Revised Course structure of pre Ph.D. course work (MCARS)

| SI.No. | Papers | P/Wk | Credits | Internal Assessment | End semester exam | Presentation | Total Marks |
|---|---|---|---|---|---|---|---|
| | **Compulsory Paper** | | | | | | |
| 1 | Research Methodology | 4 | 4 | 25 | 75 | - | 100 |
| | **Optional Papers (Any Two papers)** | | | | | | |
| 2 | Molecular Modelling and Bioinformatics | 4 | 4 | 25 | 75 | | 100 |
| 3 | Chromosome dynamics | 4 | 4 | 25 | 75 | | 100 |
| 4 | Virology | 4 | 4 | 25 | 75 | | 100 |
| 5 | Molecular Biology | 4 | 4 | 25 | 75 | | 100 |
| 6 | Molecular Parasitology | 4 | 4 | 25 | 75 | | 100 |
| 7 | Biophysics | 4 | 4 | 25 | 75 | | 100 |
| | **Compulsory** | **Paper** | | | | | |
| 8 | Annotated Bibliography | - | 2 | 20 | - | 30 | 50 |
| 9 | Research and publication ethics | - | 2 | 20 | 30 | - | 50 |
| | Total | | 16 | | | | 400 |

**MULTIDISCIPLINARY CENTRE FOR ADVANCED RESEARCH AND STUDIES**
**Jamia Millia Islamia**
**Outline for the Syllabus for Pre-Ph.D. Course**
**(16 credits=400 marks)**

| | | |
|---|---|---|
| **PAPER- I*** | | |
| **Research Methodology** | (4 credits=100 marks) | (MCPH1) |
| **PAPER- II & III** – Subject specific** | | |
| **(a) Molecular Modelling & Bioinformatics** | (4 credits=100 marks) | (MCPH2) |
| **(b) Chromosome Dynamics** | (4 credits=100 marks) | (MCPH3) |
| **(c) Virology** | (4 credits=100 marks) | (MCPH4) |
| **(d) Molecular Biology** | (4 credits=100 marks) | (MCPH5) |
| **(e) Molecular Parasitology** | (4 credits=100 marks) | (MCPH6) |
| **(f) Biophysics** | (4 credits=100 marks) | (MCPH7) |
| **PAPER- IV*** | | |
| **Annotated Bibliography** | (2 credits=50 marks) | (MCPH8) |
| **PAPER- V*** | | |
| **Research and publication ethics** | (2 credits=50 marks) | (MCPH9) |

***PAPER-I and PAPER-IV and V - are compulsory for all students.**
****PAPER-II & III- Candidate should choose any two of the subject specific. More courses will be included in future as and when faculty joins.**

**Note:** The marks distribution for the final examination and internal assessment will be as per the JMI rules.

**PAPER- I**

**MCPH1 Research Methodology (4 Credits=100 Marks)**

**Unit 1: Basic Numerical analysis**

Error Analysis; Numerical Solution of Algebric/transcendental equation; Finite Differences; Numerical Derivative; Numerical Integration; Quadratic, trapezoidal, simpson rule, Numerical solution of Differential equation; Rungekutta methods, Solving system equations; Matrix/Eigen value, Eigen functions and Basic Statistics.

**Unit 2: Computer programming**

Basic concepts of C programming (Programming basics including, data types, Tokens and keywords, Constant, Variable, array, string, pointer, decision & loop control statements) and introduction to shell scripting.

**Unit 3: Science Communications**

(a) Search for a research topic
(b) Experiments design to address a research question
(c) What is research data and how do we manage it
(d) Interpretation and representation of research data
(e) Introduction to Manuscript & Grant writing
(f) Guilty of Plagiarism
(g) Introduction to job application and preparation

**Recommended Books& references:**


**1.** Introduction to Numerical analysis, Kendal E Atlanson, WILEY INDIA.
**2.** Introductory methods of Numerical analysis, S.S. Shastry, EEE.
**3.** The C programming Language, Brian W. Kernighan and Dennis M. Ritchie.
**4.** Computer Programming in C, V Rajaraman.
**5.** Unix Shell Programming, Stephen G. Kochan and Patrick Wood, 2003
**6.** Writing in the Biological Sciences: A Comprehensive Resource for Scientific Communication 2nd Edition (2015). Angelika Hofmann (Author) ISBN-13: 978-0190245603, OXFORD Publications.
**7.** A Student's Guide to Writing in the Biological Sciences. (2005) http://isites.harvard.edu/fs/docs/icb.topic249275.files/BioSci_Writing_Guide.pdf
**8.** Successful Scientific Writing: A step-by-step guide for the biological and medical sciences. 3rd Edition. Janice R. Matthews and Robert W. Matthews

**PAPER- II & III** – Subject specific**

**(a) Molecular Modeling and Bioinformatics**

**MCPH2** **(4 credits=100 marks)**

**Unit 1: Sequence analysis**

Introduction to sequence databases, bioinformatics tools; Concepts of sequence similarity, identity and homology; Multiple sequence alignments; Sequence motifs, patterns and profiles.

**Unit 2: Fundamentals of biomolecular structures**

Introduction to protein and nucleic acid structures, structural databases, concepts of structural similarity/homology.

**Unit 3: Molecular modeling and Simulation techniques**

Homology modeling, fold recognition, threading, ab-initio structure prediction methods, Molecular Dynamics (MD) simulation concepts and application and visualization;

**Unit 4: Structure based drug design**

Chemical databases, small molecule/peptide docking concepts and applications.

**Recommended Books:**


1. **Bioinformatics: Sequence and Genome Analysis**. David W. Mount, 2004.
2. **Principles of Nucleic Acid Structure,** Martin Egli, Wolfram Saenger,1988.
3. **Introduction to protein structure**, Branden and Tooze, 1998.
4. **Protein structure and function,** Voet&Voet
5. **Molecular Modeling: Principles and Applications**, Andrew Leech,2001
6. **From Cells to Atoms: An illustrated Introduction to Molecular Biology**, Anthony R. Rees, Michael J.E. Stemberg, 1984.


**(b) Chromosome Dynamics**

**MCPH3** **(4 Credits=100 Marks)**

Organization of DNA into 3D form (nucleoid or chromosome) within a cell displays both complexity as well as elegance of biological systems. Various chemical, physical and biological forces modulate the shape, structure and dynamics of such high degree structure.In this series of lecture, our emphasis will be on understanding few facets of aforementioned phenomenon.The focus will be on tools and techniques that enable us to monitor such elegant structure and its dynamics. Also, how dynamic stage of nucleoid influences/modulates various biological and cellular processes.

**Unit-I: Advance microscopy and Imaging techniques**

a) Introduction to the Principle and application of, (i) Phase contrast Microscopy; (ii) Fluorescence Microscopy; (iii)Confocal Microscopy; (iv) Scanning & Transmission Electron Microscope (SEM); and (iv) Atomic Force Microscopy (AFM)
b) Introduction to the Principle and application of Super-Resolution Microscopy
c) Introduction to the Principle and application of time-lapse microscopy & total internal reflection fluorescence microscopy (TIRFM).

**Unit-II: Advance assay& techniques in cell biology**

a) Introduction to the Principle and application of Fluorescence *In Situ* Hybridization
b) Introduction to the Principle & application of Fluorescence receptor Operator System
c) Introduction to the Principle & application of Chromosome Conformation & Capture Assay
d) Introduction to genetic methods for genetic manipulation
e) Introduction to Fluorescence proteins.

**Unit-III: Nucleoid structure and organization:**

a) Introduction to the DNA & RNA
b) Introduction to the DNA structure & supercoiling
c) Introduction to the Nucleoid Associated Proteins
d) Overview of prokaryotic Cell-cycle
e) Introduction to Nucleoid structure and organization in bacteria
f) Introduction to Chromosome cohesion in bacteria & its regulation.

**Unit-IV: Recombination and repair**

a) Introduction to Homologous Recombination.
b) Introduction to the types of DNA damage
c) Introduction to the Homologous and non-homologous recombination mediated DNA repair
d) Introduction to the fidelity of DNA repair

**Recommended Books:**


1. **Dynamics of the Bacterial Chromosome: Structure and Function,** By Wolfgang Schumann (Prof. Dr. rer. nat), Wily Publication 2006.
2. **The Bacterial Chromosome**, N. Patrick Higgins; ASM Press, 2005.
3. Methods in Enzymology: Vol 472, **Single Molecule Tools**, **Part A: Fluorescence Based Approaches** Nils G Walter 2010 Academic Press.

4. **Fluorescence Microscopy: From Principles to Biological Applications**, edited by Ulrich Kubitscheck, Wily 2013.
5. **Genomic Stability: DNA Repair & Recombination.** James Haber. Garland Science (16 December 2013).
6. **DNA Repair, Mutagenesis, and Other Responses to DNA Damage: A Subject Collection from Cold Spring Harbor Perspectives in Biology.** Errol C. Friedberg (Editor), Stephen J. Elledge (Editor), Alan R. Lehmann (Editor), Tomas Lindahl (Editor), Marco Muzi-falconi. 2013

**(c) Virology**

**MCPH4** **(4 Credits=100 Marks)**

**Unit-I: Introduction of viruses**

(a) General properties of viruses
(b) Structure of viruses
(c) Epidemiology of viruses
(d) Virus cell culture system.

**Unit-II: Viral life cycle and pathogenesis**

(a) Interaction of viruses with cellular receptors
(b) Entry of viruses, Viral genomes (DNA and RNA) replication
(c) Viral assembly, maturation and release
(d) Mechanisms of viral infection and disease progression
(e) Study of virus-host interactions.

**Unit-III: Virus-induced host immune response and oncogenesis**

(a) Host immune responses to viral infections
(b) Viral strategies to evade host immune responses
(c) Cell transformation and characterization of transformed cells
(d) Types of oncogenic DNA and RNA viruses
(e) Detail mechanism of viral oncogenesis
(f) Tumor suppressor genes.

**Unit-IV: Diagnosis, Prevention and control of viruses**

(a) Serological and molecular diagnosis
(b) Antiviral drugs and Viral vaccines
(c) Screening of antivirals, Interferons treatment
(d) Anti-sense RNA and small interfering (siRNA).

**Recommended Books:**


**1**. Nicholas H. Acheson. 2011. **Fundamentals of Molecular Virology**. 2nd Edition, Wiley.

**2.** John Carter, Venetia Saunders. 2013. **Virology: Principles and Applications**. 2nd Edition, Wiley.

**3**. David M Knipe. 2015. **Fields Virology. 6th Ed**. Vols. I. Lippincott, Williams & Wilkins.

**4**. Hillar Kangro Brian Mahy. 1996. **Virology Methods Manual**. Academic Press. 1st Edition.

**5**. J.A. Grand. 2001. **Viruses, Cell Transformation, and Cancer**. Ist Edition, Vol 5.

**6**. E. Tabor. 2002. **Viruses and Liver cancer. Elsevier Perspectives in medical virology**, Vol 6, 1st Edition.

**7.** Isa K. Mushahwar. 2003. **Viral hepatitis molecular biology diagnosis and control**. Elsevier Perspectives in medical virology. Vol 10, 1st Edition.


**(d)Molecular Biology**

**MCPH5** **(4 Credits=100 Marks)**

**Unit-I: Introduction to Recombinant DNA Technology**

(a) Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems

(b) Expression of recombinant proteins using bacterial, animal and plant vectors. Isolation of specific nucleic acid sequences

(c) Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors.

**Unit-II: DNA sequencing methods**

(a) Strategies for genome sequencing

(b) Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array-based techniques.

**Unit-III: Gene Editing Tools**

(a) Introduction to genome editing

(b) Types of genome editing. Zinc Finger Nuclease, TALENS &CRISPR-Cas mechanism

(c) Guidelines for effective guide RNA design

(d) Finding potential guide RNA

(e) Target identification and target screening

(f) Modifications by Homologous & Non-Homologous recombination

(g) Mechanism of knock out mutagenesis

(h) Off target analysis.

**Unit-IV: Application of Genome Editing**

(a) Development of Transgenic Plants
(b) Production of Transgenic Animals
(c) Industrial Applications. Applications in Medicines
(d) Production of Antibiotics
(e) Production of Hormone Insulin
(f) Production of Vaccines. Gene Therapy
(g) Diagnosis of Disease.

**Recommended Books:**


1. **History of Genetics: Genetic Engineering Timeline**. Arnold, Paul (2009).
2. **Principles of Gene Manipulation: An Introduction to Genetic Engineering**. Old RW and Primrose SB.
3. **Genetic Engineering (Oxford Higher Education)**. Smita Rastogi and Neelam Pathak
4. **Generating mice with targeted mutations**. Capecchi, Mario R. (2001).
5. **Genetically Engineered Foods". Center for Food Safety and Applied Nutrition at the Food and Drug Administration**. Maryanski, James H. (19 October 1999).


**(e) Molecular Parasitology**

**MCPH6** **(4 Credits=100 Marks)**

**Unit-I: Fundamentals of Parasitology**

(a) General overview of parasitology, introduction to protozoan parasites
(b) Overview of life cycle of some common parasites
(c) Peculiar organelles of Protozoa: cytoskeleton, mitotic spindle, hydrogenosomes, glycosomes
(d) Genomic organization, transcription, splicing and gene regulation in parasites: Chromosomal, Extra chromosomal.

**Unit-II: Cell Biology of Parasitic Infection**

(a) General mechanism of parasitic infection
(b) Understanding pathogen survival and evasion mechanisms
(c) Approaches to understand parasite/vector cell biology.

**Unit-III: Host-Parasite Interaction**

(a) Understanding factors determining virulence of parasites
(b) Immuno-pathogenic mechanisms: innate and adaptive immune response during parasitic infection
(c) Molecular mechanisms of pathophysiology.

**Unit-IV: Recent Developments in Understanding Parasitic Diseases**

(a) Drug resistance mechanism of protozoan parasite
(b) Vaccine targets
(c) Diagnostics.

**Recommended Books:**


1. **Molecular Parasitology: Protozoan Parasites and their Molecules**. Editors: Walochnik, Julia, Duchêne, Michael (Eds.) Publisher: Springer-Verlag Wien. eBook ISBN 978-3-7091-1416-2. DOI: 10.1007/978-3-7091-1416-2. Hardcover ISBN 978-3-7091-1415-5.
2. **Molecular Medical Parasitology** Edited by J. Joseph Marr, Timothy W. Nilsen, and Richard W. Komuniecki Amsterdam: Academic Press, 2002. ISBN-0-12-473346-8.
3. **Protein Phosphorylation in Parasites Novel Targets for Antiparasitic Intervention** (eds C. Doerig, G. Späth and M. Wiese), Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany. doi: 10.1002/9783527675401.
4. **Anaerobic Parasitic Protozoa: Genomics and Molecular Biology**. Edited by: C. Graham Clark, Patricia J. Johnson and Rodney D. Adam.Caister Academic Press. ISBN: 978-1-904455-61-5.
5. **Human Parsitology. Fifth Edition**. Authors: Burton Bogitsh Clint Carter Thomas Oeltmann. eBook ISBN: 9780128137130. ISBN: 9780128137123. Imprint: Academic Press (2018).


**(f) Biophysics**

**MCPH7** **(4 Credits=100 Marks)**

**Unit-I: Thermodynamics and Statistical Physics**

(a) Particle distribution: Discrete and continuous distributions, Probability distribution functions, Statistical distributions, Partition Functions, Expectation value
(b) Laws of thermodynamics, Entropy, Free Energy and Enthalpy
(c) Equilibrium vs Non-equilibrium processes, Partition Functions, Brownian Motion, Diffusion
(d) Visco-elastic properties of membranes, micro-rheology, Reynolds number.

**Unit-II: Waves and Optics**

(a) Wave particle duality, Classical vs Quantum, Wave Function, Diffraction, K space, Resolution
(b) Fourier Transformation, Electron Density.

**Unit-III: Bonds and Interactions**

(a) Dipole-Dipole interactions in liquid
(b) Resonance Energy Transfer, Nano scale distribution through FRET
(c) Biochemical Reactions and Kinetic studies.

**Unit-IV: Macromolecular Structures and dynamics**

(a) X-ray crystallography
(b) Small/Wide Angle X-ray Scattering
(c) Pump-probe studies for macromolecular structural dynamics
(d) Allostery in macromolecules, Photobiology
(e) Monte Carlo model building.

**Recommended Books:**


1. R. Resnik, D. Halliday, J.Walker, **Fundamentals of Physics**, 2006
2. Arthur Beiser, **Concept of Modern Physics**. McGraw Hill, sixth edition, 2003
3. B. H. Bransden, C. J. Joachin, **Introduction to Quantum Mechanics**, Second
4. Edition.
5. K .M. Zeemansky, R. H. Dittmann, **Heat and Thermodynamics**, McGraw Hill,
6. 1997.
7. Frederick Reif, **Fundamentals of Statistical and Thermal Physics**, McGraw
8. Hill, 1965.
9. Donald A. McQuarrie, **Statistical Physics**, 2011.
10. Philip Nelson, **Biological Physics – Energy Information, Life**, 2007
11. P. Atkins and J. D. Paula, **Physical Chemistry**, Tenth Edition, 2014
12. B.S. Bahl, A. Bahl and G. D. Tuli, **Essentials of Physical Chemistry**,
13. S.Chand, New Delhi, 2007.
14. D. Voet and J. G. Voet, **Biochemistry, Fourth Edition**, 2010
15. T. Engel and P. J. Reid, **Physical Chemistry,** 2013
16. D. L. Nelson and M. M. Cox, Lehninger, **Principles of Biochemistry,** Seventh
17. Edition
18. Gale Rhodes, **Crystallography Made Crystal Clear**, 3rd Edition


**PAPER- IV**

**MCPH8 Annotated Bibliography (2 Credits=50 Marks)**

The main objective of this course is to introduce the students about the importance of literature survey and aid them to organize/summarize and present the same. This will be helpful to deepen their knowledge in the specific field of interest, and help them in preparation of their thesis. Students will be assigned to their respective PI for choosing a topic of interest and having critical discussions. The assessment will be based on the write up, which should be the condensed summary of literature review of a chosen topic, and an oral presentation. The sources for

annotated bibliography MUST be from peer-reviewed publications, obtained from sources like https://pubmed.ncbi.nlm.nih.gov.

**PAPER- V**

**MCPH9 Research and publication ethics (2 Credits=50 Marks)**

The main objective of this course is to create awareness among the students about publication ethics and publication misconduct.