **Class Participation: 5** • **Seminar/presentation/assignment/quiz/class test etc.: 10** • **Mid-Term Exam: 15**		**End Term Examination: 70 (T)**
Part C-Learning Resources (Books of latest edition)		
1. Kothari C.R. Research Methodology, Methods and Techniques, New Age International Publication. 2. Dawson, C. Practical research methods, UBS Publishers, New Delhi. 3. Ranjith Kumar: Research Methodology, A step by step guide for beginners, Pearson Education. 4. Cresswell, J. Research Design: Qualitative and quantitative Approaches Thousand Oaks CA, Sage Publications 5. Kothari, C.R. Research Methodology: Methods and Techniques, New Age International Publishers. 6. Kumar, R. Research Methodology: A Step-by-Step Guide for Beginners, SAGE publisher. 7. Walliman, N. Research Methods: The Basics, London; New York: Routledge.		

Session: 2024-25			
Part A – Introduction			
Subject	Biochemistry		
Semester	8		
Name of the Course	Biosafety and Intellectual Property Rights		
Course Code	B23-BCH-802		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H5		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 7th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Comprehend biosafety levels, guidelines, measures and regulations. 2. Understand the consequences of genetically modified foods & organisms on health and environment. 3. Garner knowledge about intellectual property rights, patents, trademark, copyright and various treaties dealing with them. 4. Learn about patent laws and types of patent applications.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	60	0	60

Max. Marks: 100 **Internal Assessment Marks: 30** **End Term Exam Marks: 70**	**Time: T-3hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 14 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Biosafety:** Overview of Biosafety, Risk assessment- Risk Groups; Levels of Biosafety: Biological safety cabinets: Horizontal and Vertical Laminar Air Flow Cabinet, Fume hood-Primary and secondary containments; Biosafety levels of specific Microorganisms (food and water borne pathogens), Chemicals and carcinogens; Guidelines: Biosafety Guidelines and regulations of Government of India.	15
II	**Concerns about the Safety of Consuming Genetically Modified Foods:** Alteration of the Nutritional Content of Food, Potential for Introducing Toxins or Allergens into Food and Potential for Transferring Transgenes from Food to Humans or Intestinal Microorganisms. **Concerns about the Impact of Genetically Modified Organisms on the Environment:** Impact on Biodiversity, impact of the Bt Toxin on non-target insects and environmental benefits of genetically modified organisms.	15
III	**Introduction to intellectual property rights:** Concept of IPR; types of Intellectual Property Rights- patents, industrial design, traditional knowledge, trademark, Geographical Indications & Copyright; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act.	15
IV	**Patents and Patenting System:** Patent law: Principles, Need for patent law and Types of patents; Role of a Country Patent office; Patent applications: Forms and guidelines; Types of patent application; Patent specification: provisional and	15

	complete specification; Patent databases: India, USPTO, and EPO.	
Suggested Evaluation Methods		
Internal Assessment: 30 • **Class Participation: 5** • **Seminar/presentation/assignment/quiz/class test etc.: 10** • **Mid-Term Exam: 15**		**End Term Examination: 70 (T)**
Part C-Learning Resources (Books of latest edition)		
1. Ishtiaq, M., Mazhar, M. W., Maqbool, M., Ajaib, M., Hussain, T., Muzamil, M., & Mazhar, M. Biosafety, Intellectual Property Rights (IPR), and Protection (IPP). In Genetic Engineering (pp. 1-22). Apple Academic Press. 2. Glick, B. R., & Patten, C. L. Molecular biotechnology: principles and applications of recombinant DNA. John Wiley & Sons. 3. Goel, D., & Parashar, S. IPR, biosafety and bioethics. Pearson Education India. 4. Nambisan, P. An introduction to ethical, safety and intellectual property rights issues in biotechnology. Academic Press. 5. Singh K. K. Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer India. 6. Rajmohan Joshi. Biosafety and Bioethics, Isha Books, Delhi. 7. Sateesh, M. K. Bioethics and biosafety. IK International Pvt Ltd.		

Session: 2024-25			
Part A - Introduction			
Subject	Biochemistry		
Semester	8		
Name of the Course	Stem Cell Biology		
Course Code	B23-BCH-803		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-H6		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 7th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Identify and differentiate between various types of stem cells and explain their developmental potentials and roles within stem cell niches. 2. Describe the molecular mechanisms, signal transduction pathways, and epigenetic factors regulating stem cell self-renewal and differentiation. 3. Evaluate the applications of stem cells in regenerative medicine and understand the associated ethical and regulatory considerations. 4. Demonstrate proficiency in isolating, culturing, characterizing, and manipulating stem cells using a variety of tools and techniques.		
Credits	Theory	Practical	Total
	4	0	4

Contact Hours	60	0	60
Max. Marks: 100 **Internal Assessment Marks: 30** **End Term Exam Marks: 70**		**Time: T-3hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 14 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Introduction to Stem Cells:** Definition and properties of stem cells; Types of stem cells: embryonic, adult, and induced pluripotent stem cells (iPSCs); Stem cell niches; Developmental potential of stem cells (totipotent, pluripotent, multipotent, and unipotent)	15
II	**Stem Cell Biology:** Molecular mechanisms underlying stem cell self-renewal and differentiation; Signal transduction pathways in stem cell regulation; Epigenetics and stem cells; Stem cell markers and identification methods.	15
III	**Stem Cell Applications in Regenerative Medicine:** Stem cell therapy: Concepts and clinical applications; Stem cells in regenerative medicine; Stem cells in drug discovery; Ethical issues in stem cell research; Regulatory guidelines for stem cell research and therapy.	15
IV	**Techniques in Stem Cell Research:** Isolation and culture of stem cells; Techniques for stem cell characterization; Genetic manipulation of stem cells; Cryopreservation of stem cells; Generation and culture of induced pluripotent stem cells (iPSCs).	15

Suggested Evaluation Methods

Internal Assessment: 30 • **Class Participation: 5** • **Seminar/presentation/assignment/quiz/class test etc.: 10** • **Mid-Term Exam: 15**	**End Term Examination: 70 (T)**

Part C-Learning Resources (Books of latest edition)

1. Stem Cells: A Very Short Introduction" Author: Jonathan Slack;
2. "Essentials of Stem Cell Biology" Authors: Robert Lanza, Anthony Atala; Stem Cells: An Introduction" by Michael J. Yaszemski, Paul A. Lotz, and Michael S. McCarthy;
3. Stem Cells: From Bench to Bedside" Author: Peter L. Choyke;
4. "Stem Cell Technologies: Basics and Applications" Author: Michael J. S. McGowan;
5. "Stem Cells and Regenerative Medicine" Author: Michael J. C. Gordon;
6. Stem Cells and Regenerative Medicine: Principles and Applications" edited by David L. Stocum;
7. Principles of Regenerative Medicine" edited by Anthony Atala, Robert Langer, and James Yoo;
8. "Stem Cell Biology" by Michael A. Teitell and David A. Williams;

Session: 2024-25			
Part A - Introduction			
Subject	Biochemistry		
Semester	8		
Name of the Course	Biostatistics		
Course Code	B23-BCH-804		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-H2		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 7^{th} semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn various types of variables, measurement skills, types of sampling & calculation of mean, mode, median and skewness & kurtosis. 2. Understand various kinds of probability distributions & hypothesis testing. 3. Perform χ2-test, t-test, Z-test, regression & correlation analysis. 4. Know the techniques of ANOVA, ANCOVA, MANOVA, MANCOVA and applications of statistics in biological fields.		
Credits	Theory	Practical	Total
	4	0	4

Contact Hours	60	0	60
Max. Marks: 100 **Internal Assessment Marks: 30** **End Term Exam Marks: 70**		**Time: T-3hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 14 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Basic concepts:** Types of variables: Quantitative and Qualitative Variable, Random Variable (Discrete and Continuous Random Variable), Population and sample; Measurement and Measurement scales (Nominal scale, Ordinal scale, Interval scale, Ratio scale); Sampling and Statistical inference; Systematic sampling and stratified random sampling. Frequency table, measures of central tendency (mean, mode, median) and their dispersion. Standard deviation; Concepts of moments, skewness and kurtosis.	15
II	**Probability distributions:** Probability mass function and probability density function, expectation and variance. Standard distribution; Binomial, Poisson and Normal distribution with their important properties and significance. **Hypothesis testing:** Hypothesis Testing Steps; General formula for Test Statistic, Significance level, Types of errors (Type I and Type II error).	15
III	**Data analysis:** $\chi 2$- test, t –test, Z-test and their utilization in biological data analysis; Fitting of trends; linear and quadratic with least square method; Regression analysis: Simple Linear Regression; Correlation analysis, coefficient of correlation and coefficient of variation and their significance.	15

IV	**Applications of Statistics in Biology:** Analysis of variance (ANOVA)- one way and two-way classification; Analysis of covariance (ANCOVA). Basics of MANOVA and MANCOVA; Applications of statistics in various fields of biology like agriculture, health sciences, genetics, molecular biology and bioinformatics.	15
Suggested Evaluation Methods		
Internal Assessment: 30 • **Class Participation: 5** • **Seminar/presentation/assignment/quiz/class test etc.: 10** • **Mid-Term Exam: 15**		**End Term Examination: 70 (T)**
Part C-Learning Resources (Books of latest edition)		
1. Daniel, W. W., & Cross, C. L. Biostatistics: a foundation for analysis in the health sciences. Wiley. 2. Rosner, B. Fundamentals of Biostatistics. Cengage Learning. 3. Pagano, M., Gauvreau, K., & Mattie, H. Principles of biostatistics. Chapman and Hall/CRC. 4. Saha, I., & Paul, B. Essentials of biostatistics and research methodology. Academic Publishers. 5. Whitlock, M., & Schluter, D. The analysis of biological data. Roberts and Company Publishers. 6. Van Belle, G., Fisher, L. D., Heagerty, P. J., & Lumley, T. Biostatistics: a methodology for the health sciences. John Wiley & Sons.		

Session: 2024-25			
Part A - Introduction			
Subject	Biochemistry		
Semester	8		
Name of the Course	Agriculture Waste Management		
Course Code	B23-BCH-805		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE-H2		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 7th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn about various types of agricultural wastes and their impacts on human health & environment. 2. Comprehend technologies involved in agricultural solid waste management. 3. Come across the potentials of agricultural waste in the fields of energy & fuel production. 4. Gain knowledge about management of agricultural waste arising from diary & poultry.		
Credits	Theory	Practical	Total
	4	0	4
Contact Hours	60	0	60
Max. Marks: 100 **Internal Assessment Marks: 30** **End Term Exam Marks: 70**		**Time: T-3hrs.**	

Part B- Contents of the Course		
Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 14 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.		
Unit	**Topics**	**Contact Hours**
I	**Introduction to agricultural waste management**: Nature and characteristics of agricultural waste and their impact on the environment; Types and sources of wastes; classification, role of soil and plants in waste management; impact of waste on human and animal health; Measures and Interventions to Stop Crop Residue Burning.	15
II	**Agricultural Solid Wastes:** Classification and causes/sources of agricultural solid wastes; Agricultural Solid Waste Treatment Technologies; Strategies for Management of Agricultural Wastes- Bio-methanation and Anaerobic Digestion of Farmland Wastes, Incineration of Agricultural Solid Wastes, Pyrolysis and Gasification.	15
III	**Agricultural Waste Utilization:** Production of Bioethanol; Energy Production from Agricultural Waste; Biogas Production; Production of Biochar. In-situ management of agriculture waste. Composting and Vermicomposting for bio conservation of biodegradable waste.	15
IV	**Agriculture Waste Management System:** Introduction & waste management functions; Waste management systems design; Dairy waste management systems. Management of bedding and litter, wasted feed, runoff from feed lots and holding area; agro-waste recycling through farming system, waste management machineries, environmental benefit of waste management.	15
Suggested Evaluation Methods		

Internal Assessment: 30 • **Class Participation: 5** • **Seminar/presentation/assignment/quiz/class test etc.: 10** • **Mid-Term Exam: 15**	**End Term Examination: 70 (T)**

Part C-Learning Resources (Books of latest edition)

1. Loehr, R. Agricultural waste management: problems, processes, and approaches. Elsevier.
2. Zakaria, Z. A. Sustainable technologies for the management of agricultural wastes. Singapore: Springer.
3. Koul, B., Yakoob, M., & Shah, M. P. Agricultural waste management strategies for environmental sustainability. Environmental Research, 206, 112285.
4. Nagendran, R. Agricultural waste and pollution. In Waste (pp. 341-355). Academic Press.

Session: 2024-25			
Part A – Introduction			
Subject	Biochemistry		
Semester	8		
Name of the Course	Practical Based on B23-BCH-801 TO 804/805		
Course Code	B23-BCH-806		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	PC-H2		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 7th semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn to design a research plan, compose review paper and detection of plagiarism in given article. 2. Understand the designing of BSL-III Lab and the process of applying for patents. 3. Demonstrate proficiency in stem cell culture techniques and viability assessment; analyze and interpret the impact of oxidative stress on stem cell differentiation and viability. 4. Calculate the central tendencies & deviation in the given data. Also fitting of different distributions for the given data sets will be learnt along with performing Chi-square test & t-test. **OR** a) Determine TDS & ammonia nitrogen in water sample; preparing compost and conduct survey of different type of agricultural waste.		
Credits	Theory	Practical	Total

	0	4	4
Contact Hours	0	120	120
Max. Marks: 100 **Internal Assessment Marks: 30** **End Term Exam Marks: 70**		**Time: T-6hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter:

Unit	Topics	Contact Hours
I	1. Designing a research plan. 2. Writing of a mini-review paper. 3. Design of a research survey on a specific problem. 4. Idea presentations via abstract/poster. 5. Detection of plagiarism in a given article.	30
II	1. Study of components and design of a BSL-III laboratory. 2. Filing applications for approval from biosafety committee (IBSC). 3. Study of steps of a patenting process. 4. Filing primary applications for patents.	30
III	1. To learn the technique of cryopreserving stem cells. 2. To assess the viability of stem cells after cryopreservation using the MTT assay. 3. To assess the viability of stem cells after cryopreservation using the Trypan blue assay. 4. To induce and observe the differentiation of stem cells into adipocytes (fat cells) and/or skeletal muscle cells (myocytes). 5. To compare undifferentiated stem cells and differentiated cells by the following methods: a. Morphologically (using EAO/HE staining). b. At the cellular level (by performing enzymatic assays such as CK in the case of skeletal muscle cells).	30

<table>
<tr><td>IV</td><td>1. Calculation of Mean, Median and Mode from the given data.
2. Calculation of standard deviation and coefficient of variation for the given data.
3. Fit a Poisson distribution for the given data.
4. Fit a normal distribution for the given data.
5. To test a given null hypothesis using Chi-square test of goodness of fit.
6. To perform t-test.
OR
1. Determination of TDS in drinking water.
2. To determine the Ammonia nitrogen present in water/wastewater.
3. Preparation of compost from agricultural waste.
4. Survey of different Agri waste from livestock, dairy, poultry, food processing, fruit & vegetable and agri-chemicals.</td><td>30</td></tr>
<tr><td colspan="3">Suggested Evaluation Methods</td></tr>
<tr><td colspan="2">Internal Assessment: 30
• Class Participation: 5
• Seminar/presentation/assignment/quiz/class test etc.: 10
• Mid-Term Exam: 15</td><td>End Term Examination: 70 (P)</td></tr>
<tr><td colspan="3">Part C-Learning Resources</td></tr>
</table>

1. Research Methodology, Methods and Techniques by Kothari C.R.
2. Practical research methods by Dawson, C.
3. Research Methodology, A step by step guide for beginners by Ranjith K.
4. An introduction to ethical, safety and intellectual property rights issues in biotechnology by Nambisan, P.
5. Biotechnology and Intellectual Property Rights: Legal and Social Implications by Singh K. K.
6. Human Stem Cell Manual; A Laboratory Guide: by Jeanne F. Loring; Robin L. Wessel Schmidt; Philip H. Schwartz
7. Cell culture basics Handbook- Invitrogen
8. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications" by R. Ian Freshney
9. Animal Cell Culture: John RW Masters
10. Stem Cell Technologies: A Laboratory Manual" by Michael E. McManus and Dennis L. Kasper
11. Stem Cell Protocols: edited by John R. Masters and David M. H. G. Hay
12. Basic Stem Cell Protocols: Methods and Protocols: edited by Cheryl D. Helgason and Cindy L. Miller.
13. Biostatistics: a foundation for analysis in the health sciences by Daniel, W. W. and Cross, C. L.
14. Principles of biostatistics by Pagano, M. Gauvreau, K. and Mattie, H. Koul, B. Yakoob, M. and Shah, M. P.
15. Agricultural waste management strategies for environmental sustainability. Environmental Research, 206, 112285.