School of Chemistry
University of the Punjab, Lahore

Course Outline

8th Semester

Programme	BS Chemistry	Course Code	Chem-483	Credit Hours	2
Course Title	Molecular Biology	Course Type		Major (Elective)	

Course Introduction

After studying this course, students will be able to understand molecular biology, DNA as hereditary material, DNA replication, reverse transcription, DNA damage and repair in detail. It will also assist to understand Transcription and Translation of DNA, machinery of protein synthesis and process of protein synthesis.

Introduction of molecular biology and history. DNA as genetic material. Chromatin and structure of Eukaryotic chromosomes, DNA replication and transcription in prokaryotes and eukaryotes. Translation; synthesis and splicing of RNA, Protein synthesis. DNA damage, repair and recombination. Restriction enzymes. Regulation of gene expression in prokaryotes, eukaryotes and Operon model. Plasmids, bacteriophages, and cosmids. Method of Recombinant DNA.

Learning Outcomes

on completion of this course, students will be able to:

1. Understand the fundamental concepts and historical developments in molecular biology, including the structure and function of DNA, eukaryotic chromosomes, and chromatin.
2. Compare and contrast DNA replication, transcription, and translation mechanisms in prokaryotes and eukaryotes, including RNA synthesis, splicing, and protein synthesis.
3. Analyze the processes involved in DNA damage, repair, recombination, and the regulation of gene expression in both prokaryotes and eukaryotes.

	Course Content	Assignments/Readings
Week 1	Introduction to Molecular Biology Overview of Molecular Biology Introduction to DNA, RNA, and proteins Historical perspective and fundamental concepts	Class base learning/test
	DNA Structure and Function Chemical structure of DNA DNA replication as a foundation for genetic information	Class base learning/test
Week 2	DNA Replication in Prokaryotes Mechanisms of DNA Replication in Bacteria Key enzymes involved (e.g., DNA polymerase, helicase) The replication fork and leading vs. lagging strands. Regulation of DNA Replication in Prokaryotes Initiation and control mechanisms Error checking and proofreading	Class base learning/test
	Class discussion	
Week 3	DNA Replication in Eukaryotes	Class base learning/test

	Mechanisms of DNA Replication in Eukaryotes Differences from prokaryotic replication Role of multiple DNA polymerases Regulation of DNA Replication in Eukaryotes Cell cycle controland replication origins	
	Quiz	
Week 4	Transcription in Prokaryotes Overview of Transcription Process Initiation, elongation, and termination Role of RNA polymerase and sigma factors	Class base learning/test
	Regulation of Transcription in Prokaryotes Operon model (e.g., lac operon) Gene regulation mechanisms	Class base learning/test
Week 5	Transcription in Eukaryotes Mechanisms of Transcription in Eukaryotes Structure of eukaryotic RNA polymerases Transcription factors and enhancers	Class base learning/test
	Post-transcriptional Modifications Capping, polyadenylation, and splicing Role of spliceosomes	Class base learning/test
Week 6	Class discussion	
	RNA Synthesis and Splicing RNA Synthesis Types of RNA (mRNA, rRNA, tRNA)Synthesis and processing of each RNA type	Class base learning/test
Week 7	RNA Splicing Mechanisms of splicing Alternative splicing and its effects Regulation	Class base learning/test
	Translation: Protein Synthesis Overview of Translation Process Initiation, elongation, and termination	Class base learning/test
Week 8	Post-translational Modifications Folding, cleavage, and addition of functional groups Quality control mechanisms	Class base learning/test
	Class discussion	
Week 9	Mid term	
Week 10	DNA Damage and Repair Types of DNA Damage Sources and types of DNA damage (e.g., UV light, chemical agents) Effects on cellular function DNA Repair Mechanisms Repair pathways (e.g., nucleotide excision repair, base excision repair) Role of repair enzymes and proteins	Class base learning/test

	DNA Recombination Mechanisms of DNA Recombination Homologous and non-homologous recombination Role in genetic diversity and evolution	Class base learning/test
Week 11	Applications of DNA Recombination Recombinant DNA technology Applications in biotechnology and medicine	Class base learning/test
	Restriction Enzymes Overview of Restriction Enzymes Types and properties of restriction enzymes Mechanism of action and recognition sites Applications of Restriction Enzymes Molecular cloning and DNA fingerprinting Use in genetic engineering	Class base learning/test
Week 12	Quiz	
	Regulation of Gene Expression in Prokaryotes Operon Model Structure and function of operons (e.g., lac operon, trp operon) Regulation mechanisms and their impact on gene expression Other Regulatory Mechanisms Role of small RNAs and regulatory proteins Environmental and developmental control of gene expression	Class base learning/test
Week 13	Regulation of Gene Expression in Eukaryotes Transcriptional Regulation Role of transcription factors and chromatin remodelling Enhancers, silencers, and promoter interactions	Class base learning/test
	Post-transcriptional Regulation mRNA stability and degradation Role of microRNAs and RNA interference	Class base learning/test
Week 14	Plasmids Structure and Function of Plasmids Types of plasmids and their roles in bacteria Plasmid replication and maintenance Plasmids in Biotechnology Use in gene cloning and expression systems Examples of plasmid vectors	Class base learning/test
	Bacteriophages and Cosmids Overview of Bacteriophages Structure and life cycle of bacteriophages Applications in genetics and medicine Cosmids Definition and properties of cosmids Applications in gene cloning and library construction	Class base learning/test
Week 15	Methods of Recombinant DNA Technology Overview of Recombinant DNA Methods	Class base learning/test

	Gene cloning, transformation, and selection Molecular tools and techniques (e.g., PCR, gel electrophoresis)	
	Applications and Case Studies Use in research, medicine, and agriculture. Case studies of successful recombinant DNA applications	Class base learning/test
Week 16	Submission of assignments. If required then discussion the whole chapter for final term exams preparation Final term assessment	

Reading Materials

1. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2020). Principles of biochemistry (8th ed.). W. H. Freeman and Company.
2. Voet, D. J., Voet, G. J., & Pratt, C. W. (2023). Fundamentals of biochemistry (5th ed.). Wiley.
3. Styer, L. (2021). Biochemistry (9th ed.). W. H. Freeman and Company.
4. Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., & Rodwell, V. W. (2018). Harper's biochemistry (32nd ed.). McGraw-Hill Education.
5. Champ, C., Harvey, R. A., & Ferrie, D. R. (2021). Lippincott's biochemistry (6th ed.). Wolters Kluwer.

Teaching Learning Strategies

1. Lecturing using white/black board/Multimedia
2. Written Assignments
3. Class activities and discussion
4. Quiz about last lecture

Assignments: Types and Number with Calendar

Assignment, Quiz, Task, Presentation, etc.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-484**	**Credit Hours**	1
Course Title	**Molecular Biology -Lab**		**Course Type**		**Major (Elective)**

Course Introduction

This course will help students to understand practical grounds to isolate DNA from animal and bacterial sources. It will also help students to understand the technique of gel electrophoresis. Preparation of stock and working solution for the isolation of DNA. Isolation of genomic DNA by inorganic method. Isolation of genomic DNA by organic method. Determination of messenger RNA expression of candidate gene by PCR. Determination of DNA, cDNA by gel electrophoresis. Separation of different spliced DNA by gel electrophoresis. Isolation and estimation of DNA from animal sources and bacteria. Restriction enzyme digestion of DNA and its separation by gel electrophoresis

Learning Outcomes

- This study will help students in understanding of DNA extraction by different methods
- Students will be able to perfume gel electrophoresis and PCR.
- Students will be able to Extract DNA from animal sources and bacteria

Course Content		Assignments/Readings
Week 1	Preparation of stock and working solution for the isolation of DNA	Class base learning/test
Week 2	Preparation of stock and working solution for the isolation of DNA	Class base learning/test
Week 3	Isolation of genomic DNA by inorganic method	Class base learning/test
Week 4	Isolation of genomic DNA by organic method	Class base learning/test
Week 5	Determination of messenger RNA expression of candidate gene by PCR	Class base learning/test
Week 6	Determination of DNA, cDNA by gel electrophoresis	Class base learning/test
Week 7	Discussion the practical and if need then repeat it	-
Week 8	Mid term Exams	-
Week 9	Determination of DNA, cDNA by gel electrophoresis	Class base learning/test
Week 10	Separation of different spliced DNA by gel electrophoresis	Class base learning/test
Week 11	Isolation and estimation of DNA from animal sources	Class base learning/test
Week 12	Isolation and estimation of DNA from bacteria	Class base learning/test

Week 13	Restriction enzyme digestion of DNA and its separation by gel electrophoresis	Class base learning/test
Week 14	Restriction enzyme digestion of DNA and its separation by gel electrophoresis	Class base learning/test
Week 15	Discussion all practicals if need then repeat	-
Week 16	Final Term	-

Reading Materials

1. Ausubel FM, 2005. Short Protocols in Molecular Biology (2 volume set). 5 th Edition; John Wiley and Son. 2. Green MR and Sambrook J, 2001.
2. Molecular Cloning: A Laboratory Manual. 3rd Edition; Cold Spring Harbor Laboratory Press. 3. Primrose SB and Twyman R, 2006.
3. Principles of Gene Manipulation and Genomics. 7th Edition; Wiley-Blackwell. 4. Wilson K and Walker J, 2010.
4. Principles and Techniques of Biochemistry and Molecular Biology. 7th Edition; Cambridge University Press. 5. Walker JM and Rapley, 2008.

Teaching Learning Strategies

1. Lecturing using white/black board/Multimedia
2. Written Assignments
3. Discussion about practical
4. Checking the results and discussion

Assignments: Types and Number with Calendar

Assignment, Quiz, Task, Presentation, etc.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-485**	**Credit Hours**	**2**
Course Title	**Microbiology & Drug Metabolism**	**Course Type**		**Major (Elective)**	

Course Introduction

This course will familiarize students with fundamentals of prokaryotic and eukaryotic microorganisms including viruses. This course will impart knowledge about the structure, growth, genetics, metabolism and ecology of microbes. Students will learn the mode of action of different drugs which in turn will help to understand physiology, biochemistry, and genetics of microorganisms.

Microorganisms and their gross Classification, Bacterial growth and cultivation techniques. Identification of Microorganisms, Factors for the growth of microbes. Methods of Growth measurement, Growth under extreme environments. Mutation and protoplast fusion in cultures and its benefits. Gene transfer: transformation, transduction and conjugation. Bacteriophages chemistry, metabolism and mechanism of action of anti-malarials, anti-bacterials, antivirals and antifungal drugs. Drug resistance, Biochemical transformation of drugs. Anticancer drugs

Learning Outcomes

On the completion of the course, the students will:

- Understand the fundamental principles of microbiology, relation of microbes with their habitat, their growth requirements, growth, genetics and metabolism.
- compare and differentiate between different groups of microorganisms
- elucidate the beneficial and harmful roles of microorganism
- drug metabolism and interactions

	Course Content	**Assignments/Readings**
Week 1	Introduction to microbiology Overview of Microorganisms Gross classification of microorganisms: bacteria, fungi, viruses, protozoa, algae Historical perspectives and importance of microbiology	Class base learning/test
	Bacterial Growth and Cultivation Techniques Methods for cultivating bacteria Media types and preparation	Class base learning/test
Week 2	Microbial Identification Identification Techniques Microscopy, staining techniques, and biochemical tests Molecular methods: PCR, DNA sequencing	Class base learning/test
	Factors Affecting Microbial Growth Nutritional requirements, temperature, pH, oxygen levels Environmental factors and their impact on microbial growth	Class base learning/test
Week 3	Class discussion	
		Class base learning/test

	Methods of Growth Measurement Quantifying Microbial Growth Plate counts, turbidity measurements, dry weight Growth curves and their interpretation	
Week 4	Growth Under Extreme Environments Extremophiles and their adaptations Techniques for studying growth in extreme conditions	Class base learning/test
	Quiz	
Week 5	Mutation and Protoplast Fusion Genetic Variability in Microbes Types of mutations and their effects on microorganisms Methods of inducing and analyzing mutations	Class base learning/test
	Protoplast Fusion Techniques and applications of protoplast fusion Benefits and uses in genetic engineering and biotechnology	Class base learning/test
Week 6	Transformation Mechanisms of DNA uptake and integration Applications and examples	Class base learning/test
	Transduction and Conjugation Mechanisms of gene transfer via bacteriophages and direct cell-to-cell contact Applications and implications in genetic exchange	Class base learning/test
Week 7	Class DISCUSSION	
	Bacteriophages Chemistry of Bacteriophages Structure and classification of bacteriophages Life cycles: lytic and lysogenic	Class base learning/test
Week 8	Applications and Uses of Bacteriophages Phage therapy and biotechnology applications Advantages and limitations	Class base learning/test
	Midterm assessment	
Week 9	Metabolism of Antimicrobial Drugs Mechanism of Action of Anti-malarials Types of anti-malarial drugs and their targets Mechanism of action and resistance issues	Class base learning/test
	Mechanism of Action of Anti-bacterials Classes of antibiotics and their mechanisms of action Development of resistance and strategies to combat it	Class base learning/test
Week 10	Mechanism of Action of Antiviral Drugs Types of antiviral drugs and their targets Mechanisms of action and resistance	Class base learning/test
	Mechanism of Action of Antifungal Drugs Classes of antifungal drugs and their mechanisms of	Class base learning/test

	action Resistance issues and challenges	
Week 11	Class discussion	
	Overview of Drug Resistance Mechanisms of resistance in bacteria, viruses, fungi Genetic and biochemical basis of resistance	Class base learning/test
Week 12	Strategies to Combat Drug Resistance Monitoring and surveillance of resistance patterns Development of new drugs and alternative treatments	Class base learning/test
	Quiz	
Week 13	Drug Metabolism Phase I and Phase II reactions Enzymes involved in drug metabolism	Class base learning/test
	Impact of Metabolism on Drug Efficacy Drug interactions and their effects Personalization of drug therapy based on metabolism.	Class base learning/test
Week 14	Class discussion	
	Anticancer Drugs Mechanisms of Anticancer Drugs Types of anticancer drugs (e.g., alkylating agents, antimetabolites) Mechanisms of action and targets	Class base learning/test
Week 15	Challenges in Anticancer Drug Development Drug resistance in cancer therapy Strategies to overcome resistance and improve efficacy	Class base learning/test
	Emerging Microbiological Techniques Advances in microbial genetics and biotechnology New techniques and their applications	Class base learning/test
Week 16	Submission of assignments. If required then discussion the whole chapter for final term exams preparation Final term assessment	

Reading Materials

1. Pommerville CJ. Alcamo's Fundamentals of Microbiology. 9th Ed. Jones and Bartlett Learning Company, 2018.
2. Madigan MT and Martinko J, 2010. Brock Biology of Microorganisms. 13th Edition; Pearson College Div.
3. Talaro KP. 2015. Foundations in Microbiology Companion. 8th ed. McGraw Hill.
4. Black JG, 2007. Microbiology: principles and explorations. 7th Edition; John Wiley and Sons. Willey JM, Sherwood LM, Woolverton CJ. 2014. Prescott, Harley AND Kleins's Microbiology, 9th ed., McGraw Hill.

Teaching Learning Strategies
1. Lecturing using white/black board/Multimedia 2. Written Assignments 3. Class activities and discussion **4.** Quiz about last lecture
Assignments: Types and Number with Calendar
Assignment, Quiz, Task, Presentation, etc.
Assessment

Sr. No.	Elements	Weightage	Details
4.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
5.	Formative Assessment	25%	Continuous assessmentincludes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
6.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-486**	**Credit Hours**	**1**
Course Title	**Microbiology & Drug Metabolism-Lab**		**Course Type**		**Major (Elective)**

Course Introduction

This study will provide better understanding of sterilization techniques, bacterial culturing and understanding of bacterial growth curves by chemical tests. It will also help to understand the structure of cell.
Study and practical demonstration of laboratory safety measures. Preparation of serial dilution from stock solution. Sterilization techniques, culturing of bacteria in liquid and solid medium, gram staining of bacteria, colony and cell morphology, bacterial cell count and growth curves by chemical tests. Isolation of bacteria. Growth of bacteria. Antibiotic sensitivity test. Activity of drug. Cell structure: Study of cell structure by light microscope.

Learning Outcomes

- This study will help students in understanding of practical grounds of different laboratory safety measures.
- Students will be able to culture bacteria both in solid and liquid mediums
- Students will be able to learn the use of light microscope to study cell structure.

	Course Content	**Assignments/Readings**
Week 1	Study and practical demonstration of laboratory safety measures.	Class base learning/test
Week 2	Preparation of serial dilution from stock solution	Class base learning/test
Week 3	Sterilization techniques	Class base learning/test
Week 4	culturing of bacteria in liquid medium	Class base learning/test
Week 5	culturing of bacteria in solidmedium	Class base learning/test
Week 6	gram staining of bacteria	Class base learning/test
Week 7	Discussion the practical and if need then repeat it	-
Week 8	Mid term Exams	-

Week 9	colony and cell morphology, bacterial cell count and growth curves by chemical tests	Class base learning/test
Week 10	Isolation of bacteria	Class base learning/test
Week 11	Growth of bacteria	Class base learning/test
Week 12	Antibiotic sensitivity test	Class base learning/test
Week 13	Activity of drug	Class base learning/test
Week 14	Cell structure: Study of cell structure by light microscope	Class base learning/test
Week 15	Discussion all practicals if need then repeat	-
Week 16	Final Term	-

Reading Materials

1. Wilson, K., & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge University Press.
2. Robyt, J. F., & White, B. J. (2017). Biochemical Techniques: Theory and Practice. Waveland Press.
3. Switzer, R. L., & Garrity, L. F. (1999). Experimental Biochemistry. W. H. Freeman.
4. Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques (2nd ed.). Pearson Education.
5. Varley, H., Gowanlock, A. H., McMurray, J. R., & McLauchlan, D. M. (1988). Varley Practical Clinical Biochemistry (6th ed.). Heinemann Medical Books (Open Library).
6. Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual (3rd ed.). Cold Spring Harbor Laboratory Press.

Teaching Learning Strategies

1. Lecturing using white/black board/Multimedia
2. Written Assignments
3. Discussion about practical
4. Checking the results and discussion

Assignments: Types and Number with Calendar

Assignment, Quiz, Task, Presentation, etc.

Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-487**	**Credit Hours**	**2**
Course Title	**Clinical biochemistry**		**Course Type**		**Major (Elective)**

Course Introduction

This course will help students to clearly Understand the basic concepts of clinicalbiochemistryandEnhance the understanding of biochemical basis of human disease withrelevance to clinical diagnosis.

Introduction to Clinical Biochemistry, Biochemical Basis of Disease, Markers in Disease Diagnosis, Enzyme Assays in Clinical Diagnosis, Metabolism of Carbohydrates and Its Disorders, Lipid Metabolism and Lipid-Related Disorders, Protein Metabolism and Associated Disorders, Nucleic Acids and Genetic Disorders, Clinical Enzymology, Electrolyte and Acid-Base Balance, Liver Function Tests, Renal Function Tests, Hormones and Endocrine Function Tests, Biochemical Aspects of Hematology, Tumor Markers in Cancer Diagnosis, Therapeutic Drug Monitoring, Clinical Toxicology, Nutritional Biochemistry and Disorders, Recent Advances in Clinical Biochemistry

Learning Outcomes

On the completion of the course, the students will be able to :

1. Identify, interpret and perform the role of plasma enzymes in the diagnosis of various clinical disorders
2. Assess the severity of disorder/cell damage
3. Correlate the enzymes deficiencies with inborn errors of metabolism
4. Determine the role of enzymes as prognostic indicator

	Course Content	**Assignments/Readings**
Week 1	Introduction to Clinical Biochemistry Overview of clinical biochemistry Importance in disease diagnosis and management	Class base learning/Test
	Biochemical Basis of Disease Pathophysiology of diseases Role of biochemical markers Comprehend the biochemical basis of diseases and the role of clinical biochemistry in diagnosis and management.	Class base learning/Test
Week 2	Biochemical Markers in Disease Diagnosis Common biomarkers used in clinical settings Interpretation of biomarker levelsin the context of disease states.	Class base learning/Test
	Class discussion	
Week 3	Enzyme Assays in Clinical Diagnosis Principles of enzyme assays Clinical significance of enzyme measurements	Class base learning/Test
	Metabolism of Carbohydrates and Its Disorders Carbohydrate metabolism pathways Clinical disorders related to carbohydrate metabolism	Class base learning/Test
Week 4	Lipid Metabolism and Lipid-Related Disorders Lipid metabolism pathways Dyslipidemia and other lipid-related disorders	Class base learning/Test

	Quiz	Class base learning/Test
Week 5	Protein Metabolism and Associated Disorders Protein synthesis and degradation Clinical disorders related to protein metabolism	Class base learning/Test
	Nucleic Acids and Genetic Disorders Structure and function of nucleic acids Genetic mutations and related disorders	Class base learning/Test
Week 6	Class discussion	Class base learning/Test
	Clinical Enzymology Role of enzymes in clinical diagnosis Measurement and interpretation of enzyme activity	Class base learning/Test
Week 7	Electrolyte and Acid-Base Balance Electrolyte homeostasis Blood gases	Class base learning/Test
	Acid-base balance and related disorders	Class base learning/Test
Week 8	Mid term assessment	
Week 9	Liver and Renal Function Tests Liver function tests (LFTs)	Class base learning/Test
	Renal function tests (RFTs)	Class base learning/Test
Week 10	Hormones and Endocrine Function Tests Overview of endocrine system	Class base learning/Test
	Common hormonal assays and their clinical significance	Class base learning/Test
Week 11	Class discussion	
	Tumor Markers in Cancer Diagnosis Types of tumor markers Use of tumor markers in cancer diagnosis and monitoring	Class base learning/Test
Week 12	Tumor Markers in Cancer Diagnosis Types of tumor markers	Class base learning/Test
	Use of tumor markers in cancer diagnosis and monitoring	Class base learning/Test
Week 13	Quiz	
	Therapeutic Drug Monitoring	Class base learning/Test
Week 14	Clinical Toxicology	Class base learning/Test
	Nutritional Biochemistry and Disorders Vitamins and trace minerals	Class base learning/Test
Week 15	Practical applications of clinical biochemistry in diagnosis	Class base learning/Test

	New technologies and methodologies in clinical biochemistry	
	Quality control specimen handling	
Week 16	Submission of assignments. If required then discussion the whole chapter for final term exams preparation	

Reading Materials

1. Bishop, M. L., Fody, E. P., & Schoeff, L. E. (2004). Clinical Chemistry: Principles, Procedures, Correlations (6th ed.). Lippincott Williams & Wilkins.
2. Burtis, C., Ashwood, E., & Bruns, D. (2011). Tietz Textbook of Clinical Chemistry and Molecular Diagnostics (5th ed.). Elsevier.
3. Smith, A. F., Beckett, G., Walker, S., & Rae, P. (1998). Lecture Notes on Clinical Biochemistry (6th ed.). John Wiley & Sons.
4. Gowenlock, A. H., & McMurray, J. R. (2006). Varley's Clinical Biochemistry (6th ed.). Heinemann Medical Books.
5. Gaw, A. (2014). Clinical Biochemistry: An Illustrated Colour Text (3rd ed.). Churchill Livingstone.

Teaching Learning Strategies

1. Lecturing using white/black board/Multimedia
2. Written Assignments
3. Class activities and discussion
4. Quiz about last lecture

Assignments: Types and Number with Calendar

Assignment, Quiz, Task, Presentation, etc.

Assessment

Sr. No.	Elements	Weightage	Details
7.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
8.	Formative Assessment	25%	Continuous assessmentincludes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
1.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-488**	**Credit Hours**	1
Course Title	**Clinical biochemistry lab**	**Course Type**		**Major (Elective)**	

Course Introduction

The Clinical Biochemistry Practical course is designed to provide graduate students with hands-on experience in the techniques and methodologies used in clinical biochemistry laboratories. This course emphasizes the application of biochemical principles to clinical diagnostics and the interpretation of laboratory results.
Blood sampling technique, serum/plasma isolation procedure, Determination of total plasma proteins, Determination of serum Albumin, Blood glucose estimation (Fasting and Random) Glycosylated Hemoglobin (HbA1c). Glucose tolerance test for borderline diabetics, Liver function tests, Renal Function tests, Cardiac enzymes (CPK, MB, LDH), Determination of lipid profile, Serum and urine electrolytes

Learning Outcomes

On the completion of the course, the students will:

1. Master blood sampling techniques and the isolation of serum/plasma.
2. Conduct and interpret tests for total plasma proteins and serum albumin.
3. Perform blood glucose estimations and glycosylated hemoglobin (HbA1c) assays.
4. Execute glucose tolerance tests and evaluate liver and renal function tests.
5. Analyze cardiac enzymes, lipid profiles, and electrolyte levels.
6. Develop critical thinking and data interpretation skills through case studies.
7. Apply biochemical principles to clinical diagnostics and health monitoring.
8. Gain proficiency in laboratory techniques and ensure accurate test results.
9. Integrate theoretical knowledge with practical laboratory skills.

	Course Content	**Assignments/Readings**
Week 1	**Laboratory safety measure and quality control**	Class base learning/test
Week 2	Evaluation of suitability of clinical samples	Class base learning/test
Week 3	Blood sampling technique Serum/plasma isolation procedure	Class base learning/test
Week 4	Determination of total plasma proteins	Class base learning/test
Week 5	Determination of serum albumin	Class base learning/test
Week 6	Blood glucose estimation (Fasting and Random)	Class base learning/test
Week 7	Determination Glycosylated Hemoglobin (HbA1c)	Class base learning/test
Week 8	Mid term	
Week 9	Glucose tolerance test for borderline diabetics	Class base learning/test
Week 10	Liver function tests	Class base learning/test
Week 11	Renal function tests	Class base learning/test
Week 12	Cardiac enzymes (CPK, MB, LDH)	Class base learning/test
Week 13	Determination of lipid profile	Class base learning/test

Week 14	Serum and urine electrolytes	Class base learning/test
Week 15	ELISA	Class base learning/test
Week 16	Final	

Reading Materials

1. Burtis, C. A., Bruns, D. E., & Ashwood, E. R. (2014). Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (8th ed.). St. Louis, MO: Elsevier.
2. Bishop, M. L., Duben-Engelkirk, J. L., & Fody, E. P. (2020). Clinical Chemistry: Principles, Techniques, and Correlations (8th ed.). Philadelphia, PA: Wolters Kluwer.
3. Sunheimer, R., & Graves, L. (2017). Clinical Laboratory Chemistry (2nd ed.). Upper Saddle River, NJ: Pearson.
4. Varley, H., Gowenlock, A. H., & Bell, M. (2006). Practical Clinical Biochemistry: Methods and Interpretations (7th ed.). New Delhi, India: Heinemann Medical Books
5. Arneson, W. L., & Brickell, J. M. (2007). Clinical Chemistry: Laboratory Management and Clinical Correlations (1st ed.). Philadelphia, PA: F.A. Davis Company.
6. Rose, N. R., & Detrick, B. (2006). Manual of Clinical Laboratory Immunology (7th ed.). Washington, D.C.: ASM Press.
7. Larson, D. (2016). Clinical Chemistry: A Laboratory Perspective (2nd ed.). Philadelphia, PA: Saunders.
8. Tietz, N. W. (2015). Fundamentals of Clinical Chemistry (7th ed.). St. Louis, MO: Elsevier.
9. Lee, M. (2019). Basic Skills in Interpreting Laboratory Data (6th ed.). Bethesda, MD: American Society of Health-System Pharmacists.

Teaching Learning Strategies

1. Lecturing using white/black board/Multimedia
2. Written Assignments
3. Discussion about practical
4. Checking the results and discussion

Assignments: Types and Number with Calendar

Assignment, Quiz, Task, Presentation, etc.

Assessment

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-489**	**Credit Hours**	**3**
Course Title	**Biochemical Techniques**	**Course Type**		**Major (Elective)**	

Course Introduction

After studying this course, students will be able to understand proteins extraction and purification techniques, chromatographic techniques, different biochemical techniques used for separation, typesof PCR and its applications.The course is structured to provide the information of principles &mechanisms of different equipment and analysis of Biochemical and Biological samples .The course will also focus on experimental design and result interpretation

General methods for extraction, fractionation and purification of proteins. Principles of chromatography, Ion exchange chromatography, Paper chromatography, Affinity chromatography, Gas chromatography and column chromatography. High performance liquid chromatography (HPLC), Filtration, Polyacrylamide and agarose gel electrophoresis, SDS PAGE, Southern blotting, Western blotting, Northern blotting. Immunoelectrophoresis.

Enzyme linked immunosorbent assay (ELISA) and its types, Radioisotopes and their applications in Biochemistry. PCR and its types, Flamephotometer Atomic absorption spectro-photometry (AAS) Amino acids analyzer Electron microscopy X – ray diffraction Nuclear magnetic resonance

Learning Outcomes

On the completion of the course, the students will be able to :

1. Master Biochemical Techniques: Understand and apply various biochemical techniques for the extraction, fractionation, and purification of proteins, including different types of chromatography, electrophoresis, and blotting methods.
2. Analyze and Interpret Data: Develop skills to analyze and interpret experimental data from biochemical methods such as HPLC, SDS PAGE, ELISA, and PCR, understanding their applications and troubleshooting common issues.
3. Integrate Advanced Knowledge: Integrate advanced knowledge of biochemical techniques with practical applications, focusing on real-world scenarios, research methodologies, and ethical considerations in biochemical research

	Course Content	Assignments/Readings
Week 1	Introduction to Protein Extraction and Purification General Methods for Protein Extraction Techniques for cell lysis and protein extraction Solubilization and stabilization of proteins	Class base learning /test
	Fractionation of Proteins Methods for protein fractionation: precipitation, centrifugation Principles and applications of protein fractionation	Class base learning /test
	Review of protein extraction and purification methods	Class base learning /test
Week 2	Principles of Chromatography Introduction to Chromatography Basic principles and types of chromatography Applications in protein purification	Class base learning /test

	Ion Exchange Chromatography Theory and practice of ion exchange chromatography Applications and examples in protein purification	Class base learning /test
	Paper and Affinity Chromatography Paper Chromatography Principles and applications of paper chromatography Techniques for protein analysis	Class base learning /test
Week 3	Affinity Chromatography Principles and methodology of affinity chromatography Applications for specific protein purification	Class base learning /test
	Class discussion	Class base learning /test
	Gas Chromatography and Column Chromatography Gas Chromatography Principles and applications of gas chromatography Techniques and uses in biochemical analysis	Class base learning /test
Week 4	Column Chromatography Principles and types of column chromatography Techniques for protein separation and purification	Class base learning /test
	Review of chromatography techniques and method Trouble shootings and technical aspects	Class base learning /test
	Quiz	
Week 5	High Performance Liquid Chromatography (HPLC) Introduction to HPLC Principles and instrumentation of HPLC Types of HPLC and their applications	Class base learning /test
	Practical Applications of HPLC Sample preparation and analysis using HPLC Case studies and examples Filtration Techniques Principles of Filtration Types of filtration methods: membrane, depth filtration Applications in protein purification	Class base learning /test
	Filtration in Protein Analysis Techniques for removing contaminants Practical applications in laboratory settings	Class base learning /test
Week 6	Class discussion	
	Gel Electrophoresis Polyacrylamide Gel Electrophoresis (PAGE) Principles and techniques of PAGE Applications in protein analysis	Class base learning /test
	SDS-PAGE Principles and methodology of SDS-PAGE Interpretation of results and troubleshooting	Class base learning /test

Week 7	Class discussion and review of electrophoresis and data analysis if possiblehands on training about electrophoresis	Class base learning /test
	Blotting Techniques Southern Blotting Principles and applications of Southern blotting Techniques for nucleic acid detection	Class base learning /test
	Western Blotting Principles and methodology of Western blotting Techniques for protein detection and analysis	Class base learning /test
Week 8	Mid Term	
Week 9	Northern Blotting and Immunoelectrophoresis Northern Blotting Principles and applications of Northern blotting Techniques for RNA detection	Class base learning /test
	Immunoelectrophoresis Principles and methodology of immunoelectrophoresis Applications in protein analysis and diagnostics	Class base learning /test
	2D gel electrophoresis Principles and methodology of 2D gel electrophoresis Applications in protein analysis and diagnostics	Class base learning /test
Week 10	Enzyme Linked Immunosorbent Assay (ELISA) Introduction to ELISA Principles and types of ELISA Techniques and applications in protein analysis	Class base learning /test
	ELISA Types and Applications Different types of ELISA (direct, indirect, sandwich) Case studies and practical examples	Class base learning /test
	CLASS DISCUSSION	
Week 11	Radioisotopes in Biochemistry Basics of Radioisotopes Principles and applications of radioisotopes Safety and handling of radioactive materials	Class base learning /test
	Applications in Biochemistry Uses of radioisotopes in protein and nucleic acid studies Case studies and experimental design	Class base learning /test
	Introduction to PCR Principles of PCR Basic principles and components of PCR Applications in molecular biology	Class base learning /test
Week 12	Types of PCR Conventional PCR, quantitative PCR (qPCR), and reverse transcription PCR (RT-PCR)	Class base learning /test

	Techniques and applications	
	Class discussion and review of PCR and data analysis if possible hands on training	Class base learning /test
	QUIZ	
Week 13	Advanced Techniques in Protein Analysis spectroscopy and spectrophotometry – Principles, methods and applications of infrared spectroscopy, FTIR	Class base learning /test
	Visible and ultraviolet absorption spectrophotometry and MALDI	Class base learning /test
	Flame Photometer Introduction to Flame Photometry Principles and Working Mechanism Applications and Limitations in Biochemical Analysis	Class base learning /test
Week 14	Atomic Absorption Spectrophotometry (AAS) Fundamentals of AAS Instrumentation and Techniques Sample Preparation and Analysis	Class base learning /test
	Amino Acids Analyzer Overview of Amino Acids Analysis Operational Principles of Amino Acids Analyzers Applications in Biochemistry and Clinical Diagnostics	Class base learning /test
	Electron Microscopy Introduction to Electron Microscopy Types: Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM) Sample Preparation and Imaging Techniques	Class base learning /test
Week 15	X-Ray Diffraction Basics of X-Ray Diffraction Crystallography and Structure Determination Applications in Biochemistry	Class base learning /test
	Nuclear Magnetic Resonance (NMR) Principles of NMR Instrumentation and Data Interpretation Applications in Structural Biology and Chemistry	Class base learning /test
	CLASS DISCUSSION	
Week 16	Submission of assignments. If required then discussion the whole chapter for final term exams preparation Final term assessment	
Reading Materials		

1. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2020). Principles of biochemistry (8th ed.). W. H. Freeman and Company.
2. Voet, D. J., Voet, G. J., & Pratt, C. W. (2023). Fundamentals of biochemistry (5th ed.). Wiley.
3. Styer, L. (2021). Biochemistry (9th ed.). W. H. Freeman and Company.
4. Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., & Rodwell, V. W. (2018). Harper's biochemistry (32nd ed.). McGraw-Hill Education.
5. Champ, C., Harvey, R. A., & Ferrie, D. R. (2021). Lippincott's biochemistry (6th ed.). Wolters Kluwer

Teaching Learning Strategies

1. Lecturing using white/black board/Multimedia
2. Written Assignments
3. Class activities and discussion
4. Quiz about last lecture

Assignments: Types and Number with Calendar

Assignment, Quiz, Task, Presentation, etc.

Assessment

Sr. No.	Elements	Weightage	Details
2.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
3.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
4.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

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