Course work Syllabus for Ph.D. program in Watson-Crick Centre for Molecular Medicine, Islamic University of Science and Technology, Awantipora

Paper I: Research Methodology, Bioinformatics, and Biostatistics   **Credits: 04**
Course Code: WC-RMBB801   **Marks: 200**

Unit I: Research Methodology   **(30 Lectures)**
Definition and types of research (Descriptive, Analytical, Applied, Fundamental, Qualitative, Quantitative, Conceptual, and Empirical), Significance of Research, formulation of research problem, hypothesis and research objectives, Types of Research Designs, Basic Principles of Experimental Designs, Design of experiments, Literature survey, writing a research report, Synopsis, Research paper, Review article. Preparation of transcript: Special elements: title page, table of contents, headings and sub-headings, footnotes, tables and figures, appendix, bibliography (EndNote, Mendeley, Reference Manager) etc.

Unit III: Basics of Bioinformatics and Databases   **(15 Lectures)**
History of bioinformatics. Major bioinformatics resources, Nucleic Acids Research database. Protein three-dimensional databases, Protein sequence databases. Commonly used sequence formats (FASTA and Swissprot format, European Molecular Biology Laboratory data library format).
Phylogeny: Sequence alignment. Sequence comparison scoring systems: PAM and BLOSUM family of matrices, Basics of Global and local alignments, Pair-wise alignment: Dot matrix analysis. Multiple sequence alignment as an extension of sequence pair alignment by dynamic programming. Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees.

Unit IV: Biostatistics & Biostatistics Tools   **(15 Lectures)**
Biostatistics-Using statistics to summarize Data Sets (mean, mode, median; Sample Variance and Sample Standard Deviation). Testing statistical hypothesis: Hypothesis Tests and Significance Levels; Tests concerning the mean of a Normal Population: Case of known Variance; The t-Test for the mean of a Normal Population: Case of Unknown Variance. Chi-squared goodness-of fit tests. Computer application to statistical packages like SPSS & GraphPad Prism, use of computers in data analysis: MS excel and Sigma plot analysis.

Recommended Books:
1. Research Methodology: Methods and Techniques. Kothari, C. R. New Age International Publishers.
2. How to Write and Publish a Scientific Paper?; Robert A. Day, Barbara Gastel; Cambridge: Cambridge University.
3. Research Methodology, Methods, and Statistical Techniques; Santosh Gupta; NewDelhi: Deep & Deep Publications.
4. Fundamentals of Biostatistics, Rosner. Brooks/Cole, Boston, MA.
5. Introduction to the Practice of Statistics, Moore, and McCabe. Freeman and Co., New York.
6. Introduction to Mathematical Statistics, Hoel. John Wiley & Sons, Inc, New York.

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Paper II: Molecular Biology and Disease Models   Credits: 04
Course Code: WC-MBDM802   Total Marks: 200

Unit I: Introduction to Cancer   **(15 Lectures)**
Introduction and hallmarks of cancer. Etiological factors, chemical carcinogenesis, endogenous & exogenous mutagens, Microbiome (Viriome, Bacteriome) and cancer. Oncogenes and tumor suppressor genes. Molecular mechanism of oncogenes and tumor suppressor genes, with special reference to RAS, EGFR, p53, and Rb. Aberrant signaling pathways, role of extracellular vesicles, growth factors, and receptors in cancer progression. Tumor microenvironment and its components. Chemotherapy, Radiotherapy and Immunotherapy.

Unit II: Cell Culture & Preclinical Models   **(15 Lectures)**
Tissue Culture, its types, and cell-lines. Various types of cell-infections and their remedies. Biological-hoods and their classes. Aseptic techniques. Cell culturing, media selection, and cell freezing techniques. Cell counting, passaging, and methods. Two dimensional (2D) and Three-dimensional (3D) cultures. Cell substrates and support material. Tissue engineering principle and method for cancer - spheroid generation. **Mouse models**: Athymic Nude mice, NICD, Genetically Engineered Mouse Models (GEMM), and xenograft models (subcutaneous xenografts, orthotopic implants) in cancer research. Compound administration techniques. Sampling techniques: blood sampling, tissue sampling, and urine sampling. Anesthetizing the animals, aseptic surgery, and euthanasia.

Unit III. Recombinant DNA Technology   **(15 Lectures)**
Introduction to recombinant DNA technology. Restriction enzymes, their nomenclature & mode of action. Application of Type II restriction enzymes, Terminal deoxynucleotidyl transferase, Kinases, Phosphatases, DNA ligases, DNA polymerases, Reverse Transcriptase, Bacteriophage RNA polymerases, Exonuclease III, BAL-31, mung bean nuclease, and S1 nuclease in genetic engineering.
Vectors: E. coli cloning and expression vectors-lac, tac and T7 promoter-based vectors, pET-based vectors. Yeast expression vectors, Baculovirus based vectors. Mammalian Expression Vectors- SV40, Vaccinia, Retroviral promoter-based vectors, LentiVirus Vectors.

Unit IV: Tools and techniques of Recombinant DNA Technology   **(15 Lectures)**
Polymerase chain reaction (PCR), DNA polymerases and their fidelity, primer design and applications, Cloning vectors, Transformation, Screening of clones, PCR in gene recombination, deletion, addition, overlap extension, and SOEing, site directed mutagenesis. Cloning using linkers and adaptors. Real Time PCR and other PCR types.
Gene silencing techniques: Introduction to siRNA and shRNA technology, microRNA, construction of shRNA vectors, principle and application of gene silencing. CRISPR/Cas9 technology. Gene delivery by liposome and viruses.

Construction of genomic libraries: Genomic and cDNA libraries: Preparation and screening of libraries by colony hybridization and colony PCR. Maxam-Gilbert's and Sanger's methods. Uses of genomic libraries, Next Generation Sequencing, Whole genome and whole Exome sequencing, RNA-Seq analysis (SOLiD, Ilumina and pyrosequencing).

Suggested Readings:

1. Robert A. Weinberg (2013). The Biology of Cancer (2nd Edition)
2. Primrose and Twyman (2006). Principles of Gene Manipulation and Genomics. Blackwell
3. Brown (2006). Gene Cloning and DNA Analysis - An Introduction. Blackwell
4. Glick and Pasternak (2003). Molecular Biotechnology. ASM Press
5. Kracher. Molecular Biology - A Practical Approach.
6. Krenzer and Massey (2000). Recombinant DNA and Biotechnology. ASM
7. Micklos and Freyer (1990). DNA Science. CSHL
8. Primrose (2001). Molecular Biotechnology. Panima
9. Robertson et al (1997). Manipulation & Expression of Recombinant DNA. AP
10. Sambrook et al (2010). Molecular Cloning. CSHL
11. Twyman (1999). Advanced Molecular Biology. Viva

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Paper III: Publication Ethics and Compressive   **Credits: 04**
Course Code: WC-RPEC803   **Total Marks: 200**

Unit I: **Research and Publication Ethics**   **(30 Lectures)**
Philosophy and Ethics: Introduction to philosophy: definition, nature and scope, concept, branches. **Ethics:** definition, moral philosophy, nature of moral judgements and relations. **Scientific Conduct;** Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: falsification, fabrication and plagiarism, Redundant publications: duplicate and redundant publications, salami slicing, Selective reporting and misrepresentation of data. **Publication Ethics:** Publications ethics: definition, introduction and importance, Best practices/standards setting initiative and guidelines: COPE, WAME etc., Conflicts of interest, Publication misconduct: definition, concept, problems that led to unethical behavior and vice versa, types, Violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals. **Open Access Publishing:** Open access publications and initiatives, SHERP/RoMEO online resources to check publisher copyright and self-archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc. **Publication Misconduct:** Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad, Use of plagiarism software like Turnitin, Urkund and other open source software tools. **Databases:** Indexing databases, Citation databases: Web of science, Scoups, etc. **Research Metrics:** Impact Factor of journal as per journal citation report, SNIP, IPP, cite score, Metrics: h- index, g-index, i10index, and altmetrics.

Unit II: Comprehensive
In this course work, Ph.D. student will prepare a research proposal aligning with the ongoing research in the lab. The existing literature will be used as preliminary data in the grant proposal. After the submission of the grant proposal, S/he has to defend the proposal before the DRC. It will be mandatory to qualify the comprehensive for finishing the course work.

Suggested Readings:
1. Bird, A. (2006) philosophy of Science, Routledge.
2. Maclntyre, Alasdair (1967) A short story of Ethics, London.
3. P. Chaddah, (2018) Ethics in competitive Research, Do not get scooped; do not getbplagiarized, ISBN: 978-9387480865.
4. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2009) on being a scientist: guide to Responsible conduct in research: 3rd Edition, National Academics press.
5. Resnik, D.B (2011) What is ethics in research and why it is important, National Institute of Environmental Health Sciences , 1-10, retrieved from, http://niehs.nih.gov/research/resources/bioethics/whatis/index.cfm.
6. Indian National Science Academy (INSA) Ethics in Science and Education, research and government (2019) ISBN: 978-81939482-1-7, http://www.inaindia.res.in/pdf/Ethics_Books.pdf.