MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL
(Formerly West Bengal University of Technology)
Syllabus of B. Sc Genetics
(Effective from 2023-24 Academic Sessions)

SEVENTH SEMESTER

Course Name: Bioinformatics **Code: BMGN 7401**
Credits: 3 **Modes: Offline**
Total hours: 45 hrs

Aim of the course: This course aims to introduce students of Genetics to the fundamental concepts and tools of bioinformatics. It focuses on building practical skills in accessing biological databases, performing sequence analysis, and understanding how computational approaches are applied in biological research.

Course objectives: This course is designed to provide students with a working knowledge of bioinformatics as applied to genetics. Students will learn to navigate biological databases, understand sequence formats, perform basic sequence alignments, and use tools such as BLAST and ClustalW. The course also introduces pattern recognition, motif analysis, and the relevance of bioinformatics in genomic and genetic research. By the end, students should be able to retrieve, analyse, and interpret biological sequence data using standard bioinformatics tools.

Sl	Graduate Attributes	Mapped Modules
CO1	Describe the history, scope, and importance of bioinformatics and relate it to the central dogma of molecular biology.	M1
CO2	Identify and use major biological databases (NCBI, GenBank, EMBL, UniProt, PDB) for retrieving biological sequence and structural information.	M2
CO3	Explain common sequence file formats and describe the process of sequence data submission to international databases.	M3
CO4	Perform basic sequence similarity searches using BLAST, and distinguish between local and global alignment approaches.	M4
CO5	Understand the concept of multiple sequence alignment and construct basic phylogenetic trees using distance-based methods.	M5
CO6	Navigate key genomic databases and use genome browser tools for accessing and interpreting genomic information.	M6
CO7	Describe the concept of sequence motifs, use motif databases, and understand the basics of gene finding.	M7
CO8	Appreciate the applications of bioinformatics in microbiology, genetics, and disease research.	M8

Learning Outcome/Skills: To impart basic knowledge about the following

- Explain the significance of bioinformatics and its relationship to the central dogma.
- Access and retrieve data from major biological databases including NCBI, GenBank, EMBL, and UniProt.
- Understand and use common biological sequence file formats.
- Perform pairwise sequence alignment and use BLAST for similarity searching.
- Understand multiple sequence alignment and construct simple phylogenetic trees.

- Navigate genomic databases and genome browsers for accessing genetic information.
- Identify sequence motifs and understand pattern-based approaches to gene finding.
- Appreciate the practical applications of bioinformatics in microbiology and genetics research.

Sl	Module Number	Content	Total Hours	% of Questions	Bloom Level (applicable)	Remarks, if any
THEORY						
M1	**Introduction to Bioinformatics**	History and development of bioinformatics; Importance in biology and healthcare; Goals and scope; Central dogma and bioinformatics	5	12%	1, 2	Conceptual foundation
M2	**Biological Databases**	Introduction to biological databases; Primary vs. secondary databases; NCBI, GenBank, EMBL, UniProt, PDB; Data retrieval using NCBI Entrez	5	12%	1, 2	Database literacy
M3	**Sequence Submission and File Formats**	Sequence submission tools (BankIt, Sequin); Sequence file formats (FASTA, GenBank, EMBL, Swiss-Prot); Concept of INSDC	5	8%	1, 2	Practical data handling
M4	**Sequence Alignment**	Concept of sequence similarity and homology; Dot matrix analysis; BLAST algorithm; Local vs. global alignment; Pairwise alignment	10	20%	1, 2, 3	Core topic; high weightage
M5	**Multiple Sequence Alignment and Phylogenetics**	Concept of multiple sequence alignment; ClustalW; Introduction to phylogenetics; Distance-based methods; Phylogenetic trees	6	16%	1, 2, 3	Comparative analysis skills
M6	**Genomic Databases and**	Web-based genomic resources: NCBI,	5	12%	1, 2	Applied database use

	Tools	GenBank, EMBL; Basic concept of INSDC; Model organism databases; Introduction to genome browsers				
M7	**Pattern Analysis and Motif Finding**	Concept of sequence patterns and motifs; Consensus sequences; Introduction to PROSITE and Pfam; Basic idea of gene finding	5	12%	1, 2	Pattern recognition basics
M8	**Applications of Bioinformatics**	Bioinformatics in drug discovery; Sequence-based disease analysis; Role of bioinformatics in microbiology and genetics; Overview of functional genomics	4	8%	1, 2	Applied awareness
Total Theory			**45**	**100**		

Detailed Syllabus

M1: Introduction to Bioinformatics: History and development of bioinformatics. Importance of bioinformatics in the fields of biology and healthcare. Goals and scope of bioinformatics. Relationship between the central dogma of molecular biology and bioinformatics. **(Total Hours: 5)**

M2: Biological Databases: Introduction to biological databases. Types of databases: primary and secondary. Overview of major databases: NCBI, GenBank, EMBL, UniProt, and Protein Data Bank (PDB). Data retrieval using NCBI Entrez. Introduction to sequence file formats: FASTA, GenBank, and EMBL. **(Total Hours: 5)**

M3: Sequence Submission and File Formats: Sequence submission tools: BankIt and Sequin. Common sequence file formats: flat file, FASTA, GenBank, GenPept, EMBL, and Swiss-Prot. Concept of INSDC (International Nucleotide Sequence Database Collaboration) and its member databases. **(Total Hours: 5)**

M4: Sequence Alignment: Concept of sequence similarity and its biological significance. Difference between sequence identity and homology. Alignment methods: Dot matrix analysis and BLAST (Basic Local Alignment Search Tool). Difference between local and global alignment. Pairwise sequence alignment — conceptual understanding. Introduction to the scoring of alignments. **(Total Hours: 10)**

M5: Multiple Sequence Alignment and Phylogenetics: Concept of multiple sequence alignment (MSA). Introduction to ClustalW for MSA. Basic idea of phylogenetic analysis. Distance-based approaches to phylogeny: UPGMA and Neighbour-Joining methods. Concept of phylogenetic trees: nodes, branches, clades. Basic interpretation of a phylogenetic tree. **(Total Hours: 6)**

M6: Genomic Databases and Tools: Introduction to web-based genomic resources: NCBI Genome, GenBank, and EMBL. Basic concept of INSDC. Overview of selected model organism genomes and databases. Introduction to genome browsers: basic navigation of NCBI genome browser. **(Total Hours: 5)**
M7: Pattern Analysis and Motif Finding: Concept of sequence patterns and motifs. Representation of motifs: consensus sequences and regular expressions. Introduction to motif databases: PROSITE and Pfam. Basic concept of gene finding: composition-based and motif-based approaches. Introduction to regulatory sequence identification. **(Total Hours: 5)**
M8: Applications of Bioinformatics: Role of bioinformatics in drug discovery and disease research. Application of sequence analysis in understanding microbial genomes. Bioinformatics tools relevant to genetics research. Overview of functional genomics: what genes do and how bioinformatics helps interpret this. Brief introduction to systems biology. **(Total Hours: 4)**

Suggested Readings:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
3. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
4. David W. Mount. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
5. Lesk A. M. (2014) Introduction to Bioinformatics. IV Edition. Oxford University Press.

PRACTICAL
Credit: 2
Total Hours: 60
BMGN 7491 – Lab on Bioinformatics

(Wherever computer lab or internet access is not available, the principles and concepts can be demonstrated through any other material or medium including videos, virtual labs, or offline software tools.)

1. **Introduction to Bioinformatics Tools and Databases** (4 Hours)
    - Retrieval of biological sequence and structural data from NCBI GenBank, UniProt, and PDB databases.
    - Navigation and data extraction using NCBI Entrez search tools.
    - Understanding accession numbers, sequence annotations, and database records.
2. **Sequence File Formats and Data Submission Tools** (3 Hours)
    - Study and comparison of FASTA, GenBank, and EMBL file formats.
    - Creation of FASTA files and interpretation of GenBank/EMBL records.
    - Introduction to sequence submission workflow using NCBI BankIt.
3. **Pairwise Sequence Alignment Using BLAST** (4 Hours)
    - Sequence similarity searching using NCBI BLAST.
    - Use of BLASTn and BLASTp programs.
    - Interpretation of E-values, bit scores, percent identity, and query coverage.
4. **Visualisation of Protein 3D Structures Using Ras Mol** (4 Hours)
    - Download and visualization of protein structures from PDB.

- Exploration of different molecular display modes (wireframe, backbone, ribbon, cartoon, space-fill).
- Identification of secondary structural elements such as α-helices and β-sheets.

5. **Multiple Sequence Alignment Using Clustal W / Clustal Omega** (4 Hours)
   - Alignment of homologous nucleotide or protein sequences.
   - Comparison of Clustal W and Clustal Omega outputs.
   - Identification of conserved residues and biologically significant regions.
6. **Phylogenetic Tree Construction Using Clustal Omega, MEGA, and T-Coffee** (6 Hours)
   - Multiple sequence alignment for phylogenetic analysis.
   - Construction of Neighbour-Joining and Maximum Parsimony trees using MEGA.
   - Comparison of phylogenetic trees and interpretation of evolutionary relationships using bootstrap values.
7. **Motif Identification and Pattern Analysis Using PROSITE and MEME** (5 Hours)
   - Identification of conserved functional motifs using PROSITE.
   - De novo motif discovery using MEME.
   - Biological interpretation of conserved sequence patterns and motifs.

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Course Name: Reproductive and Cancer Genetics and Emerging Technology **Code: BMGN 7402**
Credits: 4L+1T **Modes: Offline**
Total hours: 75 hrs

Aim of the course: This course provides an advanced understanding of the genetic principles governing human reproduction and cancer pathogenesis, with strong emphasis on research methodologies and emerging technologies. Students will explore the molecular basis of infertility, pregnancy loss, oncogenesis, and hereditary cancer syndromes. The course integrates cutting-edge tools such as next-generation sequencing (NGS), CRISPR-Cas9, liquid biopsy, and bioinformatics, culminating in a guided research project and dissertation.

Course Objectives: The objectives of this course are to understand the genetic and epigenetic regulation of gametogenesis and early embryonic development; identify and critically evaluate genetic causes of infertility and recurrent pregnancy loss; explain the molecular mechanisms of oncogenesis including oncogenes, tumour suppressors, and DNA repair pathways; classify hereditary cancer syndromes and genomic instability disorders; apply emerging technologies in reproductive and cancer genetics research; and design and execute a small-scale research project.

Sl	Graduate Attributes	Mapped Modules
CO1	Explain the complex genetic and molecular mechanisms regulating human reproduction and the development of cancer.	M1 (Unit 1)
CO2	Analyze the genetic basis of various infertility disorders and hereditary cancer syndromes.	M1, M3 (Units 1, 3)
CO3	Apply knowledge of molecular pathways to differentiate between genetic, genomic, and epigenetic drivers of tumorigenesis.	M2 (Unit 2)
CO4	Evaluate the principles, applications, and limitations of emerging technologies (NGS, CRISPR, liquid biopsy) in diagnosis and management of genetic disorders.	M4 (Unit 4)
CO5	Formulate evidence-based strategies for genetic testing, risk assessment, and counseling for patients with reproductive and cancer-related genetic conditions.	M3, M4 (Units 3, 4)
CO6	Design and execute a small-scale research project (in silico or literature-based) in reproductive or cancer genetics.	Research Component
CO7	Critically assess ethical, social, and regulatory issues related to genetic testing and gene editing in reproductive and cancer contexts.	M4, M5 (Tutorial)

Learning Outcome/Skills: To impart basic knowledge about the following

- Explain the genetic and epigenetic mechanisms underlying human reproduction and cancer pathogenesis at an advanced level.
- Analyse genetic causes of infertility and hereditary cancer syndromes using primary literature and genomic databases.
- Evaluate the principles, strengths, and limitations of emerging technologies (NGS, CRISPR, liquid biopsy) in research and diagnostics.
- Design and execute a small-scale research project (in silico or literature-based) in reproductive or cancer genetics.
- Interpret and present research data through a structured dissertation and oral defence, adhering to scientific writing standards.
- Critically assess ethical, social, and regulatory issues related to genetic testing and gene editing.

- Use bioinformatics tools (BLAST, UCSC Genome Browser, COSMIC) and statistical software (R or SPSS) for analysing genetic data.

Sl	Module Number	Content	Total Hours	% of Questions	Bloom Level (applicable)	Remarks, if any
THEORY						
M1	Foundations of Reproductive Genetics	Genetic control of sex determination and differentiation. Molecular regulation of spermatogenesis and oogenesis. Genetics of male infertility: Y chromosome microdeletions, CFTR mutations (CBAVD), AZF loci. Genetics of female infertility: Turner syndrome, Fragile X premutation, PCOS genetics. Genetic basis of recurrent pregnancy loss: chromosomal rearrangements, thrombophilia genes, endometrial factors. Research focus: Mini-review on a selected infertility gene using PubMed/OMIM.	15	20%	2, 3	Reproductive genetics
M2	Cancer Genetics – Mechanisms and Pathways	Hallmarks of cancer: a genetic and epigenetic perspective. Oncogenes (RAS, MYC, HER2) and tumour suppressor genes (TP53, RB1, PTEN). Genetic instability: mutator phenotype, DNA repair defects (MMR, BER, NER). Telomeres, telomerase, and cellular immortalisation. Epigenetics in cancer: DNA methylation, histone modifications, non-coding RNAs. Research focus: Analysis of a cancer pathway using KEGG or Reactome.	15	20%	3, 4	Molecular oncology
M3	Hereditary Cancer Syndromes and Genomic Disorders	Molecular genetics, clinical features, and risk assessment: HBOC (BRCA1/BRCA2), Lynch syndrome/HNPCC (MMR genes: MLH1, MSH2), Li-Fraumeni syndrome (TP53), Familial Adenomatous Polyposis (APC), Retinoblastoma (RB1). Genetic testing, counselling, and surveillance strategies. Research focus: Case study – pedigree analysis and mutation screening strategy.	15	20%	3, 4, 5	Hereditary syndromes
M4	Emerging Technologies and Research	Next-Generation Sequencing (NGS): whole-genome, whole-exome, targeted panels for germline and somatic	15	20%	4, 5, 6	Emerging technologies

Sl	Module Number	Content	Total Hours	% of Questions	Bloom Level (applicable)	Remarks, if any
	Applications	mutations. Preimplantation Genetic Testing (PGT-A, PGT-M, PGT-SR). Non-Invasive Prenatal Testing (NIPT). Liquid biopsy: circulating tumour DNA (ctDNA) for early detection and monitoring. CRISPR-Cas9: principles, delivery methods, and applications in gene editing. Bioinformatics and AI in genomic data interpretation (variant calling, pathogenicity prediction). Research focus: Design of a research proposal using one emerging technology.				
M5	Case Studies and Research Applications in Reproductive and Cancer Genetics	Analyse clinical cases involving genetic causes of male and female infertility, recurrent pregnancy loss, hereditary cancer syndromes, and genomic disorders through discussions on Y chromosome microdeletions, CFTR mutations, Turner syndrome, Fragile X premutation, BRCA1/BRCA2, TP53, APC, RB1, and mismatch repair gene mutations. Interpretation of pedigrees, risk assessment, mutation screening strategies, and genetic counselling approaches for inherited disorders. Students will critically evaluate molecular pathways involved in carcinogenesis using KEGG and Reactome databases, analyse DNA repair defects, epigenetic alterations, and genomic instability, and discuss their implications in disease progression.	15	20%	4, 5, 6	Tutorial
Total Theory			**75**	**100**		

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Detailed Syllabus

Unit 1: Foundations of Reproductive Genetics: Genetic control of sex determination and differentiation. Molecular regulation of spermatogenesis and oogenesis. Genetics of male infertility: Y chromosome microdeletions, CFTR mutations in CBAVD, AZF loci. Genetics of female infertility: Turner syndrome, Fragile X premutation, PCOS genetics. Genetic basis of recurrent pregnancy loss: chromosomal rearrangements, thrombophilia genes, endometrial factors. Research focus: Mini-review on a selected infertility gene using PubMed/OMIM. **(Total Hours: 15)**
Unit 2: Cancer Genetics – Mechanisms and Pathways: Hallmarks of cancer: a genetic and epigenetic perspective. Oncogenes (RAS, MYC, HER2) and tumour suppressor genes (TP53, RB1, PTEN). Genetic instability: mutator phenotype, DNA repair defects (MMR, BER, NER). Telomeres, telomerase, and cellular immortalisation. Epigenetics in cancer: DNA methylation, histone modifications, non-coding RNAs. Research focus: Analysis of a cancer pathway using KEGG or Reactome. **(Total Hours: 15)**
Unit 3: Hereditary Cancer Syndromes and Genomic Disorders: Molecular genetics, clinical features, and risk assessment of key syndromes: Hereditary Breast and Ovarian Cancer (HBOC) – BRCA1/BRCA2; Lynch syndrome (HNPCC) – MMR genes (MLH1, MSH2, etc.); Li-Fraumeni syndrome – TP53; Familial Adenomatous Polyposis (FAP) – APC; Retinoblastoma – RB1. Genetic testing, counselling, and surveillance strategies. Research focus: Case study – pedigree analysis and mutation screening strategy. **(Total Hours: 15)**
Unit 4: Emerging Technologies and Research Applications: Next-Generation Sequencing (NGS): whole-genome, whole-exome, targeted panels for germline and somatic mutations. Preimplantation Genetic Testing (PGT-A, PGT-M, PGT-SR). Non-Invasive Prenatal Testing (NIPT). Liquid biopsy: circulating tumour DNA (ctDNA) for early detection and monitoring. CRISPR-Cas9: principles, delivery methods, and applications in gene editing for disease models and potential therapy. Bioinformatics and AI in genomic data interpretation (variant calling, pathogenicity prediction). Research focus: Design of a research proposal using one emerging technology (e.g., CRISPR knock-in for a cancer gene). **(Total Hours: 15)**
Unit 5: Case Studies and Research Applications in Reproductive and Cancer Genetics: Analyse clinical cases involving genetic causes of male and female infertility, recurrent pregnancy loss, hereditary cancer syndromes, and genomic disorders through discussions on Y chromosome microdeletions, CFTR mutations, Turner syndrome, Fragile X premutation, BRCA1/BRCA2, TP53, APC, RB1, and mismatch repair gene mutations. Interpretation of pedigrees, risk assessment, mutation screening strategies, and genetic counselling approaches for inherited disorders. Students will critically evaluate molecular pathways involved in carcinogenesis using KEGG and Reactome databases, analyse DNA repair defects, epigenetic alterations, and genomic instability, and discuss their implications in disease progression **(Total Hours: 15)**

Suggested Readings:

1. Strachan, T., & Read, A. P. (2018). Human Molecular Genetics (5th ed.). Garland Science.
2. Vogelstein, B., & Kinzler, K. W. (2023). The Genetic Basis of Human Cancer (3rd ed.). McGraw-Hill.
3. Harper, J. C. (2018). Preimplantation Genetic Diagnosis (2nd ed.). Cambridge University Press.
4. Weinberg, R. A. (2013). The Biology of Cancer (2nd ed.). Garland Science.
5. Nussbaum, R. L., McInnes, R. R., & Willard, H. F. (2015). Thompson & Thompson Genetics in Medicine (8th ed.). Elsevier.
6. Dudley, J. T., & Karczewski, K. J. (2019). Exploring Personal Genomics. Oxford University Press.
7. Relevant review articles from journals: Nature Reviews Cancer, Nature Reviews Genetics, Human Reproduction Update, Journal of Clinical Oncology.
8. Online databases: OMIM, ClinVar, COSMIC, gnomAD, TCGA.

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Course Name: Research Methodology **Code: BMGN 7403**
Credits: 3L + 1T **Modes: Offline**
Total hours: 60 hrs

Aim of the course: The course aims to provide students with a comprehensive understanding of research methodology and biostatistics in the field of Genetics. It is designed to develop the knowledge and practical skills required for conducting scientific research, analyzing data, and communicating research findings ethically and effectively.

Course objectives: This course aims to provide students with a comprehensive understanding of research methodology and its applications in Genetics. It focuses on developing skills in research design, data collection, statistical analysis, and scientific report writing while emphasizing research ethics and academic integrity. The course also enables students to apply research principles in laboratory practice, critically evaluate scientific literature, and understand the processes involved in research funding, publication, and peer review.

Sl	Graduate Attributes	Mapped Modules
CO1	To familiarize students with the fundamental concepts, types, and applications of research in Medical Laboratory Technology.	M1
CO2	To develop skills in identifying research problems, conducting literature reviews, formulating hypotheses, and designing research studies.	M2
CO3	To enable students to apply appropriate sampling methods, data collection techniques, and basic biostatistical tools for research analysis.	M3
CO4	To train students in the preparation of research reports, abstracts, and scientific manuscripts using standard referencing styles and ethical research practices.	M4
CO5	To provide insight into scientific publication processes and the application of research in laboratory disciplines such as pathology, microbiology, biochemistry, and quality assurance.	M5

Learning Outcome/Skills: To impart basic knowledge about the following

- Understand the fundamental concepts, objectives, types, and significance of research, particularly in the field of Genetics, while adhering to principles of research ethics and academic integrity.
- Identify research problems, conduct literature reviews, formulate hypotheses, and design scientifically valid research studies using appropriate variables, sampling techniques, and study plans.
- Develop skills in collecting, organizing, and analyzing qualitative and quantitative data using standard data collection methods and basic biostatistical tools, including software such as MS Excel and SPSS.
- Interpret research findings, prepare scientific reports, dissertations, abstracts, and research proposals, and apply standard referencing styles such as Vancouver and APA.

- Apply research methodologies in laboratory disciplines including pathology, microbiology, biochemistry, and quality assurance, and understand the processes involved in research funding, scientific publication, peer review, and manuscript submission.

- Demonstrate the ability to critically evaluate scientific literature, conduct evidence-based investigations, and contribute effectively to research and innovation in healthcare and laboratory sciences.

- Acquire professional competencies in scientific communication, data management, ethical research practices, and publication strategies necessary for academic, clinical, and industrial research

Sl	Module Number	Content	Total Hours	% of Questions	Bloom Level (applicable)	Remarks, if any
THEORY						
1	**Module 1**	**Introduction to Research and its Importance -** Definition and objectives of research. Types of research: Basic, Applied, Clinical, Descriptive, Analytical. Research in Medical Laboratory Technology. Identifying research problems. Review of literature and its significance. Research ethics and plagiarism	10	10%	1,2	NA
2	**Module 2**	**Research Design and Planning -** Elements of a research design. Formulation of hypothesis. Variables: Independent, Dependent, Confounding. Sampling techniques: Probability and Nonprobability. Inclusion and exclusion criteria. Sample size determination. Pilot studies	12	20%	1, 2	NA
3	**Module 3**	**Data Collection and Analysis -** Types of data: Primary vs Secondary, Qualitative	12	20%	1,2, 3	NA

		vs Quantitative. Data collection methods: Surveys, Questionnaires, Observations, Lab data. Tools and instruments used in data collection. Introduction to biostatistics: Mean, Median, Mode, Standard deviation. Data presentation: Tables, Charts, Graphs. Use of Excel/SPSS for data entry and basic analysis **(Total Hours: 12)**				
4	**Module 4**	**Interpretation and Report Writing -** Interpretation of results. Discussion and conclusion. Limitations of the study. Referencing styles: Vancouver, APA. Structure of research reports, dissertations, and articles. Writing abstracts and proposals.	14	30%	1,2, 3	NA
5	**Module 5**	**Research in Laboratory Practice and Publication.** Clinical case study-based research. Research applications in pathology, microbiology, and biochemistry. Quality assurance and control as research. ICMR and other funding agencies. Steps in publication: Selection of journals, peer-review process. Common reasons for manuscript rejection **(Total Hours: 12)**	12	20%	1, 2,3	NA
Total Theory			**60**	**100**		

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Detailed Syllabus

Module 1: Introduction to Research and its Importance - Definition and objectives of research. Types of research: Basic, Applied, Clinical, Descriptive, Analytical. Research in Medical Laboratory Technology. Identifying research problems. Review of literature and its significance. Research ethics and plagiarism **(Total Hours: 10)**
Module 2: Research Design and Planning - Elements of a research design. Formulation of hypothesis. Variables: Independent, Dependent, Confounding. Sampling techniques: Probability and Nonprobability. Inclusion and exclusion criteria. Sample size determination. Pilot studies **(Total Hours: 12)**
Module 3: Data Collection and Analysis - Types of data: Primary vs Secondary, Qualitative vs Quantitative. Data collection methods: Surveys, Questionnaires, Observations, Lab data. Tools and instruments used in data collection. Introduction to biostatistics: Mean, Median, Mode, Standard deviation. Data presentation: Tables, Charts, Graphs. Use of Excel/SPSS for data entry and basic analysis **(Total Hours: 12)**
Module 4: Interpretation and Report Writing - Interpretation of results. Discussion and conclusion. Limitations of the study. Referencing styles: Vancouver, APA. Structure of research reports, dissertations, and articles. Writing abstracts and proposals. **(Total Hours: 14)**
Module 5: Research in Laboratory Practice and Publication. Clinical case study-based research. Research applications in pathology, microbiology, and biochemistry. Quality assurance and control as research. ICMR and other funding agencies. Steps in publication: Selection of journals, peer-review process. Common reasons for manuscript rejection **(Total Hours: 12)**

Suggested Readings:

1. Kothari C. R. and Garg G. (2019) *Research Methodology: Methods and Techniques*. 4th Edition. New Age International Publishers.
2. Creswell J. W. (2018) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 5th Edition. Sage Publications.
3. Ary D. and Jacobs L. C. (2018) *Introduction to Research in Education*. 9th Edition. Cengage Learning.