UNIVERSITY OF THE PUNJAB

NOTIFICATION

The Syndicate at its meeting held on 27-07-2023 has approved the recommendations of the Academic Council made at its meeting dated 24-05-2023 regarding approval of the Syllabi and Course of Reading for M.Phil. Molecular Biology & Forensic Sciences and Ph.D. Molecular Biology & Forensic Sciences for Centre for Applied Molecular Biology with effect from the Academic Session 2023.

The Syllabi & Course of Reading for M.Phil. Molecular Biology & Forensic Sciences and Ph.D. Molecular Biology & Forensic Sciences is Attached.

Admin. Block,
Quaid-i-Azam Campus,
Lahore.

Sd/-
Registrar

No. D/**9173**/Acad.

Dated: **01/12/2023.**

Copy of the above is forwarded to the following for information and further necessary action: -

1. The Dean, Faculty of Life Science
2. The Director, Centre for Applied Molecular Biology.
3. Chairperson, DPCC
4. Controller of Examinations
5. Director, Quality Enhancement Cell
6. Director, IT for uploading on website.
7. Admin Officer (Statutes)
8. Secretary to the Vice-Chancellor
9. PS to the Registrar
10. Assistant Syllabus

Assistant Registrar (Academic)
for Registrar

CURRICULA/ SYLLABI OF M.PHIL DEGREE PROGRAM

Program Title: M.Phil in Molecular Biology & Forensic Sciences

Department: Centre for Applied Molecular Biology

Faculty: Life Sciences

1. Department Mission

The CAMB's Quality Policy is aligned with the University of the Punjab's policy/ goals. We are committed to imparting efficient and cost-effective education/ training to our students in the field of Applied Molecular Biology/ Biotechnology and producing high-quality scientists/ researchers/ trained professionals who shall be instrumental in executing their technical skills in areas of their specialization. We promise and wish to achieve our aims and goals by fulfilling quality objectives, training our academia, regular monitoring, and assuring continual quality improvement in CAMB's working system. The Institute's mission is threefold, i.e.

- Teaching and Learning
- Research and Development
- Outreach and Public Service

2. Introduction

To build a national capability in the newly emerging science, the Federal Ministry of Science & Technology (MoST) approved the establishment of the Centre for Applied Molecular Biology (CAMB) at the University of the Punjab, Lahore in 1987 which is located back to back with the laboratory block of the Centre of Excellence in Molecular Biology (CEMB). In March 2015, the Prime Minister of Pakistan approved the transfer of CAMB to the University of the Punjab. Accordingly, MoST handed over the administrative control of CAMB to University of the Punjab, Lahore w.e.f 01.07.2015 along with all assets and liabilities. The CAMB's laboratory block includes Forensic DNA Typing, Molecular Diagnostics of Infectious Diseases, Proteomics, Virology, Plant Molecular Biology, DNA Core Facility, and Genomics of Human Diseases laboratories and is surrounded by a vast area of land where crops and other plants are sown for research purposes. CAMB being a renowned scientific research entity encourages the osmosis of research from Lab into different sectors of society. It strives to provide a suitable environment and encourages researchers to work on collaborative research projects to advance knowledge, propose solutions to some of the major issues of today, and develop new technologies for the future. CAMB is providing reliable, accurate, rapid, and more economical diagnostic & forensic services to law enforcement agencies, courts, and the general public and DNA Sequencing and genotyping facilities to various academic and R&D organizations throughout Pakistan. In academics, CAMB is offering M. Phil & Ph.D. degree programs in "Molecular Biology and Forensic Sciences". Students of various universities also use the platform of CAMB for the completion of their degrees. The whole setup of CAMB represents a unique and economical mode to optimally utilize the extremely limited resources of personnel and materials.

3. Program Introduction and Alignment with the University Mission

MPhil in Molecular Biology and Forensic Sciences program started in 2015, the year CAMB was transferred to University of the Punjab. Since then, the centre is delivering quality education to its students through teaching in classes as well as guiding them in research labs. It is two years program of four semesters including teaching and research. Students enrolled in CAMB are involved in different research groups of the centre according to their interest fields and the available infrastructure of labs. They are engaged

in molecular genetics of human diseases, cancer research, plant biotechnology, population genetics, molecular bacteriology and virology, genomics, proteomics, etc. 30 credit hours including 6 credit hours of research thesis are necessary for the award of an MPhil degree. This program is aligned with the university's mission.

4. Program Objectives

The MPhil Program in Molecular Biology and Forensic Sciences, through high-quality academics, also aims to train students to conduct independent research in the subject. An MPhil degree holder in Molecular Biology and Forensic Sciences is expected to demonstrate good knowledge in the discipline and to develop and create new knowledge, contributing to the field. Following will be some specific objectives of the program.

i. Prepare/Generate the next generation pioneer/cadre of manpower specifically trained in the modern field of applied molecular biology and forensic sciences through teaching and training.
ii. Systematic understanding of the subject and expertise in the skills and methods associated with this subject.
iii. The capacity building for critical analysis, assessment, and synthesis of new ideas.
iv. The capacity building in developing further the progress made in technological, social, or cultural terms within an academic and professional context.
v. Organize national and international seminars/conferences/workshops on the latest developments in the field with the participation of students.
vi. Goal-oriented molecular biology research on specific problems related to the economic needs of the country for agriculture, health, forensics, and industry.
vii. Production of critical laboratory materials used in molecular biological research.

5. Market Need/ Rationale of the Program

a) Potential Students for program

Students with 4 years BS degree in Zoology, Botany, Biotechnology, Molecular Biology, Molecular Genetics, Biochemistry, Chemistry, DVM, Pharm-D, or other medical sciences, etc. are eligible for enrollment in the program.

b) Potential Employers

i. Agriculture
ii. Animal Husbandry
iii. Enviroment conservation
iv. Genetic Engineering
v. Medicine
vi. Industrial Research and development
vii. Halal Product Industry
viii. Universities
ix. Forensic Agencies
x. Diagnostic Labs
xi. Research Organizations
xii. Academia
xiii. Forensic and Human Identification
xiv. Molecular Biology research labs
xv. Food industries
xvi. Pharmaceutical Industries
xvii. Biochemistry Labs
xviii. Healthcare centres
xix. Trained human resources outsourcing abroad etc.

c) Academic Projections

The core focus of an MPhil degree is the acquisition of academic skills through class lectures, practical research in the labs, and drafting a piece of academic work (dissertation). Publications of articles in recognized specialist journals relating to either several or one specific areas of research will be an added aspect.

d) Faculty

Life Sciences

e) Physical Facilities

Conventional PCR & Real-Time PCR machines, DNA Sequencers, Gel electrophoresis systems, well-equipped labs, and well-experienced/trained teaching and research staff Mammalian Cell Culture Lab, Natural Drug Development Lab/Proteomics Lab, Plant Tissue Culture Lab, Genetic Diseases Lab, Virology, BSL-2, BSL-3, Diagnostics, Forensics, Digital Library, Main Library at PU.

6. Admission Eligibility Criteria

- **Year of Study Completed**

  16 Years

- **Study Program/ Subject**

  MSc/BS (Hons.) (16 Years Education) in Agriculture, Biochemistry, Biological Sciences, DVM, Pharm-D, Biotechnology, Bioinformatics, Botany, Zoology, Chemistry, Microbiology, MBBS/BDS, MLT, Molecular Genetics, Animal Sciences, or any other relevant degree in Molecular Biology/ Forensic Sciences.

- **Percentage/CGPA**

  60/2.5 (As per PU/DPCC)

- **Entry Test (if applicable) with a minimum requirement**

  50 Marks out of 100 (As per PU/DPCC)

- **Any other (if applicable)**

7. Duration of Program

4 semesters/ 2 Years/ 30 Credit Hours

8. Assessment Criteria

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	It will take place at the mid-point of the semester.
2.	Formative Assessment	25%	It will be a continuous assessment. It includes classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on activities, short tests, quizzes, etc.
3.	Final Assessment	40%	It will take place 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 a term paper, research proposal development, fieldwork, report writing, etc.
4.	Research and Thesis	100 marks	The student will produce a thesis out of his/her research results and data. The thesis will be evaluated by the board of examiners comprising of the director, supervisor, and an external examiner from outside of the department.

9. Categorization of courses as per HEC Recommendation and Difference

Semester	Courses	Category (Credit Hour)					
		Core Courses	**Basic Courses**	**Major Electives**	**Minor Electives**	**Any Other**	**Semester Load**
First	Advances In DNA Manipulation	✓					03
	Frontiers in Forensic Science		✓				03
	Cell and Tissue Culture Techniques		✓				02
	Crime Scene Management		✓				03
	Forensic and Biotechnology Laws and Regulations		✓				02
	Biological Safety and Risk Management		✓				02
	Advances in Plant and Agriculture Molecular Biology		✓				03
	Recent Trends in Molecular Biology Techniques	✓	✓				03
	Paper, Grant, & Proposal Writing Skills		✓				02
	Molecular Bacteriology		✓				03
Second	Genomics and Bioinformatics		✓				03
	Bioethics & Dual Use of Education		✓				02
	Quality Control and Quality Assurance		✓				02
	Forensic Chemistry and Toxicology		✓				03
	Forensic Serology & DNA	✓					03
	Cyber Technology and Forensic Science		✓				03
	Molecular Immunology		✓				03
	Trends in Nucleic Acid Sequencing Techniques	✓					03
	Molecular Virology		✓				03
Third–Fourth	Research and Thesis						6
HEC Guidelines							30
Difference (HEC & PU)							None

* Minimum 24 credit hours will be taught in total in the first two semesters

10. Scheme of studies/ Semester-Wise Workload

Sr. No.	Code	Course title	Course Type	Prerequisite	Credit Hours		
Semester-I							
1.	MBFS 501	Advances In DNA Manipulation	Core	All enrolled students	03		
2.	MBFS-503	Frontiers in Forensic Science	Basic	All enrolled students	03		
3	MBFS 504	Cell and Tissue Culture Techniques	Basic	All enrolled students	02		
4	MBFS-505	Crime Scene Management	Basic	All enrolled students	03		
5	MBFS 507	Forensic and Biotechnology Laws and Regulations	Basic	All enrolled students	02		
6	MBFS 508	Biological Safety and Risk Management	Basic	All enrolled students	02		
7	MBFS 512	Advances in Plant and Agriculture Molecular Biology	Basic	All enrolled students	03		
8	MBFS 514	Recent Trends in Molecular Biology Techniques	Core	All enrolled students	03		
10	MBFS 517	Paper, Grant, Proposal Writing Skills	Basic	All enrolled students	02		
11	MBFS-519	Molecular Bacteriology	Basic	All enrolled students	03		
Semester-II Basic							
1	MBFS 502	Genomics and Bioinformatics	Basic	All enrolled students/Passed in the 1st Semester	03		
2	MBFS 506	Bioethics & Dual Use of Education	Basic	All enrolled students/Passed in the 1st Semester	02		
3	MBFS 509	Quality Control and Quality Assurance	Basic	All enrolled students/Passed in the 1st Semester	02		
4	MBFS 511	Forensic Chemistry And Toxicology	Basic	All enrolled students/Passed in the 1st Semester	03		
5	MBFS-513	Forensic Serology & DNA	Core	All enrolled students/Passed in the 1st Semester	03		
7	MBFS 515	Cyber Technology and Forensic Science	Basic	All enrolled students/Passed in the 1st Semester	03		
8	MBFS 516	Molecular Immunology	Basic	All enrolled students/Passed in the 1st Semester	03		
9	MBFS 518	Trends in Nucleic Acid Sequencing Techniques	Core	All enrolled students/Passed in the 1st Semester	03		

11	MBFS-510	Molecular Virology	Basic	All enrolled students/Passed in the 1st Semester	03		
Semester-III – IV							
1.		Research and Thesis			06		

* Minimum 24 credit hours will be taught in total in the first two semesters

11. Award of Degree

Degree awarding criteria stating:
CGPA percentage required to quality : 2.5
Thesis/ Project/ Internship: Thesis
Any other requirement e.g. comprehensive examination (if applicable) NA

12. NOC from Professional Councils (if applicable)

1. Board of Studies on 10.08.2015
2. Board of Faculty on 21.08.2015
3. Academic Council on 14.10.2015
4. Syndicate on 14.11.2015

For Revision

1. Board of Studies on 12.04.2021
2. Board of Faculty on 08.07.2021
3. Academic Council on 11-03-22 and 21-03-22 (Referred it back to BOF)
4. Syndicate on

13. Faculty Strength

Degree	**Area/ Specialization**			**Total**
PhD	1	Dr. Rehan Sadiq Shaikh	Molecular Biology	17
	2	Dr. Aleena Sumrin	Molecular Biology	
	3	Dr. Muhammad Farooq Sabar	Molecular Biology	
	4	Dr. Tahir Mehmood	Molecular Biology & Biochemistry	
	5	Dr. Muhammad Zafar Saleem	Molecular Biology	
	6	Dr. Manzoor Hussain	Microbiology & Molecular Genetics	
	7	Dr. RukhsanaParveen	Molecular Biology	
	8	Dr. Nazim Hussain	Biochemistry & Molecular Biology	
	9	Dr. Safdar Hussain	Biochemistry & Molecular Biology	
	10	Dr. Hamid Bashir	Molecular Biology	
	11	Dr. Muhammad Bilal	Molecular Biology	
	12	Dr. Ghulam Zahra Jahangir	Biotechnology	
	13	Dr. Muhammad Usman Ghani	Molecular Biology and Forensic Sciences	
	14	Dr. M. Adnan Shan	Forensic Genetics/ Forensic Sciences	
	15	Dr. Farheena Iqbal Awan	Molecular Biology & Molecular Genetics	
	16	Mr. M. Shahzad	Molecular Biology and Forensic Sciences	
MS/ M.Phil	17	Ms. SaimaYounas	Molecular Biology	

MS/ M.Phil	1.	Ms. Sadia Manzoor	Molecular Biology		02
	2	Mr. Muhammad Akram	Molecular Biology and Forensic Sciences?		(On Study Leave)

14. Present Student Teacher Ratio in the Department

15. Student Faculty Ration (M.Phil Program) = $\frac{N_{Students}}{N_{Faculty}}$
=8:1

16. Course Outlines separately for each course

- Attached

Checklist for a New Academic Program

Parameters	
1. Department Mission and Introduction	☐
2. Program Introduction	☐
3. Program Alignment with University Mission	☐
4. Program Objectives	☐
5. Market Need/ Rationale	☐
6. Admission Eligibility Criteria	☐
7. Duration of the Program	☐
8. Assessment Criteria	☐
9. Courses Categorization as per HEC Recommendation	☐
10. Curriculum Difference	☐
11. Study Scheme / Semester-wise Workload	☐
12. Award of Degree	☐
13. Faculty Strength	☐
14. NOC from Professional Councils (if applicable)	☐

Program Coordinator **Chairperson**

COMPARISON SHEET OF M.Phil COURSES
Molecular Biology and Forensic Sciences

OLD COURSES			NEW (REVISED) COURSES		
Course Code	**Course Title**	**Credit Hour**	**Course Code**	**Course Title**	**Credit Hour**
Semester-I & II					
MBFS 501	Advance Molecular Biology & Biotechnology	03	MBFS 501	Advances In DNA Manipulation	03
MBFS 502	Genomics, Biostatistics, and Bioinformatics	03	MBFS 502	Genomics and Bioinformatics	03
MBFS 503	Forensic Process	03	MBFS 503	Frontiers in Forensic Science	03
MBFS 504	Tissue Culture and Techniques	03	MBFS 504	Cell and Tissue Culture Techniques	02
MBFS 505	Crime Scene Management	03	MBFS 505	Crime Scene Management	03
MBFS 506	Bioethics & Dual Use of Education	03	MBFS 506	Bioethics & Dual Use of Education	02
MBFS 507	Biotechnology Law and Regulation	03	MBFS 507	Forensic and Biotechnology Laws and Regulations	02
MBFS 508	Biological Safety and Risk Management	03	MBFS 508	Biological Safety and Risk Management	02
MBFS 509	Quality Control and Quality Assurance	03	MBFS 509	Quality Control and Quality Assurance	02
MBFS 510	Molecular Virology and Bacteriology	03	MBFS 510	Molecular Virology	03
MBFS 511	Forensic Chemistry and Toxicology	03	MBFS 511	Forensic Chemistry and Toxicology	03
MBFS 512	Plant Molecular Biology	03	MBFS 512	Advances in Plant and Agriculture Molecular Biology	03
MBFS 513	Forensic DNA Typing	03	MBFS 513	Forensic Serology & DNA	03
MBFS 514	Molecular Biology Techniques	03	MBFS 514	Recent Trends in Molecular Biology Techniques	03
MBFS 515	Cyber Crimes and Questioned Document Examination	03	MBFS 515	Cybertechnology and Forensic Science	03
MBFS 516	Immunology	03	MBFS 516	Molecular Immunology	03
MBFS 517	Law and Forensic Science	03	MBFS 517	Paper, Grant, Proposal Writing Skills	02
MBFS 518	Paper Writing Skill	01	MBFS 518	Trends in Nucleic Acid Sequencing Techniques	03
			MBFS 519	Molecular Bacteriology	03

COMPARISON SHEET OF M.PHIL COURSES BEFORE & AFTER THE ACADEMIC COUNCIL MEETING, DATED: 11.03.2022 & 21.03.2022

MOLECULAR BIOLOGY AND FORENSIC SCIENCES

OLD TITLES			REVISED TITLES		
Course Code	**Course Title**	**Credit Hour**	**Course Code**	**Course Title**	**Credit Hour**
MBFS 501	Fundamentals of Molecular Biology	2+0	MBFS 501	Advances In DNA Manipulation	03
MBFS 502	Genomics and Bioinformatics	1+2	MBFS 502	Genomics and Bioinformatics	03
MBFS 503	Fundamentals of Forensic Science	2+0	MBFS 503	Frontiers in Forensic Science	03
MBFS 504	Tissue Culture and Techniques	2+0	MBFS 504	Cell and Tissue Culture Techniques	02
MBFS 505	Crime Scene Management	2+0	MBFS 505	Crime Scene Management	03
MBFS 506	Bioethics & Dual Use of Education	2+0	MBFS 506	Bioethics & Dual Use of Education	02
MBFS 507	Biotechnology Law and Regulation	2+0	MBFS 507	Forensic and Biotechnology Laws and Regulations	02
MBFS 508	Biological Safety and Risk Management	2+0	MBFS 508	Biological Safety and Risk Management	02
MBFS 509	Quality Control and Quality Assurance	2+0	MBFS 509	Quality Control and Quality Assurance	02
MBFS 510	Molecular Virology	2+1	MBFS 510	Molecular Virology	03
MBFS 511	Forensic Chemistry and Toxicology	3+0	MBFS 511	Forensic Chemistry and Toxicology	03
MBFS 512	Fingerprints and foot wear evidence	3+0	MBFS 512	Advances in Plant and Agriculture Molecular Biology	03
MBFS 513	Forensic Serology & DNA	3+1	MBFS 513	Forensic Serology & DNA	03
MBFS 514	Molecular Biology Instrumentation	2+1	MBFS 514	Recent Trends in Molecular Biology Techniques	03
MBFS 515	Cybertechnology and Forensic Science	3+0	MBFS 515	Cybertechnology and Forensic Science	03
MBFS 516	Immunology	2+0	MBFS 516	Molecular Immunology	03
MBFS 517	Paper writing skills	1+0	MBFS 517	Paper, Grant, Proposal Writing Skills	02
MBFS 518	DNA and RNA Sequencing Techniques	2+1	MBFS 518	Trends in Nucleic Acid Sequencing Techniques	03
MBFS 519	Molecular Bacteriology	2+1	MBFS 519	Molecular Bacteriology	03

CENTRE FOR APPLIED MOLECULAR BIOLOGY
University of the Punjab, Lahore

REVISED COURSES OF M.PHIL IN MOLECULAR BIOLOGY & FORENSIC SCIENCES

Course No.: **MBFS 501**
Course Title: **ADVANCES IN DNA MANIPULATION**
Credit Hours: **03**

Course Objectives:

This course will enable the students to know and understand

1. Basic Genetic Engineering.
2. Advances in Recombinant DNA Technology
3. Applications of DNA Manipulations in Biotechnology.

Course Contents:

1. Extraction and Purification:

   Modern methods for extraction and purification of animal, plant, and microbial genomic materials.
2. Digestions, Ligations, and Cloning:

   Restriction endonucleases digestion of genomic and vector DNA; strategies for ligation, genomic DNA library preparations, hosts selection for cloning, preparation, and transformation of competent cells, identification of transformed bacterial colonies, analysis and cloning of eukaryotic genomic DNA, synthesis of oligonucleotide probes.
3. Expression of Cells:

   Expression vectors for mammalian cells, yeast cells, plant cells, and bacterial cells, the introduction of recombinant vectors into the expression hosts, regulation of gene expression in prokaryotes and eukaryotes, cloned gene product expressed as fusion proteins expressed from cloned genes - production of antibodies, purification of antibodies, purification, and methodology.
4. Mutagenesis:

   Generation of deletion and insertion, linker insertion mutagenesis, linker scanning mutagenesis, nested sets of deletion mutants, oligonucleotide mediated mutagenesis, use of site-directed mutagenesis to study proteins, insertion of hexameric linkers into protein-coding sequences, creation of mutations in a defined fragment of DNA, modification, and improvement of proteins using site-directed mutagenesis.

Learning Outcomes:

After the completion of the course, students will be able to understand

1. The basic concept of cloning & Methods used in cloning,
2. Selection of suitable host cells & Suitable expression vectors used for cloning,
3. Methods of mutagenesis and Creation of mutant cells.

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Brown, T. A. (2020). *Gene cloning and DNA analysis: an introduction.* John Wiley & Sons.

2. Chaudhuri, K. (2013). *Recombinant DNA technology.* The Energy and Resources Institute (TERI).

3. Sandhu, S. S. (2010). *Recombinant DNA technology.* IK International.

4. Griffiths, A. J., Miller, J. H., Suzuki, D. T., Lewontin, R. C., & Gelbart, W. M. (2000). *Structure of DNA. In An Introduction to Genetic Analysis.* WH Freeman.

5. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). *Molecularcloning: a laboratory manual.* Cold Spring Harbor Laboratory Press.

6. Desmond S. T. Nicholl. (2008). *An Introduction to Genetic Engineering.* 3rd Edition.

7. Julia Lodge, Pete Lund & Steve Minchin. (2006). *Gene Cloning: principles and applications.* Taylor & Francis.

Course No.: **MBFS 502**
Course Title: **GENOMICS AND BIOINFORMATICS**
Credit Hours: **03**

Course Objectives:

This course will provide an opportunity to know and practice

1. Principles of genomics
2. Genomic data retrieval and analysis
3. Understanding of different computational biological algorithms
4. Use of biological databases & biological data analysis-based software
5. Use of DNA/RNA/protein sequences
6. Latest technological developments in the field of genomics.

Course Contents:

1. Genome Informatics/Computational Genomics
2. Advanced Bioinformatics/Computational Biology
3. Systems Biology
4. Protein Informatics/Computational Proteomics
5. Computational Drug Design
6. Computational Molecular Evolution
7. Biophysics
8. Molecular Modelling and Simulation
9. Mathematical Models in Biology
10. Machine Learning
11. Metagenomics
12. Data Mining
13. Stochastic Processes
14. Computational Neuroscience
15. Synthetic Biology
16. Functional genomics
17. Cheminformatics
18. Health informatics
19. Big data analysis and management

Learning Outcomes:

Upon completion of this course, the students will be able to analyze

1. What type of statistical and bioinformatics tools can be applied to analyze their genomics data.
2. A better understanding of genomics databases and their utilization
3. Understanding of machine learning and data mining.

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%

2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Lesk, A. (2019). *Introduction to bioinformatics.* OUP.

2. Mohammad Yaseen Sofi, Afshana Shafi, Khalid Z. Masoodi (2021). *Bioinformatics for Everyone.* Academic Press.

3. Andreas D. Baxevanis, Gary D. Bader, David S. Wishart. (2020). *Bioinformatics 4thed.* John Wiley & Sons.

4. Basant K. Tiwary (2022). *Bioinformatics and Computational Biology-A Primer for Biologists.* Springer.

5. Larson, R. S., & Oprea, T. I. (Eds.). (2006). *Bioinformatics and drug discovery.* Humana Press.

6. David, W. (2003). *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor Laboratory

7. Andreas D. Baxevanis & B. F. Francis Ouellette. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. John Wiley & Sons.

8. Choudhuri, S. (2014). *Bioinformatics for Beginners: Genes, genomes, molecular evolution, databases and analytical tools.* Academic Press

Course No: **MBFS-503**
Course Title: **FRONTIERS IN FORENSIC SCIENCE**
Credit Hours: **03**

Course Objectives:

Forensic science is an application of science to the law and encompasses various scientific disciplines. This course will introduce scholars to different aspects of forensic science such as acquiring knowledge on the different evidence such as bone, hairs, fibers, chemicals, drugs of abuse, blood, semen, glass fractures, paints, soil, fingerprints, documents, firearms, bullet trajectory, tool marks, casting, and molding.

Course Contents:

1. Introduction to Forensic Science,
2. History of forensic Sciences
3. Different fields of Forensic Science
   - 3.1 Forensic Toxicology-
   - 3.2 Forensic Pathology
   - 3.3 Forensic Odontology
   - 3.4 Forensic Entomology
   - 3.5 Forensic Anthropology
   - 3.6 Forensic Psychology
   - 3.7 Trace Evidence Analysis
   - 3.8 Question Documents
   - 3.9 Digital Forensics
   - 3.10 Forensic Proteomics
   - 3.11 Android Forensics
   - 3.12 Latent Prints
   - 3.13 Firearms and ballistic
   - 3.14 Digital Forensics
   - 3.15 Artificial intelligence in Forensic
   - 3.16 Forensic Accounting
   - 3.17 Forensic Optometry
4. Legal and ethical issues in forensic science
5. Law and forensic science.

Learning Outcomes:

On successful completion of this course, students will be able to gain knowledge and understanding of the relationship between the forensic sciences and the law. Methods and principles of forensic investigations and how forensic science can be applied in criminal investigations.

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%

2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Nigrini, M. J. (2020). *Forensic analytics: methods and techniques for forensic accounting investigations.* John Wiley & Sons.

2. Taupin, J. M., & Cwiklik, C. (2019). *Scientific protocols for forensic examination of clothing.* CRC Press.

3. Kranacher, M. J., & Riley, R. (2019). *Forensic accounting and fraud examination.* John Wiley & Sons.

4. Carvey, H. (2018). *Windows forensic analysis DVD toolkit.* Syngress.

5. Dettmeyer, R. B. (2018). *Forensic histopathology: fundamentals and perspectives.* Springer.

6. Skulkin, O., Tindall, D., & Tamma, R. (2018). *Learning Android Forensics: Analyze Android devices with the latest forensic tools and techniques.* Packt Publishing Ltd.

7. Byers, S. N. (2016). *Introduction to forensic anthropology.* Taylor & Francis.

8. Gudjonsson, G. H., & Haward, L. R. (2016). *Forensic psychology: A guide to practice.* Routledge.

9. Allen, M. J. (2015). *Foundations of forensic document analysis: theory and practice.* John Wiley & Sons.

10. Houck, M. M. (Ed.). (2015). *Professional issues in forensic science.* Academic Press.

11. Bertino, A. (2011). *Forensic Science: Fundamentals and Investigations 2012 Update.* Nelson Education.

12. Sapse, D., & Kobilinsky, L. (Eds.). (2011). *Forensic science advances and their application in the judiciary system.* CRC Press.

13. Brown, R., & Davenport, J. (2011). *Forensic Science: Advanced Investigations.* Nelson Education.

14. Houck, M. M., & Siegel, J. A. (2009). *Fundamentals of forensic science.* Academic Press.

Course No.: **MBFS 504**
Course Title: **CELL AND TISSUE CULTURE TECHNIQUES**
Course Hours: **02**
Course Objectives:
This course is designed to help students understand

1. Workings of the cell structure
2. Function at the cellular and molecular level.
3. Different methods of animal and plant cell cultures

Course Contents:

1. Animal Tissue Culture:
   1.1 Introduction to animal cell and tissue culture.
   1.2 Media requirements and sterilization techniques, primary and established cell lines.
   1.3 Culture methods like hanging drop, monolayer, and cell suspension.
   1.4 Applications of animal cell culture.
2. Plant Tissue Culture:
   2.1 Introduction to plant cell and tissue culture.
   2.2 Cell and callus culture, Anther culture.
   2.3 Micropropagation, somatic cell hybridization, protoplast fusion, cybrids, artificial seeds.
   2.4 Agrobacterium-mediated gene transfer and use of Ti-plasmid.
   2.5 Applications of plant tissue culture engineering.
   2.6 Pathogen resistance (BT gene), herbicide tolerance, salt tolerance.
   2.7 Production of secondary metabolites and transgenic plants.

Learning Outcomes:
On successful completion of this course, the students will be aware of different plant and animal cell culturing and applications in molecular biology.
Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Paul Jr, F. (Ed.). (2012). *Tissue culture: methods and applications. Elsevier.*
2. Saurabh, B., Kiran, S., Randhir, D., & Tanmoy, B. (2015). *Modern Applications of Plant Biotechnology in Pharmaceutical Sciences.* Academic Press.
3. Lanza, R., Langer, R., & Vacanti, J. (2007). *Principles of Tissue Engineering*. Academic Press.

4. Jenkins, N. (Ed.). (1999). *Animal cell biotechnology: methods and protocols.* Humana Press.
5. Jennie, P. M., & Penelope, E. R. (1998). *Introduction To Cell And Tissue Culture: Theory and Technique.* Penum Press, New York.
6. Alan, D., & J. Bryan, G. (1998). *Cell and tissue culture: laboratory procedures in biotechnology.* John Wiley & Sons.
7. Freshney, R. I. (2010). *Culture of animal cells: A manual of basic technique and specialized applications*. Wiley-Blackwell.
8. Smith, R. H. (2013). *Plant tissue culture: Techniques and experiments*. Academic Press.

Course No: **MBFS-505**
Course Title: **CRIME SCENE MANAGEMENT**
Credit Hours: **03**

Course Objectives:

The objective of the course is to educate the students about the techniques and procedures used for approaching and protecting the crime scene.

Course Contents:

1. Introduction: Crime scene, types of crime scene, crime scene investigation
2. Crime Scene Management: Role of the first responding officer, the scope of the crime scene (boundaries, multiple scenes, safety & security), the CSI team and its role, Crime scene management, crime scene equipment
3. Processing the Scene: Preliminary documentation and evaluation of the scene, processing the scene, crime scene documentation (notes and logs, sketches, photography, videography), crime scene search methods, completing and recording the crime scene investigation, explosive scene investigation, Specialized crime scene circumstances
4. Collection and Preservation of Evidence Material: Evidence and its types, collection, and preservation of different types of biological evidence materials, trace evidence collection, question documents, the chain of custody, reconstruction of crime scene

Learning Outcomes:
On successful completion of this course, students will be able to analyze all aspects of a crime scene including properly documenting a crime scene, photography, crime scene search, chain of custody, and reconstruction of the crime scene process.

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books

1. Sutton, R., Trueman, K., & Moran, C. (Eds.). (2016). *Crime scene management: scene specific methods.* John Wiley & Sons.
2. Suboch, G. (2016). *Real-world Crime Scene Investigation: A step-by-step procedure manual.* CRC Press.
3. Fisher, B. A., & Fisher, D. R. (2012). *Techniques of crime scene investigation.* CRC Press.
4. Shaler, R. C. (2011). *Crime scene forensics: A scientific method approach.* Taylor & Francis.
5. Pepper, I. (2010). *Crime Scene Investigation: Methods And Procedures: Methods and Procedures.* Mc Graw-Hill Education.

Course No. **MBFS 506**
Course Title: **BIOETHICS & DUAL USE OF EDUCATION**
Credit Hours: **02**

Course Objectives:

Recent advances in biotechnology have brought benefits in the fields of health and agriculture; however, it has also raised concerns about their potential misuse. The course is targeted to educate students about their ethical responsibilities while interacting with modern techniques.

Course Contents:

1. Introduction to ethics branches.
2. Modern molecular biology/biotechnology and social implications.
3. Biological research and bioethics.
4. Religion and ethics. Ethical Issues in Medical Diagnosis. Ethical Review Board (ERB).
5. National and International Bioethics Committees.
6. Experimentation on human embryos.
7. Ethical issues related to Stem cell research. Ethical aspects of organ transplantation &harvesting the dead: organ transplantation.
8. Informed Consent.
9. Indigenous Knowledge and Patenting. Commercialization and Benefit-sharing.
10. Regulation of Molecular biology/biotechnology for benefit sharing. GMOs, Genetically Modified Food, and Biosafety.
11. ISO International Organization of Standardization.
12. Biological samples handling and transportation.
13. Dual use dilemma in modern science.
14. Bio-weapons.
15. Human genome project.
16. Genetic testing: an ethical approach
17. Ethics in synthetic biology.
18. Euthanasia- A Boon or A Bane?

Learning Outcomes:

After the completion of this course, the students will be able to

1. Understand genetically modified crops and their impact on the environment
2. Know about ethical issues and objections to organ donation,
3. Understand ethical concerns in stem cell technology and genetic testing.
4. Get knowledge about Islamic, social and legal perspectives of modern technologies
5. Understand ethical issues in eugenics and genetic pool.

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Carl, S. E. (2015). *The Censor's Hand: The Misregulation of Human-Subject Research.* MIT Press.
2. Helga KUdoSPeterS (2015). *Bioethics: An Anthology, 3rd Edition.* ISBN: 978-1-118-94152-2 Wiley-Blackwell.
3. Lydia D (2015). *Dyingin the Twenty-First Century: Toward a New Ethical Framework for the Artof Dying* Well. MIT Press.
4. Ashwani Kumar Singh (2012). *Intellectual Property Rights and Bio-technology: Biosafety and Bioethics.* Narendra Publishing House.

Course No.: **MBFS 507**
Course Title: **FORENSIC AND BIOTECHNOLOGY LAW**
Credit Hours: **02**

Course Objectives:

The present course will help the students to understand the responsibilities of an individual and organization in the R&D and commercial aspects of biotechnology.

Course Contents:

1. Responsibilities In Research and Development
   1.1. Individual responsibility
   1.2. Organizational responsibility
2. Commercial aspects of biotechnology
   2.1 Intellectual property,
   2.2 Key issues in intellectual property and patent law and how they influence the development and commercialization of advances in the field of biotechnology privacy
   2.3 Government and industrial regulation
   2.4 Liability
   2.5 Ethics
   2.6 Policy responses to societal concerns
3. Case Studies
   3.1 Gene therapy
   3.2 Cloning
   3.3 Biomaterials in the medical and health sector
   3.4 Farming and crop modification in the agricultural sector

Learning Outcomes:

After the completion of this course, the students are expected to know about the bioethical issues and regulations while working in the research labs as well as regulations regarding the submission of applications for patents and copyrights, etc.

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Sheridan, B. (2001). *EU biotechnology law & practice: Regulating genetically modified & novel food products.* Palladian Law Publishing, Bembridge, UK.
2. Matthias, H. (2018). *The International Law of Biotechnology-Human Rights, Trade, Patents, Health and the EnvironmentPrinciples of International Law series.* Elgar Online.
3. Maria, L. (2008). *EU Regulation Of GMOs: Law and Decision Making for New Technology*. Biotechnology Regulation Series.

4. Farah, H., Peter, T. R., Peter, T. R., & Farah, H. (2012). *Exploring Central and Eastern Europe's Biotechnology Landscape*. Springer Netherlands.
5. Hugh, B. W., Eileen, S. E. (2007). *Biotechnology and the law*. American Bar Association
6. Naidu, B. David (2009). *Biotechnology and Nanotechnology - Regulation under Environmental, Health, and Safety Laws.* Matthew Bender & Company, Inc.
7. Avery N. Goldstein (2005). *Patent Laws for Scientists and Engineers.* CRC Press

Course No.: **MBFS 508**
Course Title: **BIOLOGICAL SAFETY AND RISK MANAGEMENT**
Credit Hours: **02**

Course Objectives:

The present course will enable students in assessing and managing the risks from exposure to biological agents at work in either a laboratory or a healthcare setting.

Course Contents:

1. Hazard Identification:
   Microbial Flora of Humans, Indigenous and Pathogenic Agents, Epidemiology of Laboratory Associated Infections.
2. Hazard Assessment: Risk Assessment of Biological Hazards, Pathogens (Bacteria, Fungi & Viruses), and Biological Toxins.
3. Biosafety: Biosafety in Teaching/Research Laboratories & Industry.
4. Biosecurity: Regulatory Impact.
5. Hazard Control: Design of Lab Facilities, Primary Barriers, Personal Respiratory Protection, Decontamination and Disinfection, Packing, and Shipping Biological Materials.
6. Biological Safety Program Management: Biosafety Compliance, Program Effectiveness Measurement

Learning Outcomes:
Upon the completion of this course, the students will be able to know about possible hazards while working in micro and molecular research labs and what biosafety measures should be taken to avoid those hazards.

Teaching-Learning Strategies:
1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:
1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:
1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Diane O. Fleming and Debra L. Hunt. *Biological Safety: Principles and Practices.* Latest Ed. ASM Press.
2. Michael S.Bronze and Ronald A. Green field (2005). *Biodefence.* Horizon Biosciences.
3. Lindler L. E., F. J. Lebeda and G. W. Korch. (2004). *Biological Weapon Defence: Infectious Diseases and Counter Bioterrorism.* Humana Press
4. Wald P. H. and G. M. stave. (2002). *Physical and Biological Hazards of the Work Place. 2nd Ed.* Willey-Inter-sciences.
5. Charles N. Haas, Joan B. Rose, Charles P. Gerba (1999). *Quantitative Microbial Risk Assessment.* John Willey & Sons.

Course No.: **MBFS 509**
Course Title: **QUALITY CONTROL AND QUALITY ASSURANCE**
Credit Hours: **02**

Course Objectives:

This course will enable the students to understand the comprehensive coverage of modern quality control and quality assurance measures required to be observed while working in modern molecular biology and biotechnology labs

Course Contents:

1. Introduction Quality Control And Quality Assurance
2. Nine Elements of QC/QA system
   - 2.1 Quality Objectives.
   - 2.2 Quality Manual
   - 2.3 Organizational Structure and Responsibilities.
   - 2.4 Data Management.
   - 2.5 Processes.
   - 2.6 Customer Satisfaction with Product Quality.
   - 2.7 Continuous Improvement
   - 2.8 Quality Instrumentation
   - 2.9 Quality Documentation
3. Practical Applications of Molecular Biology
   - 3.1 Practical consideration in developing QC/QA system
   - 3.2 Detection, quantitation, and genotyping of infectious agents
   - 3.3 Clinical validity and utility of molecular biology and DNA typing tests
   - 3.4 Inventory agency
   - 3.5 QC/QA plan
   - 3.6 General QC Procedures

Learning Outcomes:

The expected learning outcome of this course is to get the knowledge of QC/QA and efficient use of equipment in the labs

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. World Health Organization (2011). *Laboratory quality management system: a hand book.* World Health Organization.
2. Lynne Shore Garcia, (2004). *Clinical Laboratory Management.* ASM Press.
3. Charles N. Haas, Joan B. Rose, Charles P. Gerba (1999). *Quantitative Microbial Risk Assessment.* John Willey & Sons.
4. Samuel Baron M. D. (1996). *Medical Microbiology.* Fourth Edition. The University of Texas Medical Branch at Galveston

Course No.: **MBFS-510**
Course Title: **MOLECULAR VIROLOGY**
Credit Hours: **03**

Course Objective:
This course will develop an understanding of viral diseases and their threat to human health. Learning the concepts of viruses, their structure, and the molecular mechanism by which they cause diseases.

Course Contents

1. Introduction to virology:
   - 1.1. What Are Viruses
   - 1.2. The History of Virology
   - 1.3. Viral classification
   - 1.4. Living Host Systems
   - 1.5. Cell Culture Methods
   - 1.6. Serological/ Immunological Methods
   - 1.7. Ultra-structural Studies
2. Virus structure and Genome:
   - 2.1 Function and Formation of Virus Particles
   - 2.2 Capsid Symmetry and Virus Architecture
   - 2.3 Helical Capsids
   - 2.4 Icosahedral
   - 2.5 (Isometric)
   - 2.6 Capsids
   - 2.7 Enveloped Viruses
   - 2.8 Virus Receptors
   - 2.9 Recognition and Binding
   - 2.10 Structure and Complexity of Virus Genomes
   - 2.11 Molecular Genetics
   - 2.12 Virus Genetics Virus Mutants
   - 2.13 Genetic Interactions between Viruses
   - 2.14 Nongenetic Interactions between Viruses
   - 2.15 Small DNA Genomes
   - 2.16 Large DNA Genomes
   - 2.17 Positive-Strand RNA Viruses
   - 2.18 Negative-Strand RNA Viruses
3. Viral replication, expression, and infection
   - 3.1 Virus attachment, penetration, Uncoating
   - 3.2 Genome Replication
   - 3.3 Investigation of Virus Replication
   - 3.4 The Replication Cycle
   - 3.5 Gene Expression
   - 3.6 Assembly, Maturation & Release
   - 3.7 Immune Responses to Virus Infections in animals
   - 3.8 Viruses and Apoptosis Interferons
   - 3.8.1 Evasion of Immune responses by Viruses
   - 3.8.2 Virus host interactions
   - 3.8.3 Course of viral infections
   - 3.8.4 Prevention and therapy of virus infection.
4. Viral pathogenesis, diagnosis, and viral pharmacology:
   - 4.1 Mechanisms of Cellular Injury
   - 4.2 Viruses and Immuno-deficiency

4.3 Virus-Related Diseases
4.4 Bacteriophages and Human Disease
4.5 Cell Transformation by Viruses
4.6 Viruses s and Cancer, Zoonoses
4.7 Bioterrorism
4.8 Subviral agents/particles; viroids, virosoids, prions
4.9 Viral diseases and Molecular diagnosis of viral diseases
4.10 Viral pharmacology; vaccines, antiviral drugs.

Learning Outcomes:

After the completion of this course, the students will be able to know about

1. What virus is and how viruses differ from all other organisms
2. Identify significant and original problems of viruses that affect human health
3. Main structural types of virus particles and subviral agents
4. What are the replication cycles?
5. Clinical implications of viruses in terms of vaccines, antiviral drugs, and viral pathogenesis
6. Viral diseases and their molecular diagnosis.

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Ryu, W. S. (2016). *Molecular virology of human pathogenic viruses.* Academic Press.
2. Oxford, J. S., Collier, L. H., & Kellam, P. (2016). *Human Virology*. Oxford University Press.
3. Dimmock, N. J., Easton, A. J., & Leppard, K. N. (2016). *Introduction to modern virology.* John Wiley & Sons.
4. Flint, J., Racaniello, V. R., Rall, G. F., & Skalka, A. M. (2015). *Principles of virology-Volume I & II* (5^{th} ed). John Wiley & Sons.

Course No.: **MBFS 511**
Course Title: **FORENSIC CHEMISTRY AND TOXICOLOGY**
Credit Hour(s): **03**

Course Objectives:

The students will learn and evaluate the importance of forensic chemistry and toxicology in criminal investigations. Various standard procedures were followed in the examination of different evidence materials.

Course Contents:

1. Introduction to Forensic Chemistry and Toxicology
2. Examination of hair and fibers
3. Casting and Examination of three-dimensional impressions
4. Soil analysis
5. Explosives and Gunpowder residues
6. Examination of glass fragments/fractures etc.
7. Classification of Poisons
   7.1 Drugs of Abuse.
   7.2 Alcohol.
8. Toxicological Investigation of Drug-Facilitated Sexual Assaults,
   8.1 Standard operating procedures in the collection
   8.2 Handling and Preservation
   8.3 Documentation of Toxicological Evidence.

Learning Outcomes:

This course will enable the students to learn

1. An overview of the analytical tools used in a forensic chemistry laboratory
2. Evaluate the quality and reliability of various available analytical techniques
3. Define the most common illicit drugs, doping agents, and injurious substances used for forensic applications and how different analytical techniques and assays can be used in investigations of narcotics in a variety of materials, formulations, and matrices
4. Chemical analysis is used for investigations of physical evidence from a crime scene.

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Karpas, Z. (2019). *Analytical chemistry of uranium: environmental, forensic, nuclear and toxicological applications.* CRC press.

2. Sojic, N. (Ed.). (2019). *Analytical electrogenerated chemiluminescence: from fundamentals to bioassays.* (Vol.15). Royal Society of Chemistry.

3. Evans-Nguyen, K., & Hutches, K. (Eds.). (2019). *Forensic Analysis of Fire Debris and Explosives.* Springer Nature.

4. Khan, J. V. I., Christian, D. R., & Kennedy, T. J. (2012). *Basic principles of forensic chemistry.* New York: Humana Press.
5. Levine, L. (2012). *Forensic chemistry hand book* (pp.269-282). L. F. Kobilinsky (Ed.). Hoboken, NJ: John Wiley & Sons.
6. Vij, K. (2011). *Text book of forensic medicine and toxicology: Principles and practice.*
7. Levine, B. (Ed.). (2003). *Principles of forensic toxicology.* Amer. Assoc. for Clinical Chemistry.

Course No.: **MBFS 512**
Course Title: **ADVANCES IN PLANTS AND AGRICULTURE MOLECULAR BIOLOGY**
Credit Hour(s): **03**

Course Objectives:
To impart fundamental concepts of structural, functional, and comparative genomics of plants. To develop an understanding of the latest *in-silico* tools and their applications in plant sciences

Course Contents:

1. Introduction: Basic concepts about plants and plant genomes (nuclear and organelle)
2. Structural Genomics of Plants
3. Structure of the Plant Nuclear and Organelle Genomes
4. Sequencing of Plant Genomes
5. Exploration of Plants genomes databases and sequence comparisons
6. Functional Genomic Studies in Plants
7. Prediction of genes and detection of protein function using bioinformatics tools
8. Genetic transformation in plants
9. Construction of mutant libraries
10. The DNA Microarrays in Plants
11. Gene Expression studies and analysis strategies in plants
12. Proteomic and metabolomic profiling
13. Plant Models and role in understanding plants genomics
14. *Arabidopsis thaliana*, Oryza sativa, *Medicago truncatula*, Tomato, Sugarcane, *Physcomitrella patens*
15. Genomics and Genetic Variability in Plants
16. Molecular Markers assisted in High-throughput genotyping Analysis of Plant Biodiversity and Molecular Evolution
17. Candidate Gene analysis

Learning Outcomes:
At the end of the course, students will be able to;

1. Understand in-depth knowledge of plant genomics
2. Learn genomics-assisted advanced technologies and their applications in plant sciences
3. Gain a deeper insight into the execution and analysis of plant genomics data and related research work

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Palmiro, P. (2017) *From Plant Genomics to Plant Biotechnology.* Woodhead Publishing
2. Caetano-Anolles, G. (2010). *Evolutionary Genomics and Systems Biology*. Wiley-Blackwell.
3. Somers, D. J., Langridge, P., & Gustafson, J. P. (2011). *Plant Genomics: Methods and Protocols, Methods in Molecular Biology.* Humana Press.
4. Pevsner, J. (2009). *Bioinformatics and Functional Genomics.* Wiley- Blackwell.
5. Galperin, M. Y. & Koonin, E. V. (2003). *Frontiers in Computational Genomics.* Academic Press

Course No: **MBFS-513**
Course Title: **FORENSIC SEROLOGY & DNA**
Credit Hours: **03**

Course Objectives:

This course has been designed to provide advances in knowledge about

1. Forensic biology with a focus on current short tandem repeat (STR) technologies
2. The logical progression of a forensic DNA case analysis
3. Different DNA markers are used in forensics.

Course Content:

1. Forensic Serology:
   Overview of Forensic serology, screening of evidence for the presence of biological stains, presumptive and confirmatory tests for different body fluids i.e. blood, semen, saliva, etc.
2. Forensic DNA Typing:
   Overview and history of DNA typing, DNA extraction techniques, DNA quantification, and amplification methods, Capillary electrophoresis, Data analysis, interpretation methods utilized for single-source profiles, mixed profiles, parentage, and kinship scenarios, report writing, case studies, DNA database, quality assurance standards, courtroom testimony, different DNA markers used in forensic science including Y-STRs, SNPs, Forensic DNA phenotyping

Learning Outcomes:

On successful completion of this course, students will be able to understand the general concepts of forensic serology and DNA. Learn different methodologies involved in DNA profiling. Learn how DNA profiling in criminal investigations is helpful to associate a person, place, or item with a crime, and in civil applications, such as paternity testing, and baby mix-ups, and as an aid in identifying an individual from the group of suspects

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Pilli, E., & Berti, A. (Eds.). (2021). *Forensic DNA Analysis: Technological Development and Innovative Applications.* CRC Press.

2. Shrivastava, P., Dash, H. R., Lorente, J. A., & Imam, J. (2020). *Forensic DNA Typing: Principles, Applications and Advancements.* Springer Nature.

3. Buckleton, J. S., Bright, J. A., & Taylor, D. (Eds.). (2016). *Forensic DNA evidence interpretation.* CRC press.

4. McClintock, J. T. (2014). *Forensic analysis of biological evidence: A laboratory guide for serological and DNA typing*. CRC Press. 14,571-85.

5. Elkins, K. M. (2012). *Forensic DNA biology: a laboratory manual.* Academic Press.

6. Butler, J. M. (2011). *Advanced topics in forensic DNA typing: methodology*. Academic Press.
7. Butler, J. M. (2009). *Fundamentals of forensic DNA typing.* Academic Press.

Course No.: **MBFS 514**
Course Title: **RECENT TRENDS IN MOLECULAR BIOLOGY TECHNIQUES**
Credit Hours: **03**

Course Objectives:

Students will be enabled to

1. Use and apply basic and advanced molecular biology techniques in biotechnology research
2. Learn the principles of DNA/RNA and protein/peptide isolation and purification techniques and instrumentation involved in it

Course Contents:

1. Principal and Applications:

   General procedures and instrumentation in centrifugation, electrophoresis, chromatography, Ion exchange chromatography, molecular sieve chromatography, affinity chromatography, paper chromatography, thin layer chromatography, ultrafiltration, Ultracentrifugation, spectrophotometry, spectroscopy, microscopy, general techniques in microbiology, PCR, Real-Time PCR.
2. Isolations:

   Protein/peptide separation techniques, Cell disintegration, and extraction techniques, and separation of proteins by fractionation (ammonium sulfate, organic solvents).
3. Analysis:

   MALDI-TOF, HPLC, FPLC, FT-IR spectroscopy for the identification of biological stains for forensic purposes, applications of quantitative enzyme assay, enzyme activity, and specific activity determination Nucleic acid & protein blotting techniques. DNA Sequencing

Learning outcomes:

After the completion of this course the student will be able to

1. Learn and perform different techniques used in the field of molecular biology
2. Use different instruments involved in molecular biology and biotechnology

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Biassoni, R.& Raso, A., 2016. *Quantitative Real-Time PCR.* Humana Press.

2. Birnie, G. D. & Rickwood, D. eds., 2014. *Centrifugal separations in molecular and cell biology.* Butterworth-Heinemann.

3. Snyder, L. R., Kirkland, J. J. and Glajch, J. L., 2012. *Practical HPLC method development.* John Wiley & Sons.

4. Primrose, S. B. and Twyman, R., 2013. *Principles of gene manipulation and genomics.* John Wiley & Sons.

5. Sharma, R. K., 2010. *Basic techniques in bio chemistry and molecular biology.* IK International Pvt Ltd.
6. Wilson, K. & Walker, J. eds., 2000. *Principles and techniques of practical biochemistry.* Cambridge University Press.

Course No.: **MBFS 515**
Course Title: **CYBERTECHNOLOGY AND FORENSIC SCIENCE**
Credit Hours: **03**

Course Objectives:

Digital Forensics is concerned with identifying, reporting, and responding to security breaches. In this course, students will be enabled to learn

1. How to acquire, analyze and report digital evidence
2. To gain the technical skills to discover electronic traces of cybercrime

Course Contents:

1. Cyber security and Network Forensics
   Use of computers in forensic science, Cyber security principles, practice, tools and techniques, a framework for investigating computer-related crime, Hacking, Software Piracy, On-line Gambling, Pornography by Internet Relay Chat (IRC), Credit Card Fraud E-mail Threat/extortion, Phising, On-line Scam, Illegal recruitment/human trafficking, video image processing and animation software., Monitoring and analysis of computer network traffic for information gathering, legal evidence, or intrusion detection.
2. Mobile Forensics
   Digital forensics relates to the recovery of digital evidence or data from a mobile device and any other digital device that has both internal memory and communication ability including PDA devices, GPS devices, and tablet computers.
3. Database forensics
   Forensic study of databases and their related metadata. Database security with several different techniques and approaches to assure data confidentiality, integrity, and availability.

Learning Outcomes:

After the completion of this course, students will be confident in

1. Analyzing the digital evidence materials in forensic issues
2. Solving the technical issues involved in cybercrime investigations
3. Helping law enforcement agencies with cybercrime investigation on the bases of digital evidence data

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Suresh S. (2020). *Digital Forensic Science.* DOI: 10.5772/ intechopen. 78450. eBook (PDF) ISBN: 978-1-83968-742-6.

2. Casey, E. (2011). *Digital evidence and computer crime: Forensic science, computers and the internet.* Academic Press.

3. Taylor, R. W., Fritsch, E. J., & Liederbach, J. (2014). *Digital crime and digital terrorism.* Prentice Hall Press.
4. Wiles, J., & Reyes, A. (2011). *The best damn cybercrime and digital forensics book period.* Syngress.
5. Lewis, J., & Baker, S. (2013). *The economic impact of cybercrime and cyber espionage*. McAfee.

Course No.: **MBFS 516**
Course Title: **MOLECULAR IMMUNOLOGY**
Credit Hours: **03**

Course Objectives:

Through this course, the students will learn about basic and advanced concepts of immunology. Working on vaccines, Mechanisms of B and T cells in lymphocyte activation, and autoimmunity and tolerance.

Course Content:

1. Introduction.
   Innate Immunity and Adaptive Immunity, antibodies antigens,
2. Structure and Classes.
   Structure and classes of Antibodies. Complement fixation. Genetic basis of antibody diversity. MHC I and II: Structure and antigen presentation. Introduction of B and T lymphocytes, B and T lymphocytes activation and role in humoral and cell-mediated immunity.
3. Vaccines.
   Vaccines and types of Vaccines, Vaccines live and attenuated, killed, multi-subunit and DNA vaccines. Hypersensitivity, ELISA, and Hybridoma Technology.

Learning Outcomes:

On successful completion of this course, students will be able to

1. Describe the basic mechanisms, distinctions and functional relationship of innate and adoptive immunity
2. Understand the molecular basis of complex, cellular processes involved in inflammation and immunity

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Murphy, K., & Weaver, C. (2017). *Janeway's immunobiology*. Garland Science.
2. Levinson, W. (2016). *Review of Medical microbiology and immunology:* Appleton & Lange.
3. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). *Cellular and molecular immunology.* Elsevier Health Sciences.
4. Owen, J. A., Punt, J., & Stranford, S. A. (2013). *Kuby immunology*. New York: WH Freeman.
5. Goldsby, R. A., Kindt, T. J., Osborne, B. A., & Kuby, J. (2003). *Immunology*. WH Freeman and Company.

Course No.: **MBFS 517**
Course Title: **PAPER, GRANT, AND PROPOSAL WRITING SKILLS**
Credits Hours: **02**

Course Objectives:

The objective of this course is to

1. Give an insight into research document definitions and basic concepts, objectives, significance, and techniques of research.
2. Enable the students in finding research materials, and literature surveys and compiling the records
3. Enable the students to prepare research articles, theses, and funding proposals and prepare them as a good writer

Course Content:

1. Definitions: Definition and kinds of scientific documents-research papers, review papers, book reviews, theses, conference and project reports (for the scientific community and funding agencies).
2. Components of Articles: Components of a research paper; title, authors and addresses, abstract, acknowledgments, references, tables and illustrations, IMRAD, article conclusion.
3. Dealing with Editors and publishers: Dealing with publishers – submission of the manuscript, ordering reprints, major libraries, and subscribing to journals related to molecular biology, forensic sciences, and biotechnology in the region and country
4. Presentation of Papers: Oral and poster presentation of research papers at conferences/symposia.
5. Proposals Submissions for Funding: Preparation and submission of research project proposals to funding agencies, scientific literature for the proposal,

Learning Outcomes:

This course will enable the students to know and practice the good practical skills to write an impressive scientific manuscript and funding proposals.

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Robert, A. D., & Barbara, G. (2016) *How to write and publish a scientific paper* (8th ed) Greenwood, California.
2. Mack, C. A., (2018). January. *How to write a good scientific paper*. SPIE.
3. Tichy, H. J. and Fourdrinier, S. (1988). *Effective writing for engineers, managers, scientists.* Wiley

Course No.: **MBFS 518**
Course Title: **TRENDS IN NUCLEIC ACID SEQUENCING TECHNIQUES**
Credit Hours: **03**

Course Objectives:

Objective of this course is to

1. Develop an understanding of the structure of nucleic acids and proteins and their analysis
2. Teach the history of the development of first-generation nucleic acid sequencing techniques
3. Teach briefly the chemistries of sequencing techniques
4. Teach the basic principles of instruments used in nucleic acid sequencing

Course Contents:

1. Introduction:

   Introduction and history of DNA sequencing, sequencing gels, and equipment
2. Central Dogma of Molecular Biology and PCR:

   Brief concept of the central dogma, Amplification PCR, Sequencing PCR, Mini sequencing, or single base extension (SBE)
3. DNA Sequencing Methods:
   - 3.1. Maxim and Gilberts method
   - 3.2. Sanger's method
   - 3.3. Autoradiography of sequencing gels
   - 3.4. Random sequencing
   - 3.5. Direct sequencing
   - 3.6. de novo and re-sequencing
   - 3.7. Labeling materials used for primer or nucleotide labeling
   - 3.8. Concept of dye terminators
   - 3.9. Role of PCR in DNA sequencing
   - 3.10. Role of fluorescent materials and capillary electrophoresis in sequencing automation
   - 3.11. Spectral calibration of sequencing machines
   - 3.12. Electropherograms of DNA sequences
   - 3.13. Sequencing of homopolymers
   - 3.14. A brief of next-generation sequencing techniques and whole genome/exome sequencing
   - 3.15. Single-molecule sequencing
4. RNA Sequencing:
   - 4.1. Types of RNA sequencing
   - 4.2. mRNA Sequencing
   - 4.3. Targeted RNA Sequencing
   - 4.4. Ultra-Low-Input and Single-Cell RNA sequencing
   - 4.5. RNA Exome Capture Sequencing
   - 4.6. Total RNA Sequencing
   - 4.7. Small RNA Sequencing
   - 4.8. Ribosome Profiling.

Learning Outcomes:

After the completion of this course, students will have a theoretical as well as practical understanding of

1. Different DNA sequencing techniques and methods
2. Automated DNA sequencing
3. How to solve the problems in the analysis of sequencing data
4. Using the instruments involved in sequencing

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books:

1. Chaitanya, K. V. (2019). *Genome and Genomics.* Springer Singapore.

2. Kevin Davies (2015). *The $ 1,000 Genome: The Revolutionin DNA Sequencing and the New Era of Personalized Medicine.* Free Press

3. Anjana Munshi (2012). *DNA Sequencing-Methods and Applications.* In Techpublisher

4. Terence A. Brown (1994). *DNA Sequencing.* Oxford University Press.

5. Michal Janitz, (2011). *Next-Generation Genome Sequencing: Towards Personalized Medicine.* John Wiley & Sons.

Course No. **MBFS-519**
Course Title: **MOLECULAR BACTERIOLOGY**
Credit Hours: **03**

Course Objectives:

Molecular Bacteriology course will enable the students to

1. Learn and describe various biological and molecular aspects of bacteria
2. Learn the molecular biology of bacteria that infect humans and animals and cause serious bacterial infections/diseases.

Course Contents

1. Introduction of molecular bacteriology, Bacterial Cell. Culture and Identification of Infectious Agents. Nutrition, Growth and Energy Metabolism. Cell Envelope, Spores, and Macromolecular Biosynthesis.
2. Antibiotics – Cell Envelope. Protein Synthesis, Nucleic Acid Synthesis, and Metabolism.
3. Bacteriophages. Exchange of Genetic Information. Genetic Regulatory Mechanisms.
4. General Aspects of Bacterial Pathogenesis. Streptococci. Anaerobes and Pseudomonas-Opportunistic
5. Infections, Zoonoses. Bacterial diseases. Importance of Bacteria in molecular biology.
6. New Molecular Diagnostic Approaches to Bacterial Infections and Antibacterial Resistance.

Learning Outcomes:

After the completion of this course, the students will be able to understand bacterial cell structure, culturing techniques, identification of bacterial infectious agents, antibiotics susceptible and resistant bacteria, protein & nucleic acid syntheses in bacteria, gram-negative and gram-positive bacterial strains, preparation of different types of media, exchange of genetic information and genetic regulatory mechanisms.

Teaching-Learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Distribution of Marks:

1. Mid-term 35%
2. Final-term 40%
3. Continuous Assessment and Assignments 25%

Reference Books

1. Tang, Y. W., 2014. *Molecular medical microbiology.* Academic press.
2. Snyder, L., & Snyder, L. (2013). *Molecular genetics of bacteria.* ASM Press.
3. Warren, L,. & Ernest, J. 2003. *Medical Microbiology & Immunology* Mc Graw-Hill Publications.
4. Joseph Sambrook & David W. Russell. 3rd Ed. 2001. *Molecular Cloning A Laboratory Manual.* Cold Spring Harbor Laboratory Press, New York.

Curricula/ Syllabi of Ph.D. Degree Program

Program Title: Ph.D. in Molecular Biology & Forensic Sciences

Department: Centre for Applied Molecular Biology

Faculty: Life Sciences

1. Department Mission

The CAMB's Quality Assurance Policy is aligned with the University of the Punjab's policy/ goals. CAMB is committed to imparting efficient and cost-effective education/ training to its students in the field of Applied Molecular Biology/ Biotechnology with the production of high-quality scientists/ researchers/ trained professionals, who will be instrumental in executing their technical skills in areas of their specialization. CAMB will achieve its aims and goals by fulfilling quality objectives, training its academicians, regular monitoring, and assuring continual quality improvement in CAMB's working/delivery system. The Institute's mission is therefore as follows i.e.

- Research and Development
- Teaching and Learning
- Outreach and Public Service

2. Introduction

To build a national capability in the newly emerging science, the Federal Ministry of Science & Technology (MoST) approved the establishment of the Centre for Applied Molecular Biology (CAMB) at the University of the Punjab Lahore in 1987 which is located back-to-back with the laboratory block of the Centre of Excellence in Molecular Biology (CEMB). In March 2015, the Prime Minister of Pakistan approved the transfer of CAMB to the University of the Punjab. Accordingly, MoST handed over the administrative control of CAMB to the University of the Punjab, Lahore w.e.f 01.07.2015 along with all assets and liabilities. The CAMB's laboratory block includes Proteomics/Functional Genomics/Biomedicine, Forensics, Molecular Diagnostics of Infectious Diseases like Hepatitis B, C & COVID-19, Virology, Plant Biotechnology, Genetic Diseases, and DNA Core Facility Laboratories. It is surrounded by a vast area of land where crops and other plants are sown for research in different domains of Molecular Biology and Agriculture. CAMB being a renowned scientific research entity encourages the osmosis of research from Lab into different sectors of society. It strives to provide a suitable environment and encourages researchers to work on collaborative research projects to advance knowledge, propose solutions to some of the major issues of today, and develop new technologies for the future. CAMB is providing reliable, accurate, rapid, and more economical diagnostic & forensic services to hospitals, medical practitioners, the general public, law enforcement agencies, and courts, respectively along with DNA Sequencing and Genotyping facilities to the various academic & R&D organizations throughout Pakistan. Centre is also offering M. Phil & Ph.D. degree programs in "Molecular Biology & Forensic Sciences" in academics. Students at various universities also use the CAMB platform for the completion of their degrees. The whole setup of CAMB represents a unique and economical mode to optimally utilize the extremely limited resources of personnel and materials.

3. Program Introduction and Alignment with the University Mission

The Ph.D. program is aimed at students who anticipate a career in which research plays a major role and who want to focus on an independent piece of research. CAMB provides a stimulating environment with state-of-the-art facilities in which to carry out research training in different disciplines of Molecular Biology. This degree involves the presentation of a thesis on a research topic in a field appropriate to the student's or sponsor's needs and the centre's research expertise. All students register for a 04-year program for Ph.D. An option for students without previous academic training in their discipline of interest is to undertake appropriate lab training as a first step before registering for a Ph.D.

Each student is assigned to a supervisor, under whose guidance they develop the intellectual and technical skills required for a research career. Although the earlier stages of the degree may include some coursework or formal training in research methodology. Such work is normally regarded as establishing the necessary ground for a research study, rather than as an integral part of a Ph.D. degree. In this respect, the CAMB system differs from that at most other departments within and other universities, where coursework is regarded as part of the degree and is included in the formal examination process.

4. Program Objectives

Ph.D. program in Molecular Biology and Forensic Sciences, through high-quality academics, also aims to train scholars to conduct independent research in the subject field. A Ph.D. degree holder in Molecular Biology and Forensic Sciences is expected to demonstrate good knowledge in the discipline and to develop and create new knowledge by contributing to the field. Following are some specific objectives of the program.

I. Prepare/Generate the next generation pioneer/cadre of manpower specifically trained in the modern field of Applied Molecular Biology and Forensic Sciences through teaching and training.
II. Extending the limits of what is currently known through innovative and high-quality work.
III. The capacity building for critical analyses, assessments, and syntheses of new ideas.
IV. The capacity to devise, design and conduct research that has real academic weight, is targeted, and shows integrity.
V. Systematic understanding of a subject and mastery of the skills and methods associated with this subject.
VI. The capacity to develop further progress made in technological, social, or cultural terms within an academic and professional context.
VII. To satisfy standards associated with national and international peer-reviewed publications.
VIII. Organize national and international seminars/conferences/workshops on the latest developments in the field with the participation of students.
IX. Goal-oriented molecular biology research on specific problems related to the economic needs of the country for agriculture, Health, Forensics, and industry.
X. Production of critical Laboratory materials used in Molecular Biology research.

5. Market Need/ Rationale of the Program

a) Potential Students for the program

MS/M.Phil Molecular Biology & Allied Sciences* having equivalence in the field of Molecular Biology, Forensic Sciences, Biological Sciences, Biotechnology, Biochemistry,

Agriculture, Bioinformatics, Botany, Zoology, Microbiology, Molecular Genetics, Veterinary Sciences, Medical Sciences, etc. are eligible for the enrollment in the program.

b) Potential Employers

Research Organizations, Medico-Legal practitioners, Agriculture, Animal Husbandry, Environment Conservation, Genetic Engineering, Medicine, Industrial Research & Development, Halal Product Industry, Universities, Forensic Agencies, Diagnostic Labs, Pharmacologists, Academia, Forensic, and Human Identification, in Molecular Biology Research Labs as Biologists., Ecologists., Nature Conservation officers, Biotechnologists., Forensic Scientists., Government Agency roles, Food Industrialists for Research and Academic Projections, Health Care Centres & Trained human resources outsourcing abroad, etc.

c) Academic Projections

The core focus of a doctorate is the acquisition of academic skills by drafting a piece of academic work (dissertation). Depending on the faculty, the dissertation can take the following forms:

- a monograph (an individual, "self-contained" paper) or
- articles published in recognized specialist journals relating to either several or one specific areas of research (cumulative dissertation).

d) Faculty

Life Sciences/Bio-Sciences/ Biological Sciences

e) Physical Facilities

Mammalian Cell Culture Lab, Biomedicine/Proteomics Lab, Plant Tissue Culture Lab, Sequencing, Genotyping, Genetic Diseases Lab, Virology, BSL-2, BSL-3, Diagnostics, Forensics, Digital Library, Main Library at PU.

6. Admission Eligibility Criteria

- **Year of Study Completed**

  16 &18 years of education. as per DPCC/HEC criteria

- **Study Program/ Subject**

  MSc/BS (Hons.)/MPhil (16 & 18 Years Education) in Agriculture, Biochemistry, Biological Sciences, DVM, Pharm-D, Biotechnology, Bioinformatics, Botany, Zoology, Chemistry, Microbiology, MBBS/BDS, MLT, Molecular Genetics, Animal Sciences, or any other relevant degree in Molecular Biology/Forensic Sciences.

- **Percentage/CGPA**

  Equal or greater than 3.0 / OPM 70%, as per HEC PU/DPCC guidelines

- **Entry Test (if applicable) with a minimum requirement**

  70 Marks out of 100, as per PU/DPCC/HEC

- **Any other (if applicable)**

  If, as per HEC PU/DPCC guidelines

7. Duration of Program

8 semesters/ 4 Years/ 18+6=24 Credit Hours, as per HEC PU/DPCC guidelines

8. Assessment Criteria

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	It will take place at the mid-point of the semester.
2.	Formative Assessment	25%	It will be a continuous assessment. It includes classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on activities, short tests, quizzes, etc.
3.	Final Assessment	40%	It will take place 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 a term paper, research proposal development, fieldwork, report writing, etc.
4.	Research and Thesis	100 marks	The student will produce a thesis out of his/her research results and data. The thesis will be evaluated by the board of examiners comprising of the director, supervisor, and external examiners from outside of the department.

9. Categorization of courses as per HEC Recommendation and Difference as follows

Semester	Courses	Category(CreditHours)					
		Core Courses	Basic Courses	MajorElectives	MinorElectives	Any Other	Semester Load
First& Second	Advances in Applied Molecular Biology	✓					03
	Advances in Practical Approaches to Nucleic Acid Analysis and Genomics		✓				03
	Advances in Forensic DNA Typing	✓					03
	Advances in Recombinant DNA Technology	✓					03
	Advances in Genetically Modified Organisms		✓				03
	Advances in Cell and Tissue Culture		✓				03
	Advances in Proteomics & Protein Purification	✓					03
	Advances in Plant Molecular Biology		✓				03
	Advances in Plant Forensic		✓				03
	Bio Informatics		✓				03
	Advanced Biostatistics		✓				03
	Advances in Legal and Ethical Aspects of Forensic Sciences		✓				03
	Advances in Digital Forensic and Cybercrimes		✓				03
	Pharmacogenetics and Pharmacogenomics		✓				03
	Cancer Biology		✓				03
PU							18
HEC Guidelines							18
Difference (HEC &) PU							None

**Core: Compulsory, Basic: Foundation, Major Electives: Professional Minor Electives: Specialization*

Note: The course/column heads are customizable according to the nature and level of the program.

Major/Minor Electives N.A

10. Scheme of studies/ Semester-Wise Workload

As follows

#	Code	Course Title	Course Type	Prerequisite	Credit hours		
Semester I							
1.	MBFS 701	Advances in Applied Molecular Biology	Core		03		
2.	MBFS 702	Advances in Practical Approaches to Nucleic Acid Analysis and Genomics	Basic		03		
3	MBFS 703	Advances in Forensic DNA Typing	Core				
4	M3BFS 705	Advances in Genetically Modified Organisms	Basic				
5	MBFS 708	Advances in Plant Molecular Biology	Basic				
6	MBFS 710	Bio Informatics	Basic				
7	MBFS 714	Pharmacogenetics and Pharmacogenomics	Basic				
Total Credit Hours: Minimum 09 Credit Hours will be taught							
Semester II							
8	MBFS 704	Advances in Recombinant DNA Technology	Core		03		
9	MBFS 706	Advances in Cell and Tissue Culture	Basic		03		
10	MBFS 707	Advances in Proteomics & Protein Purification	Core		03		
11	MBFS 709	Advances in Plant Forensic	Basic		03		
12	MBFS 711	Advanced Biostatistics	Basic		03		
13	MBFS 712	Advances in Legal and Ethical Aspects of Forensic Sciences	Basic		03		
14	MBFS 713	Advances in Digital Forensic and Cybercrimes	Basic		03		
15	MBFS 715	Cancer Biology	Basic		03		
Total Credit Hours: Minimum 09 Credit Hours will be taught							
Semester III							
1.							
Total Credit HoursRESEARCH							
Semester IV							
1.							
Total Credit HoursRESEARCH							
Semester V							
1.							
Total Credit HoursRESEARCH							
Semester VI							
1.							
Total Credit HoursRESEARCH							

#	Code	Course Title	Course Type	Prerequisite	Credit hours		
Semester VII							
1.							
Total Credit HoursRESEARCH							
Semester VIII							
1.							
Total Credit HoursRESEARCH							

11. Award of Degree

Degree awarding criteria stating:

CGPA percentage required to quality: 3.0

Thesis/ Project/ Internship: Thesis

Any other requirement e.g. comprehensive examination (if applicable) ***Comprehensive Examination***

12. NOC from Professional Councils (if applicable)

1. Board of Studies on 10.08.2015
2. Board of Faculty on 21.08.2015
3. Academic Council on 14.10.2015
4. Syndicate on 14.11.2015

For Revision

1. Board of Studies on 12.04.2021
2. Board of Faculty on 08.07.2021
3. Academic Council on 11-03-22 and 21-03-22 (Referred it back to BOF)
4. Syndicate on

13. Faculty Strength

Degree	Area/ Specialization			Total
PhD	1	Dr. Rehan Sadiq Shaikh	Molecular Biology	17
	2	Dr. Tahir Mehmood	Molecular Biology & Biochemistry	
	3	Dr. Muhammad Farooq Sabar	Molecular Biology	
	4	Dr. Aleena Sumrin	Molecular Biology	
	5	Dr. Muhammad Zafar Saleem	Molecular Biology	
	6	Dr. Manzoor Hussain	Microbiology & Molecular Genetics	
	7	Dr. Rukhsana Parveen	Molecular Biology	
	8	Dr. Nazim Hussain	Biochemistry & Molecular Biology	
	9	Dr. Safdar Hussain	Biochemistry & Molecular Biology	
	10	Dr. Hamid Bashir	Molecular Biology	
	11	Dr. Muhammad Bilal	Molecular Biology	
	12	Dr. Ghulam Zahra Jahangir	Biotechnology	
	13	Dr. Muhammad Usman Ghani	Molecular Biology and Forensic Sciences	
	14	Dr. M. Adnan Shan	Forensic Genetics/ Forensic Sciences	
	15	Dr. Farheena Iqbal Awan	Molecular Biology & Molecular Genetics	
	16	Mr. M. Shahzad	Molecular Biology and Forensic Sciences	
	17	Ms. Saima Younas	Molecular Biology	
MS/ M.Phil	1.	Ms. Sadia Manzoor	Molecular Biology	02 on study leave
	2	Mr. Muhammad Akram	Molecular Biology and Forensic Sciences?	

14. Present Student Teacher Ratio in the Department

Student/Faculty Ratio (PhD Program) = 8:1

15. Course Outlines separately for each course

Annexed-I

Checklist for a New Academic Program

Parameters	
1. Department Mission and Introduction	☐
2. Program Introduction	☐
3. Program Alignment with University Mission	☐
4. Program Objectives	☐
5. Market Need/ Rationale	☐
6. Admission Eligibility Criteria	☐
7. Duration of the Program	☐
8. Assessment Criteria	☐
9. Courses Categorization as per HEC Recommendation	☐
10. Curriculum Difference	☐
11. Study Scheme / Semester-wise Workload	☐
12. Award of Degree	☐
13. Faculty Strength	☐
14. NOC from Professional Councils (if applicable)	☐

Program Coordinator **Chairperson**

COMPARISON SHEET OF PH.D. COURSES

OLD COURSES			NEW COURSES		
Course Code	**Course Title**	**Credit Hour**	**Course Code**	**Course Title**	**Credit Hour**
Semester-I& II					
MBFS 701	Advances in Plant Molecular Biology	3+1	MBFS 701	Advances in Applied Molecular Biology	03
MBFS 702	Advances in Practical Approaches to Nucleic Acid Sequencing	3+1	MBFS 702	Advances in Practical Approaches to Nucleic Acid Analysis and Genomics	03
MBFS 703	Advances & Practical Approaches to Real-Time/ Quantitative PCR	3+1	MBFS 703	Advances in Forensic DNA Typing	03
MBFS 704	Recent Advances in Forensic Molecular Biology	3+1	MBFS 704	Advances in Recombinant DNA Technology	03
MBFS 705	Ethics In Biological Sciences	3+1	MBFS 705	Advances in Genetically Modified Organisms	03
MBFS 706	Advances In Biosafety	4+0	MBFS 706	Advances in Cell and Tissue Culture	03
MBFS 707	Practical Approaches in Genetic Manipulation	3+1	MBFS 707	Advances in Proteomics & & Protein Purification	03
MBFS 708	Advancements In Genetically Modified Plants and Pests	3+1	MBFS 708	Advances in Plant Molecular Biology	03
MBFS 709	Application of Mammalian Cell Culture	3+1	MBFS 709	Advances in Plant Forensic	03
MBFS 710	Application of Protein Purification Methodology	2+0	MBFS 710	Bioinformatics	03
MBFS 711	Edible Plant Vaccines Production	2+0	MBFS 711	Advanced Biostatistics	03
			MBFS 712	Advances in Legal and Ethical Aspects of Forensic Sciences	03
			MBFS 713	Advances in Digital Forensic and Cybercrimes	03
			MBFS 714	Pharmacogenetics and Pharmacogenomics	03
			MBFS 715	Cancer Biology	03

COMPARISON SHEET OF PH.D. COURSES BEFORE & AFTER THE ACADEMIC COUNCIL MEETING, DATED: 11.03.2022 & 21.03.2022
MOLECULAR BIOLOGY AND FORENSIC SCIENCES

OLD TITLES			REVISED TITLES		
Course Code	**Course Title**	**Credit Hour**	**Course Code**	**Course Title**	**Credit Hour**
MBFS 701	Advance Molecular Biology	03+1	MBFS 701	Advances in Applied Molecular Biology	03
MBFS 702	Advances in Practical Approaches to Nucleic Acid Analysis and Genomics	03+01	MBFS 702	Advances in Practical Approaches to Nucleic Acid Analysis and Genomics	03
MBFS 703	Advances In PCR Approaches	02+01	MBFS 703	Advances in Forensic DNA Typing	03
MBFS 704	Forensic DNA Profiling	03+01	MBFS 704	Advances in Recombinant DNA Technology	03
MBFS 705	Ethics In Biological Sciences	01	MBFS 705	Advances in Genetically Modified Organisms	03
MBFS 706	Advances In Biosafety	01	MBFS 706	Advances in Cell and Tissue Culture	03
MBFS 707	Recombinant DNA Technology	03+01	MBFS 707	Advances in Proteomics & & Protein Purification	03
MBFS 708	Advancements In Genetically Modified Organisms	02	MBFS 708	Advances in Plant Molecular Biology	03
MBFS 709	Application Of Mammalian Cell Culture	01+01	MBFS 709	Advances in Plant Forensic	03
MBFS 710	Protein Purification Methodologies	01+01	MBFS 710	Bioinformatics	03
MBFS 711	Edible Vaccines	02	MBFS 711	Advanced Biostatistics	03
MBFS 712	Advance Plant Molecular Biology	02	MBFS 712	Advances in Legal and Ethical Aspects of Forensic Sciences	03
MBFS 713	Advances in Plant Forensic	03+01	MBFS 713	Advances in Digital Forensic and Cybercrimes	03
MBFS 714	Advances in Forensic Science	02	MBFS 714	Pharmacogenetics and Pharmacogenomics	03
MBFS 715	Genomics and Proteomics	03	MBFS 715	Cancer Biology	03
MBFS 716	Cell and Tissue Culture	02+01			
MBFS 717	Instruments & Techniques	01			
MBFS 718	Research Methodology & Skill Enhancement	01			

MBFS 719	Cell Biology	03			
MBFS 720	Bio informatics I	02			
MBFS 721	Bio informatics II	02			
MBFS 722	Bio Statistics	02			
MBFS 723	Forensic Psychology	03+01			
MBFS 724	Advances in Law, Legal and Ethical Aspects of Forensic Sciences	03			
MBFS 725	Digital Forensic and Cybercrimes	03+01			
MBFS 726	Seminar/Presentation/Term Paper	01			

FRAMEWORK FOR PH.D. IN MOLECULAR BIOLOGY AND FORENSIC SCIENCES

S. No.	Course Code	Course Title	Credit Hours
1.	MBFS 701	Advances in Applied Molecular Biology	03
2.	MBFS 702	Advances in Practical Approaches to Nucleic Acid Analysis and Genomics	03
3.	MBFS 703	Advances in Forensic DNA Typing	03
4.	MBFS 704	Advances in Recombinant DNA Technology	03
5.	MBFS 705	Advances in Genetically Modified Organisms	03
6.	MBFS 706	Advances in Cell and Tissue Culture	03
7.	MBFS 707	Advances in Proteomics & Protein Purification	03
8.	MBFS 708	Advances in Plant Molecular Biology	03
9.	MBFS 709	Advances in Plant Forensic	03
10.	MBFS 710	Bioinformatics	03
11.	MBFS 711	Advanced Biostatistics	03
12.	MBFS 712	Advances in Legal and Ethical Aspects of Forensic Sciences	03
13.	MBFS 713	Advances in Digital Forensic and Cybercrimes	03
14.	MBFS 714	Pharmacogenetics and Pharmacogenomics	03
15.	MBFS 715	Cancer Biology	03

DETAILED COURSE CONTENTS FOR PH.D. IN MOLECULAR BIOLOGY & FORENSIC SCIENCES

Course No: MBFS 701

Course Title: ADVANCES IN APPLIED MOLECULAR BIOLOGY

Course Rating: 03 Credit Hours

Course Objectives:

This course will enable the students to acquire an advanced level of knowledge on the activity of genes and genomes and the mechanisms of genome regulation at the transcriptional and post-transcriptional levels. This course will enable the students to know and understand the substantial theoretical and practical bases with key concepts of Applied Molecular Biology, its applications, and techniques in scientific research.

Course Contents:

1.0 Nucleic Acids to Proteins

1.1 Overview of synthesis, structure, and function of biologically important macromolecules (DNA, RNA, and proteins).

1.2 Regulation and control of the synthesis of RNA and proteins.

1.3 In-depth analysis of current topics in molecular biology regarding the flow of information in the nucleus of eukaryotic/prokaryotic cells.

2.0 Genomics and Regulation

2.1 Genomic flexibility

2.2 Signal transduction to the nucleus and chromatin structure

2.3 Gene expression and cell cycle checkpoints.

2.4 Basic concepts of gene expression with regulation

2.5 Transcriptional regulation, regulatory promoters, enhancers, terminators, anti-terminators

2.6 Activation of transcription

2.7 Post-transcriptional regulation

2.8 mRNA processing, degradation, and analysis

3.0 Proteomics and Regulation

3.1 Post-translational control and modification of proteins

3.2 Correlation of mRNA and protein expression, antisense sequences

3.3 Protein expression analyses, birth, assembly, and death of proteins

3.4 Housekeeping genes

3.5 Protein localization, sorting & trafficking

3.6 Transport of proteins into and out of the nucleus, mitochondria, and chloroplast

3.7 Signal transduction, the general principle

3.8 Signaling via G-protein-linked cell-surface receptors

3.9 Signaling via enzyme-linked cell surface receptors

3.10 Hormonal regulation of gene expression and cell cycle.

3.11 Epigenetic regulation of gene expression (DNA methylation, histone variants, and modifications, chromatin accessibility and ncRNAs association, etc), technologies and alterations in human diseases

3.12 In vivo imaging to study the key DNA metabolic factors mediating cancer cell proliferation and metastasis.

3.13 Pathologies related to increased genome instability.

3.14 Cell response to environmental cues (infection and immune response, heat shock genes response, vernalization, mechanical stress, tumor microenvironment, etc

4.0 Techniques

4.1 Isolation of nucleic acids and proteins from various sources

4.2 Diagnosis of infectious diseases through ELISA, PCR.

4.3 Genetic transformation of microbes/mammalian cells/plants.

4.4 Detection of foreign genes and proteins in microbes/mammalian cells/plants through PCR quantification.

4.5 Restriction digestion of DNA and preparation of restriction maps

4.6 Gel electrophoresis, polymerase chain reaction (PCR)

4.7 Detection of mutations by Restriction Fragment Length Polymorphism (RFLP)

4.8 Preparation of competent cells

4.9 Transformation of bacteria with plasmid DNA

4.10 Analyses of proteins by electrophoresis

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

1. Expected outcomes, divided into "knowledge, understanding, abilities", are: Upon completion of this course work the students will develop an understanding of the basic concepts and mechanisms of advanced Applied Molecular Biology with its applications.
2. Moreover, the students will practically get acquainted with different methods and advanced techniques being used in the laboratory for conducting successful molecular biological research.

Distribution of Marks:

1. Mid-term Assessment	35%
2. Final-term Assessment	40%
3. Formative Assessment Assignments	25%
4. Research/Thesis	100 Marks

Recommended Books:

1. Sengar, R.S., Kumar, A., Chaudhary, R., & Singh, A. (2018) .*Advances in Molecular Techniques*. CRC Press.
2. Alberts, B., Bray, D., Hopkin, K., Johnson, A.D., Lewis, J., Raff, M., & Walter, P. (2015). *Essential Cell Biology*. Garland Science.
3. Primrose, S.B., & Twyman, R. (2013). *Principles of Gene Manipulation and Genomics*. John Wiley & Sons.

4. Lodish, H., Berk, A., Kaiser, C.A., Kaiser, C., Krieger, M., Scott, M.P., & Matsudaira, P. (2008). *Molecular Cell Biology.* Macmillan.
5. Lorkowski, S., & Cullen, P.M. (Eds.) (2006). *Analyzing Gene Expression*: *A Handbook of Methods, Possibilities, and Pitfalls*. John Wiley & Sons.

Course No: MBFS-702

Course Title: ADVANCES IN PRACTICAL APPROACHES TO NUCLEIC ACID ANALYSIS AND GENOMICS

Credit Hours: 03 Credits

Course Objectives:

1. This advanced course will provide recent developments in the practical approaches to nucleic acid analyses, particularly DNA sequence analysis.
2. Students will be fully aware of the latest techniques and methods of genome/exome sequencing analysis and innovations in this field.

Course Contents:

1.0 **Changing Landscape of Genomics**

- 1.1 Human genome, Genome sequencing technologies
- 1.2 Gene and genome duplications, and transposable elements
- 1.3 Genomics in Medicine
- 1.4 Comparative genomics
- 1.5 Paleo genomics and synthetic genomics
- 1.6 Functional genomics
- 1.7 Genomics perspectives of domestication: animals and plants.
- 1.8 Microbial Genomics

2.0 **Overview of Developments in DNA sequencing and Instrumentation**

- 2.1 Chemical degradation method of Sequencing
- 2.2 Sanger sequencing and significance of chain terminators
- 2.3 Automated DNA sequencing
- 2.4 Mini sequencing or single base extension (SBE) sequencing
- 2.5 Next-Generation Sequencing (NGS)

3.0 **Next-Generation Sequencing Platforms and their Methodology**

- 3.1 Illumina sequencing
- 3.2 Helicos sequencing
- 3.3 Roche sequencing, emulsification PCR
- 3.4 Real-time sequencing
- 3.5 Nanopore sequencing
- 3.6 Whole Genome Sequencing (WGS)
- 3.7 Whole Exome Sequencing (WES)

4.0 Genome Analysis

- 4.1 Sequence assembly
- 4.2 Targeted resequencing
- 4.3 Sequencing alignments
- 4.4 Variant calling and annotation

5.0 Applications of Next-Generation Sequencing

- 5.1 Gene discovery in the research and diagnostics
- 5.2 Single gene, gene panel, exome, and genome sequencing analysis
- 5.3 How to design a gene panel
- 5.4 ChIPseq, DNA methylation mapping

6.0 Microarrays and RNA-Seq

6.1 Data normalization, differential expression, clustering, enrichment analysis, and network construction.

6.2 DNA sequence annotation, homopolymers in the genome, STRs, mutation analysis

6.3 Phylogenetic Analysis

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

1. After completion of this course, the students will be well aware of the current and old technologies in nucleic acid and genome analysis.
2. They will be able to demonstrate an understanding of the molecular principles underlying Next Generation Sequencing (NGS) technologies and identify appropriate applications of these technologies to clinical scenarios within both the diagnostic and research settings.
3. They will also learn about the advancements in this field.
4. After learning this course, they will give confidence in using these technologies available in Pakistan or abroad to analyze the data, generated.

Distribution of Marks:

1. Mid-term Assessment	35%
2. Final-term Assessment	40%
3. Formative Assessment Assignments	25%
4. Research/Thesis	100 Marks

Reference Books:

1. Sobti, R.C., Manishi Mukesh, and Aastha Sobti, eds. (2022) *Genomic, Proteomics, and Biotechnology*. CRC Press.
2. Lewin, B., Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2014) *Lewin's Genes XI.* Jones & Bartlett Publishers.
3. Wilson, K., & Walker, J. (Eds.). (2010). *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.
4. Romero, P. (2004). *Bioinformatics: Sequence and Genome Analysis*.

Course No.: MBFS-703
Course Title: ADVANCES IN FORENSIC DNA TYPING
Course Rating: 03Credit Hours
Course Objectives:

This course will focus on modern DNA profiling methods

a. Regarding the Historial Perspective of Forensic DNA Typing
b. For Human identification & Forensic Laboratory Practices
c. Advances & Applicability of DNA for Justice.

Course Contents:

1.0 Overview and History of Forensic DNA Typing

1.1 Briefly covering a historical perspective of human identification beginning with blood typing and isozyme protein
1.2 Electrophoresis assays through the modern minisatellite short tandem repeat (STR), mitochondrial DNA (mtDNA) sequence analysis, and single nucleotide polymorphism (SNP) techniques.

2.0 Forensic DNA & Serology

2.1 Advanced crime scene investigation techniques
2.2 Sample collection and preservation
2.3 Advanced techniques of identification of different body fluids including Blood, Semen, Saliva, etc.

3.0 DNA Biology and Genetics

3.1 Structure of nucleotide basis and nucleic acids
3.2 Watson–Crick base-pairing
3.3 Principles of heredity and discrimination challenges
3.4 Autosomal and Y chromosomal STRs analysis
3.5 Mitochondrial DNA analysis

4.0 Recent Tools and Techniques for DNA Analysis

4.1 Advanced DNA extraction, quantitation, and amplification methods
4.2 DNA fragment analysis including DNA separation technologies like slab gel and capillary gel electrophoresis for the generation of the DNA profile
4.3 Electropherogram and results' interpretation
4.4 Data interpretation
4.5 Statistical analysis
4.6 Quality Assurance and Quality Control

5.0 Advance Topics in Forensic DNA Typing

5.1 Single Nucleotide Polymorphism (SNP) in lineage analysis
5.2 Non-human DNA testing (domestic and wild animals, microbial, viral, and fungal)
5.3 DNA methylation
5.4 DNA database
5.5 DNA phenotyping
5.6 DNA barcoding
5.7 Next-Generation Sequencing

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions

3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcome:

1. Upon completion of the described course, students will not only be able to identify different body fluids but also get the knowledge of processes and methods involved in the generation of conclusive DNA reports.
2. Furthermore, students will understand the advanced technology involved in forensic DNA science.
3. Moreover, the students will practically get experience with different methods and advanced techniques used in the laboratory for conducting forensic DNA analysis.

Distribution of Marks:

1. Mid-term Assessment	35%
2. Final-term Assessment	40%
3. Formative Assessment Assignments	25%
4. Research and Thesis	100 Marks

Recommended Books:

1. Bell, S., & Butler, J.M. (2022). *Understanding Forensic DNA*. Cambridge University Press.
2. Buckleton, J. S., Bright, J. A., & Taylor, D. (Eds.). (2018). *Forensic DNA evidence interpretation.* CRC Press.
3. Bader, S. (2016). *A guide to forensic DNA profiling*. John Wiley & Sons.
4. Shewale, J. G., & Liu, R. H. (Eds.) (2013). *Forensic DNA analysis: current practices and emerging technologies* CRC Press.
5. Butler, J. M. (2011). *Advanced topics in forensic DNA typing: methodology.* Academic Press.
6. Goodwin, W., Linacre, A., & Hadi, S. (2011). *An introduction to forensic genetics (Vol.2)*. John Wiley & Sons.
7. McClintock, J. T. (2008). *Forensic DNA analysis: A laboratory manual*. CRC Press.
8. Butler, J. M. (2005). *Forensic DNA typing: biology, technology, and genetics of STR markers*. Elsevier.

Course No.: MBFS 704
Course Title: ADVANCES IN RECOMBINANT DNA TECHNOLOGY
Course Rating: 03 Credits Hours
Course Objectives:
Through this course, the students will have

1. A substantial theoretical and practical base to understand key experimental techniques used in modern molecular biology and recombinant DNA research.
2. A theoretical experience in some of these methods, as well as skills to analyze and present experimental data both in oral and written form.
3. The students will also be trained on how to design relevant experiments to address a biological question, and how to critically evaluate experimental data.
4. As a complement to the "wet labs", Bioinformatic exercises will be performed during several computer labs.

Course Contents:

1.0 Overview of Genetic Engineering

1.1. Anatomy of a gene organization, the flow of genetic information
1.2. Isolation, quantification, labeling, and hybridization of nucleic acids
1.3. Restriction enzymes, restriction mapping
1.4. DNA Manipulative enzymes: Nucleases, Ligases, Polymerases & Modifying enzymes

2.0 Methodology of Gene Manipulation

2.1 Host cells, host cell types, Prokaryotic & Eukaryotic hosts
2.2 Plasmid vectors, Artificial chromosomes
2.3 Transformation and transfection
2.4 Alternative DNA delivery methods

3.0 Cloning Strategies

3.1 Cloning from mRNA
3.2 Cloning cDNA in plasmid vectors
3.3 Cloning cDNA in bacteriophage vectors
3.4 Cloning from genomic DNA
3.5 Preparation of DNA fragments for cloning
3.6 Advanced cloning strategies
3.7 Cloning large DNA fragments in BAC and YAC vectors
3.8 Expression of cloned DNA molecules
3.9 Site-Directed Mutagenesis

4.0 Selection, Screening, and Recombinants Analysis

4.1 Selection and screening using nucleic acid hybridization and nucleic acid probes
4.2 The use of chromogenic substrates
4.3 Insertional inactivation
4.4 Complementation of defined mutations
4.5 Screening clone banks
4.6 Use of the PCR in screening protocols
4.7 Immunological screening for expressed genes
4.8 Analysis of cloned genes
4.9 Characterization based on mRNA translation in vitro
4.10 Restriction mapping, blotting techniques, and DNA sequencing

5.0 Application of Recombinant DNA Technology

5.1 Disease diagnosis

5.2 Interpretation of hereditary diseases and related cures

5.3 Recombinant HB vaccines, human insulin. Hormones production, gene therapy

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

1. This advanced course will provide excellent and advanced knowledge about all recent improvements related to biotechnological and genetic manipulation.
2. The students will be trained enough to design a cloning experiment and address a biological question along with the capacity to evaluate experimental data.

Distribution of Marks:

1. Mid-term Assessment	35%
2. Final-term Assessment	40%
3. Formative Assessment Assignments	25%
4. Research and Thesis	100 Marks

Recommended Books:

1. Brown, T. A. (2020). *Gene cloning and DNA analysis: an introduction.* John Wiley & Sons.
2. Chaudhuri, K. (2013). *Recombinant DNA technology*. The Energy and Resources Institute (TERI).
3. Sandhu, S. S. (2010). *Recombinant DNA technology*. IK International.
4. Griffiths, A. J., Miller, J. H., Suzuki, D. T., Lewontin, R. C., & Gelbart, W. M. (2000). *Structure of DNA. In An Introduction to Genetic Analysis*. WH Freeman.
5. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). *Molecular cloning: a laboratory manual*. Cold Spring Harbor Laboratory Press.

Course No.: MBFS 705
Course Title: ADVANCES IN GENETICALLY MODIFIED ORGANISMS
Course Rating: 03 Credit Hours

Course Objectives:

The students will be abreast with the recent advances in the field of transgenic organisms starting from microorganisms, plants, and mammals as well as related laws and litigations.

Course Contents:

1.0 Introduction to GMOs

1.1 Historical Perspectives and GMO Technology
1.2 Why Use GMOs & New Opportunities
1.3 GMO Applications
1.4 Potential Issues with the Commercial Application of GMO
1.5 Intragenetic Horizontal Transfers & Economic Issues

2.0 Microbial GMOS

2.1 Genetically Modified Microorganisms: Development and Applications
2.2 Producing Proteins Derived From Genetically Modified Organisms for Toxicology and Environmental Fate Assessment of Biopesticides
2.3 Genetically Modified Organisms: Biosafety and Ethical Issues

3.0 Plant GMOs

3.1 Development of Genetically Modified Agronomic Crops
3.2 Gene Silencing in Plants: Nature's Defense
3.3 Value Creation and Capture With Transgenic Plants
3.4 Biosafety Issues, Assessment, and Regulation of Genetically Modified Food Plants

4.0 Mammalian GMOs

4.1 Large-Scale Exogenous Protein Production in Higher Animal Cells
4.2 Transgenic Aquatic Animals
4.3 Biosafety, Ethics, and Regulation of Transgenic Animals

5.0 Government Regulation and Litigation for GMO Foods

5.1 Agricultural Biotechnology Regulation and Litigation: Preventing "Contamination"
5.2 European Union Reference Methods Database and Decision Supporting Tool for the Analysis of Genetically Modified Organisms

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

1. This advanced course will introduce and explain the fundamentals of molecular biotechnology as a scientific discipline, provides an understanding of how current

GMO research is conducted, and discusses the problems that have arisen from genetic technology.

2. It explains the tools needed to address and resolve conflicts on GMO issues and provides in-depth discussions on how GMO-derived technology may impact our lives in the future. It gives a cross-section of current accomplishments in GMO research and provides insight into future developments related to GMOs.

Distribution of Marks:

1. Mid-term Assessment	35%
2. Final-term Assessment	40%
3. Formative Assessment Assignments	25%
4. Research and Thesis	100 Marks

Recommended Books:

1. Sarad R. Parekh (2004). *The GMO handbook: genetically modified animals, microbes, and plants in biotechnology.* Humana Press Inc.
2. Ronald Ross Watson & Victor R. Preedy (2016). *Genetically Modified Organisms in Food Production, Safety, Regulation, and Public Health.* Academic Press.
3. Sheldon Krimsky (2019). *GMOs decoded: a skeptic's view of genetically modified foods*. The MIT Press.
4. Umaiyal Munusamy (2019). *Genetically Modified Organisms in Food Production.* Delve Publishing.

Course No.: MBFS 706
Course Title: ADVANCES IN CELL AND TISSUE CULTURE
Course Rating: 03 Credit Hours

Course Objectives:

This course aims to convey the importance of

1. Cells, tissue, organ culture and their applications in life sciences
2. Providing students with a thorough understanding of the subject.
3. Drug development through mammalian cell lines and culturing
4. To study the molecules which can be the future candidate as a drug.

Course Contents:

1.0 Plant Cell Culturing

1.1 Introduction & Historical Developments of Cell and Tissue Culture Techniques
1.2 Cell Culture facilities & Sterile techniques
1.3 Media preparation and Culture Handling
1.4 Callus Cultures
1.5 Cell Suspension Cultures
1.6 Protoplast Cultures
1.7 Haploid Techniques
1.8 Plant Propagation-Meristem Cultures, Somatic Embryogenesis
1.9 Endogenous and Exogenous Factors in Cell Culture Systems
1.10 Phytohormones and Growth Regulators
1.11 Primary & Secondary Metabolism
1.12 Organ Culture
1.13 Industrial uses of plant cell culture
1.14 Tissue culture in genetic engineering and biotechnology.

2.0 Mammalian Cell Culturing

2.1 The cell: Origin, principles, selection, and standardization of cell culture
2.2 Qualitative characteristics of cell cultures & Cell counting
2.3 Cryopreservation & Cell banking and subculture (variety of different systems)
2.4 Culture & Growth Environment
2.5 Culture Processes, Scale-Up, Design, and Operation
2.6 Primary cell culture techniques
2.7 Development of immortalized cell line
2.8 Detection of microbial contaminants
2.9 Animal cells for bioassays and bioproducts
2.10 Bioreactors for therapeutic protein production
2.11 Stem cell culture

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions

3. Assignments/Tests/Quizzes

Learning Outcomes:

The students will have a thorough understanding of various requirements to set up cell and tissue culture laboratories along with an in-depth knowledge of various cell and tissue culture techniques for both plant and mammalian cells

Distribution of Marks:

1. Mid-term Assessment	35%
2. Final-term Assessment	40%
3. Formative Assessment Assignments	25%
4. Research and Thesis	100 Marks

Reference Books:

1. Paul Jr, F. (Ed.) (2012). *Tissue culture: methods and applications.* Elsevier.
2. Saurabh, B., Kiran, S., Randhir, D., & Tanmoy, B. (2015). *Modern Applications of Plant Biotechnology in Pharmaceutical Sciences.* Academic Press.
3. Lanza, R., Langer, R., & Vacanti, J. (2007). *Principles of Tissue Engineering* Academic Press.
4. Jenkins, N. (Ed.) (1999). *Animal cell biotechnology: methods and protocols.* Humana Press.
5. Jennie, P. M., & Penelope E. R. (1998). *Introduction to Cell and Tissue Culture: Theory and Technique.* Penum Press, New York.
6. Alan, D., & Bryan, G. (1998). *Cell and tissue culture: laboratory procedures in biotechnology.* John Wiley & Sons.

Course No.: MBFS 707
Course Title: ADVANCES IN PROTEOMICS & PROTEIN PURIFICATION
Course Rating: 03 Credit Hours
Course Objectives:

Through this course, the students will be able to understand

1. Concepts of Proteomics – its principles and techniques which play a significant role in modern systems biology and related areas.
2. This course introduces the basics of the evolution of proteomics as an area and the experimental aspects of tools and techniques in addressing systems-level applications. As a result of this course, the students will have strong foundations and first-hand scientific understanding of current trends in Proteomics.

Course Contents:

1.0 Amino Acids and Proteins

1.1 Principles and applications of various expression systems for protein and enzyme production,
1.2 Principles and applications of various methods for protein molecular modification to facilitate its downstream processing.
1.3 Protein engineering by directed evolution and rational design.
1.4 Mutant selection and identifications, and establishment of a mutant library for protein engineering.
1.5 Principles and applications of the most current unit operations used in bioseparations
1.6 In vitro synthetic enzymatic biosystems for biomanufacturing.

2.0 Protein Chemistry to Proteomics

2.1 Introduction to proteomics: protein structure and function
2.2 Evolution from protein chemistry to proteomics
2.3 Abundance-based proteomics
2.4 Sample preparation and prefractionation steps

3.0 Gel-Based Proteomics Techniques

3.1 Two-dimensional gel electrophoresis (2-DE)
3.2 Two-dimensional fluorescence difference in-gel electrophoresis (DIGE)
3.3 Staining techniques

4.0 Mass Spectrometry and Quantitative Proteomics

4.0 Central role of mass spectrometry: ionization sources, mass analyzers
4.1 Hybrid Mass Spectrometry Configurations
4.2 Tandem Mass Spectrometry for Protein Identification
4.3 *In Vitro* Quantitative Proteomics Using Itraq
4.4 *In Vivo* Quantitative Proteomics Using SILAC

5.0 Interactomics: Basics and Application

5.1 Introduction
5.2 Antigen and Antibody Microarray
5.3 Cell-Free Expression-Based Protein Microarray
5.4 Surface Plasmon Resonance
5.5 Protein Interaction Analysis Using SPR and SPRi

5.0 Modificomics

5.1 Post-translational modifications

5.2 Structural proteomics

5.3 Bioinformatics in proteomics

7.0 Advancements in Proteomics

7.1 Proteomics for Translational Research

7.2 Future of Proteomics for Clinical Applications

7.3 Challenges in Clinical Proteomics

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

1. Upon completion of this course work the students will practically learn protein purification.
2. Moreover, the students will have experience with different methods and advanced techniques used in the laboratory for conducting molecular biology research based on sequencing and expression studies.

Distribution of Marks:

1. Mid-term Assessment	35%
2. Final-term Assessment	40%
3. Formative Assessment Assignments	25%
4. Research and Thesis	100 Marks

Recommended Books:

1. Srivastava, S. (2022).*From Proteins to Proteomics: Basic Concepts, Techniques and Applications.* CRC Press.
2. Manual, A. J., & Linkand, J. L. (2009) *Proteomics: A Cold Spring Harbor Laboratory Course*. Cold Spring Harbor Laboratory Press.
3. R. Westermeier, T. Naven (2008). *Proteomics in Practice: A Guide to Successful Experimental Design.* Wiley-VCH.
4. T.D. Veenstra, J.R. Yates III (2006). *Proteomics for Biological Discovery.* John-Wiley & Sons. (Latest Edition).
5. R. Hubert (2006). *Protein Biochemistry and Proteomics.* Academic Press.
6. R.M. Twyman (2004). *Principles of Proteomics* Bios Scientific Pub.

Course No.: MBFS 708
Course Title: ADVANCES IN PLANT MOLECULAR BIOLOGY
Course Rating: 03 Credit Hours

Course Objectives:

This course will provide a substantial theoretical basis for the key concepts in Plant Genotyping, Plant Growth Regulations, and the Hormones, Effects of Various Stresses on Plants, Edible Vaccines, and Application of CRISPR in Plants

Course Contents:

1.0 Plant Genotyping

1.1 Plant Genetics and Molecular Biology: An Introduction.
1.2 Advances in Sequencing and Resequencing in Crop Plants.
1.3 Revolution in Genotyping Platforms for Crop Improvement.
1.4 Trait Mapping Approaches Through Linkage Map ing in Plants.
1.5 Trait Mapping Approaches Through Association Analysis in Plants.
1.6 Genetic Mapping of Plant Population for High-Resolution Trait Mapping.

2.0 Growth Regulation and Plant hormones

2.1 Dynamics of Growth – phases of growth – factors affecting growth.
2.2 Biosynthesis of plant hormones (gibberellins, abscisic acid, cytokinins, auxins, ethylene)
2.3 Novel growth regulators – brassinosteroids, polyamines, jasmonic acid, salicylic acid, and strigonolactones
2.4 Growth retardants and Commercial uses of PGRs

3.0 Pathogenicity and Abiotic Stress

3.1 Responses to plant pathogens.
3.2 Pathways for PAMP-triggered immunity and Effector-triggered immunity
3.3 Responses to abiotic stress
3.4 Gene expression and signal transduction in oxidative stress
3.5 Cross talk in stress responses

4.0 CRISPR & Genome Engineering

4.1 Plant DNA Repair Pathways and Their Applications in Genome Engineering.
4.2 CRISPR Design and Mutation Analysis.
4.3 CRISPR-CAS9 Editing In Monocots.
4.4 CRISPR-CAS9 Editing In Dicots.
4.5 Non-Agrobacterium Based CRISPR Delivery Systems.

5.0 Edible Vaccines

5.1 Concept of edible vaccines and vaccine delivery systems.
5.2 Expression of Genes of bacterial/viral antigens in edible tissues.
5.3 Factors affecting the efficacy of edible vaccines.
5.4 Plants used for edible vaccines.
5.5 Recent edible plant vaccines and their applications.
5.6 Advantages and disadvantages of edible vaccines.

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work

4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

Upon completion of this course work the students will be well versed in Plant Genotyping, Plant Growth Regulations, and the Hormones, Effects of Various Stresses on Plants, Edible Vaccines, and the Application of CRISPR in Plants.

Distribution of Marks:

1. Mid-term Assessment	35%
2. Final-term Assessment	40%
3. Formative Assessment Assignments	25%
4. Research and Thesis	100 Marks

Reference Books:

1. Yuri, S. (2023). *Plant Genotyping-Methods and Protocols.* Humana Press.
2. Rajeev, K. V., Manish, K. P., & Annapurna, C. (2018). *Advances in Biochemical Engineering/Biotechnology-Plant Genetics and Molecular Biology.* Springer Nature.
3. Grotewold, E., Chappell, J., & Kellogg, E. A. (2015). *Plant genes, genomes and genetics.* John Wiley & Sons.
4. Yiping, Q. (2019). *Plant Genome Editing with CRISPR Systems-Methods and Protocols*. Humana Press.
5. de Vere, N., Rich, T. C., Trinder, S. A., & Long, C. (2015). *DNA barcoding for plants. In Plant Genotyping.* Humana Press, New York, NY.
6. Alexander V. Karasev (2009). *Plant-produced Microbial Vaccines-Current Topics in Microbiology and Immunology.* Springer-Verlag

Course No: MBFS 709
Course Title: ADVANCES IN PLANT FORENSIC
Course Rating: 03 Credit Hours

Course Objectives:

To describe major classes of drugs that are derived from plants, and how they were discovered. Explain how plants can be used in crime scene investigations. Discuss major historical cases where plants played a key role in forensic science. Evaluate scientific literature and examine conclusions and findings.

Course Contents:

1.0 Introduction to Plant Forensic

- 1.1 Botanical evidence
- 1.2 Legal plant definition
- 1.3 Gravesite growth
- 1.4 Stomach contents

2.0 Plants as Evidence

- 2.1 Types of plants
- 2.2 Plant habitats and associations
- 2.3 Plant characteristics/plant morphology
- 2.4 Basic plant characteristics for the forensic investigator
- 2.5 Plant habitat and dispersal

3.0 Evidence Collection and Analysis

- 3.1 Initial crime scene notation
- 3.2 Where to search for evidence & storage
- 3.3 Step-wise method for the collection of botanical evidence
- 3.4 Documentation of botanical evidence
- 3.5 How to have botanical evidence analyzed
- 3.6 Transportation of botanical evidence
- 3.7 Evidence retention and disposition

4.0 Guidelines for plant DNA Analyse in Forensics

- 4.1 Types of samples and collection for DNA analyses.
- 4.2 Uses of genetic data.
- 4.3 Genotyping methods.
- 4.4 Development of Plant DNA barcodes

5.0 Expert evidence

- 5.1 Forensic guidelines for plant material
- 5.2 The common laws of botanical evidence

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

1. Upon completion of this course work the students will be acquainted with the field of forensic botany and would be ready to apply botanical knowledge to criminal investigations.
2. Moreover, the students will get experience with different methods, and advanced techniques used in the laboratory for conducting a plant DNA barcoding technique.

Distribution of Marks:

1. Mid-term Assessment 35%
2. Final-term Assessment 40%
3. Formative Assessment Assignments 25%
4. Research and Thesis 100 Marks

Reference Books:

1. David, W. H., & Jason, B. (2012). *Forensic botany: a practical guide.* John Wiley & Sons.
2. Bock, J. H., & Norris, D. O. (2016). *Introduction to forensic plant science-Forensic Plant Science.* Elsevier Academic Press.
3. Coyle, H. M. (Ed.). (2004). *Forensic botany: principles and applications to criminal case work*. CRC Press.
4. Kress, W. J., & Erickson, D. L. (2012). *DNA barcodes: methods and protocols. In DNA Barcodes.* Humana Press.
5. de Vere, N., Rich, T. C., Trinder, S. A., & Long, C. (2015). *DNA barcoding for plants. In Plant Genotyping.* Humana Press.

Course No.: MBFS 710
Course Title: BIOINFORMATICS
Course Rating: 03 Credit Hours
Course Objectives:

Through this course, the students will learn

1. To store the biological data organized in the form of a database.
2. To develop tools and resources that aid in the analysis of data.
3. To exploit these computational tools to analyze the biological data, and interpretation of results in a biologically meaningful manner.
4. To develop an understanding of genes and proteins at the structural level using computational tools.

Course contents:

1.0 Basics to Advancements

1.1 Timeline & Databases.
1.2 Sequence storage, retrieval, and analysis.
1.3 Similarity and homology, creating alignments.
1.4 Phylogenetic analysis.
1.5 Dot matrix plots.
1.6 Dynamic programming algorithm.
1.7 Word (k-tuple) methods.
1.8 Substitution matrices PAM and BLOSUM.
1.9 Scoring algorithms & Gap penalties.
1.10 Genome, gene prediction in prokaryotes and eukaryotes.
1.11 ORF, TFBS.
1.12 Codon usage table.
1.13 EST and SNP databases.
1.14 Primer designing.
1.15 Restriction enzyme databases.

2.0 Modeling

2.1 RNA structure prediction.2.2 Computational secondary and tertiary protein structures.
2.3 Prediction methods.
2.4 Structure optimization and refinement methods.
2.5 Hydrogen bonding.
2.6 PTMs of proteins.
2.7 Chou Fasman, PHD and PSIPred.
2.8 Neural network.
2.9 Threading and homology modeling methods.
2.10 Protein fold identification using Pfam (A & B) and other tools.

3.0 Tools

3.1 Online tools BLAST, BLAT, and FASTA.
3.2 PDB file structure.
3.3 Gene finder, ORF finder, and EST database.
3.4 Accessing NCBI, ENSEMBL, UniProt, Genbank, EMBL and SWISS-PROT.
3.5 Accessing structural databases including PDB, SCOP, and CATH

3.6 EXPASY and FASTA using tools for pairwise and multiple sequence alignment, Phylogenetic analysis.

3.7 Bioediting.

3.8 Protein structure prediction using an Online server.

3.9 Protein structure using visualization programs.

3.10 Secondary structure prediction, using the Pfam database.

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Out Comes:

1. After this course, the students will have the knowledge and awareness of the basic principles and concepts of bioinformatics
2. Using existing software, extracting the information from large databases, and using this information in computer modeling and homology testing.

Distribution of Marks:

1. Mid-term Assessment	35%
2. Final-term Assessment	40%
3. Formative Assessment Assignments	25%
4. Research and Thesis	100 Marks

Reference Books:

1. Lesk, A. (2019). *Introduction to bioinformatics*. OUP.
2. Mohammad, Y. S., Afshana, S., & Khalid, Z. M. (2021). *Bioinformatics for Everyone.* Academic Press.
3. Andreas, D. B., Gary, D. B., & David, S. W. (2020). *Bioinformatics 4th ed.* John Wiley & Sons.
4. Basant, K. T. (2022). *Bioinformatics and Computational Biology-A Primer for Biologists.* Springer.
5. Larson, R. S., & Oprea, T. I. (Eds.). (2006). *Bioinformatics and drug discovery.* Humana Press.
6. David, W. (2003). *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor Laboratory Press.

Course No.: MBFS 711
Course Title: ADVANCED BIOSTATISTICS
Course Rating: 03 Credit Hours

Course Objectives:

Through this course, the students will understand

1. the advanced statistical science and its application to problems of human diseases.
2. to statistically design studies and analyze data from research problems.
3. to use statistical tools to summarize the biological data
4. apply statistical software to analyze and evaluate biological data

Course Contents:

1.1 Introduction To Biostatistics
1.2 Describing Populations
1.3 Random Sampling
1.4 Summarizing Random Samples
1.5 Measuring the Reliability of Statistics
1.6 Confidence Intervals
1.7 Testing Statistical Hypotheses
1.8 Simple Linear Regression
1.9 Multiple Regression
1.10 Logistic Regression
1.11 Design of Experiments
1.12 Analysis of Variance
1.13 Survival Analysis

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

After reading this course the students will be acquainted with several different statistical analyses used in the statistical analysis of biomedical and healthcare data. It will also introduce students to the basic ideas of biostatistics and modeling approaches used in biostatistics.

Distribution of Marks:

1. Mid-term Assessment 35%
2. Final-term Assessment 40%
3. Formative Assessment Assignments 25%
4. Research and Thesis 100 Marks

Recommended Books

1. Richard, J. R. (2022). *Applied biostatistics for the health sciences 2nd edition.* Wiley.
2. Julien, I. E. H. (2019). *Basic Biostatistics for Medical and Biomedical Practitioners 2nd Edition.* Academic Press.

3. Antonisamy, B., Premkumar, P. S., & Christopher, S. (2017). *Principles and Practice of Biostatistics.* Elsevier Health Sciences.
4. Daniel, W. W., & Cross, C. L. (2018). *Biostatistics: a foundation for analysis in the health sciences.* Wiley.

Course No.: MBFS 712

Course Title: ADVANCES IN LEGAL AND ETHICAL ASPECTS OF FORENSIC SCIENCE

Course Rating: 03 Credit Hours

Course Objectives:

Students will develop an understanding of the issues and aspects of law and ethics in forensics especially evidence integrity and admissibility in courts; law enforcement agencies, attorneys, analyst, and other related components. Students will also learn the appropriate guidelines for professionalism and will be exposed to both the general principles that underlie criminal and constitutional law.

Course Contents:

1.0 History to Advancements

1.1 History of Forensic Law & Law enforcement agencies
1.2 Attorney and the Law
1.3 Forensic Scientist & Code of scientific conduct
1.4 Scientific testimony
1.5 Evidentiary value of physical and biological evidence
1.6 Admissibility in criminal and civil cases
1.7 Chain of custody and evidence contamination

2.0 Procedures

2.1 Advance criminal procedures
2.2 Interrogation techniques
2.3 Witness identification and lie detection theories
2.4 Misinformation effects
2.5 Codes of ethics & Responsibilities of a forensic scientist in legal settings
2.6 Criminological Perspectives.

3.0 Analyses

3.1 Evaluate data as an expert witness in court
3.2 Ethics in a courtroom
3.3 Legal issues /aspects of forensic science
3.4 Post-conviction remedies for innocence claims
3.5 International Criminal Law & Criminal laws and prosecution of Pakistan.

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

At the course completion students would be abreast with legal requirements, engagement in criminal and civil proceedings, and results of their work. They would be

aware of how to give an expert testimony and also knows the legal regulations.

Distribution of Marks:

1. Mid-term Assessment 35%
2. Final-term Assessment 40%
3. Formative Assessment Assignments 25%
4. Research and Thesis 100 Marks

Recommended Books:

1. Bowen, R. T. (2017). *Ethics and the practice of forensic science.* CRC Press.
2. Allen, R. J., Hoffmann, J. L., Livingston, D. A., Leipold, A. D., & Meares, T. L. (2020). *Comprehensive criminal procedure.* Aspen Publishers.
3. Kiely, T. F. (2005). *Forensic evidence: science and the criminal law.* CRC Press.
4. Barnett, P. D. (2001). *Ethics in forensic science: professional standards for the practice of criminalistics.* CRC press.

Course No.: MBFS 713

Course Title: ADVANCES IN DIGITAL FORENSIC AND CYBER CRIMES

Course Rating: 03 Credit Hours

Course Objectives:

1. In this course, students will learn the principles and techniques for digital forensics investigation and the spectrum of available computer-related crimes, core forensic procedures to ensure court admissibility of digital evidence, and to perform a forensic investigation on (Unix/Linux) Windows systems.
2. To understand the process of conducting computer crime investigation and indicating security characteristics, threats, and responses via security measure assessments from technology; policy and practice, education, training, and awareness.
3. The students will practice the technique of computer forensics to train them with the knowledge of legal processes, and ethical principles to assure reliable and detailed digital evidence that can be used for courtroom needs, well-structured investigation, and a follow-up of processes to resolve incidents and malfunctions in an organization.

Course Content:

1.0 Basics vs Advancements

1.1 Advances in digital forensics, a four-step procedure
1.2 Concepts: computer/network/Internet forensic and anti-forensics
1.3 Memory forensics
1.4 Windows incident response tools
1.5 Use of computers in forensic science
1.6 Windows file systems
1.7 Windows forensics tools
1.8 Malware
1.9 Cyber-crime and its types
1.10 Hacking
1.11 Software Piracy
1.12 Online gambling
1.13 Pornography by Internet Relay Chat (IRC)
1.14 Credit Card Fraud E-mail Threat/extortion
1.15 Phishing
1.16 Online Scam
1.17 Illegal recruitment/human trafficking
1.18 Databases
1.19 Video image processing and animation software.

2.0 Management

2.1 Understand cyber Security Management
2.2 Threats and responses via security measure assessment from technology
2.3 Policy and practice
2.4 Education, training, and awareness dimensions
2.5 Laws and Standards

2.6 The legal admissibility of digital evidence and recognizing various cybercrime environment issues
2.7 Security Policies and Procedures
2.8 Mobile Forensics & Security.

3.0 Practices

3.1 Procedures of Network Forensics and Investigating Logs
3.2 Network Traffic Investigations
3.3 Web Attack Investigations
3.4 Router Forensics
3.5 Denial of Service Investigations
3.6 Internet Crime Investigations
3.7 Email Crime Investigations
3.8 Wireless Attack Investigations
3.9 PDA Forensics
3.10 iPod and iPhone Forensics
3.11 Blackberry Forensics
3.12 Corporate Espionage Investigations
3.13 Trademark and Copyright Investigations
3.14 Investigating Sex-Related Activities.

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand the importance of a systematic procedure for the investigation of data found on digital storage media that might provide evidence of wrongdoing.
2. Understand the file system storage mechanisms of two common desktop operating systems (i.e. versions of Microsoft Windows and LINUX).
3. Use tools for faithful preservation of data on disks for analysis.
4. Find data that may be clear or hidden on a computer disk.
5. Learn the use of computer forensic tools used in data analysis, such as searching, absolute disk sector viewing, and editing, recovery of files, password cracking, etc.
6. Understand how to present the results of disk data analysis in a court proceeding as an expert witness as well as understanding the limitations imposed by data privacy laws.

Distribution of Marks:

1. Mid-term Assessment	35%
2. Final-term Assessment	40%
3. Formative Assessment Assignments	25%
4. Research and Thesis	100 Marks

Recommended Books:

1. Holt, T. J., Bossler, A. M., & Seigfried, S. K. C. (2017). *Cybercrime and digital forensics: An introduction.* Routledge.
2 Brenner, S. W. (2010). *Cybercrime: criminal threats from cyberspace.* ABC-CLIO.
3 Clough, J. (2010). *Cybercrime Principles.* Cambridge, UK: Cambridge University Press.
4 Koppenhaver, K. (2007). *Forensic document examination: Principles and practice.* Totowa, N. J: Humana Press.
5 Lewis, J. (2014). *Forensic document examination: Fundamentals and current trends.* Burlington: Elsevier Science.
6 Altheide, C., & Carvey, H. (2011). *Digital forensics with open source tools.* Elsevier.
7 Reyes, A., Brittson, R., O'Shea, K., & Steele, J. (2011). *Cybercrime investigations: bridging the gaps between security professionals, law enforcement and prosecutors.* Elsevier.
8 Kipper, G. (2007).*Wireless crime and forensic investigation.* Auerbach Publications.
9 Casey, E. (2009). *Hand book of digital forensics and investigation.* Academic Press.

Course No.: MBFS 714
Course Title: PHARMACOGENETICS AND PHARMACOGENOMICS
Course Rating: 03 Credit Hours

Course Objectives:

In this course, students will learn about the principles of pharmacogenomics and precision medicine, followed by the pharmacogenomics aspects of major therapeutic areas such as cardiovascular disease, cancer, thrombotic disease, etc. Students will also learn about genotyping technologies, ethical, legal, and regulatory issues; the cost-effectiveness of pharmacogenomics-guided drug therapy.

Course Content:

1.0 Pharmacogenetics: A Historical Perspective

2.0 Pharmacogenetics: Relationship to Pharmacokinetics and Pharmacodynamics

- 2.1 Pharmacogenetics in Drug Metabolism: Role of Phase I Enzymes
- 2.2 Pharmacogenetics of Phase II Drug Metabolizing Enzymes
- 2.3 Pharmacogenetics of Drug Transporters
- 2.4 Pharmacogenetics of Drug Targets

3.0 Pharmacogenetics: Therapeutic Areas

- 3.1 Cardiovascular Pharmacogenetics
- 3.2 Pharmacogenetics in Cancer
- 3.3 Pharmacogenetics of Asthma and COPD
- 3.4 Pharmacogenetics of Pain Medication
- 3.5 Pharmacogenetics of Adverse Drug Reactions

4.0 Developments in Pharmacogenetic Research

- 4.1 High-Throughput Genotyping Technologies for Pharmacogenetics
- 4.2 Developments in Analyses in Pharmacogenetic Datasets

5.0 Pharmacogenetics: Social, Ethical, Industry, and Regulatory Affairs

- 5.1 Ethical and Social Issues in Pharmacogenomics Testing
- 5.2 Applications of Pharmacogenetics in Pharmaceutical Research and Development
- 5.3 Role of Pharmacogenetics in Registration Processes

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

Upon successful completion of this course, the student will be able to apprehend the principles, tools, techniques, ethical, and legal issues about pharmacogenomics and precision medicine as well as pharmacogenomics aspects of major therapeutic areas such as cardiovascular disease, cancer, organ transplantation, psychiatry, infection, and thrombotic disease.

Distribution of Marks:

1. Mid-term Assessment 35%
2. Final-term Assessment 40%
3. Formative Assessment Assignments 25%
4. Research and Thesis 100 Marks

Recommended Books:

1. Weimin, C., Zhaoqian, L., Liyan, M., & Xiaoqiang, X. (2020). *Pharmacogenomics in Precision Medicine-From a Perspective of Ethnic Differences.* Springer Nature.
2. Anke-Hilse,. Mailand-van der, Z., & Ann, K. D. (2012). *Pharmacogenetics and individualized therapy.* John Wiley & Sons.
3. Joseph, S. B., Angela, K., Joseph, D. M., Uwe, F., & C. Lindsay, D. (2012). *Pharmacogenomics: An Introduction and Clinical Perspective.* McGraw-Hill Education.
4. Federico, I., Ron, H., & N. van, S. (2013). *Pharmacogenomics-Methods and Protocols, 2nd Edition.* Humana Press.
5. Y. W. Francis, L., & Stuart. A. S. (2019). *Pharmacogenomics-Challenges and Opportunities in Therapeutic Implementation, 2nd Edition.* Academic Press.

Course No.: MBFS 715
Course Title: CANCER BIOLOGY
Course Rating: 03 Credit Hours

Course Objectives:

This course will provide a general overview of cancer. It focuses on the molecular basis of the disease, cellular aspects of cancer as well as explain the concepts of an efficient therapy against cancer. Understanding the basic cellular mechanism of cancer along with clinical examples will improve the knowledge of students.

Course Content:

1.0 Introduction to Cancer
- 1.1 The Global Burden of Cancer
- 1.2 Categorization and Diagnosis of Tumors
- 1.3 Crucial Transitions in Cancer
- 1.4 Causes of Cancer & Cancer Prevention

2.0 Oncogenes and Signal Transduction
- 2.1 Cellular Transformation
- 2.2 Activating Oncogenes in Signal Transduction Pathways
- 2.3 Oncogenic Translocations and Amplifications
- 2.4 The Hallmarks of Cancer Concept

3.0 Tumor Suppressor Genes and Cell Fate Control
- 3.1 p53-A Master Example
- 3.2 Tumor Suppressors and Oncogenes in Cell Cycle Control
- 3.3 Tumor Suppressor Inhibition and Cancer Onset

4.0 Multi-step Tumorigenesis and Genome Instability
- 4.1 Characteristics of Tumor Growth
- 4.2 Multi-step Tumorigenesis
- 4.3 Genome Instability
- 4.4 Cancer Driver Mutations and Genes

5.0 Cancer Genomics
- 5.1 Human Genetic Variation and Cancer Susceptibility
- 5.2 The Cancer Genome & Cancer Genome Projects

6.0 Cancer Epigenomics
- 6.1 Epigenetic Mechanisms of Cancer
- 6.2 DNA Methylation and Cancer
- 6.3 Chromatin Changes and Cancer
- 6.4 Epigenetic Reprogramming in Cancer

7.0 Aging and Cancer
- 7.1 Central Role of Aging During Chronic Diseases
- 7.2 The Hallmarks of Aging
- 7.3 Epigenetics of Aging
- 7.4 Telomeres and Replicative Immortality

8.0 Tumor Microenvironment
- 8.1 The Impact of the Wound Healing Program for Cancer
- 8.2 Cell Types of the Tumor Microenvironment
- 8.3 Inducing Angiogenesis

8.4 Tumor-Promoting Inflammation
8.5 Deregulating Cellular Energetics

9.0 Metastasis and Cachexia

9.1 The Metastatic Cascade
9.2 Epithelial-Mesenchymal Transition
9.3 Metastatic Colonization
9.4 Cachexia

10.0 Cancer Immunity

10.1 Outline of Cancer Immunity
10.2 Recognition of Tumor Antigens
10.3 Monoclonal Antibodies in Cancer Immunotherapy
10.4 Immune Cell Therapies

11.0 Architecture of Cancer Therapies

11.1 Classical Cancer Treatments
11.2 Targeted Therapies
11.3 Precision Oncology

Teaching-learning Strategies:

1. Class Lectures
2. Group Discussions
3. Laboratory Work
4. Seminars/Presentations/Workshops

Assessment Strategies:

1. Lecture-Based Examination (Objective/Subjective)
2. Class Discussions
3. Assignments/Tests/Quizzes

Learning Outcomes:

Upon successful completion of this course, the student will be able to apprehend the molecular basis of the disease, and cellular aspects of cancer as well as understand the efficient approaches to treat cancer.

Distribution of Marks:

1. Mid-term Assessment	35%
2. Final-term Assessment	40%
3. Formative Assessment Assignments	25%
4. Research and Thesis	100 Marks

Recommended Books:

1. Carsten, C., Eunike, V. (2021). *Cancer Biology: How Science Works.* Springer Nature.
2. Weinberg, R. A. (2014). *The biology of cancer 2nd Edition.* Garland Science.
3. Vincent, T. D. Jr., Theodore, S. L., & Steven, A. R. (2021). *Cancer: principles & practice of oncology. Primer of the molecular biology of cancer.* Wolters Kluwer.
4. Rita, F., & Rita, Z. (2019). *Molecular and Cell Biology of Cancer-When Cells Break the Rules and Hijack Their Own Planet.* Springer Nature.
5. Francesco, P., Mahvash, T., & David, J. K. (2019). *Oxford Textbook of Cancer Biology.* Oxford University Press.