Centre for Genetic Diseases and Molecular Medicine

Ph.D. Course Work

Semester-I

S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				E
							A	B	C	D	
1	GDM.701	Research Methodology and Biostatistics	5			5	25	25	25	25	100
2	GDM.703	Good Laboratory Practices	5	-	-	5	25	25	25	25	100
3	GDM.704	Trends in Molecular Medicine	4	-	-	4	25	25	25	25	100
4	GDM.705	Advanced Techniques in Molecular Biology	4	-	-	4	25	25	25	25	100
5	GDM.706	Computational Tools and Molecular Modeling	4	-	-	4	25	25	25	25	100
6	GDM.707	Seminar	-	-	-	2	-	-	-	-	100
TOTAL						24					600

Course Title: Research Methodology and Biostatistics

Course Code: GDM.701

L	T	P	Credits	Marks
5	0	0	5	100

Course Objective: To teach students the basics of research, scientific writing, literature search and paper writing.

PART-A **20 Hours**

General principles of research: Meaning and importance of research, Critical thinking, Formulating hypothesis and development of research plan, Review of literature, Interpretation of results and discussion.

Technical writing: Scientific writing, Writing synopsis, Research paper, Poster preparation and Presentations and Dissertation.

PART-B **20 Hours**

General Statistics: Difference between parametric and non-parametric statistics, Univariant and multivariant analysis, Confidence interval, Errors, Levels of significance, Hypothesis testing.

Measures of central tendency and dispersal, Histograms, Probability distributions (Binomial, Poisson and Normal), Sampling distribution, Kurtosisand skewness

PART-C **25 Hours**

Comparative Statistics: Comparing means of two or more groups: Student's t-test, Paired t-test, Mann-Whitney U-test, Wilcoxon signed-rank, One-way and two-way analysis of variance (ANOVA), Critical difference (CD), Fisher's LSD (Least significant difference), Kruskal–Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks, Chi-square test

Regression and correlation: Standard errors of regression coefficients, Comparing two regression lines, Pearson Product - Moment Correlation Coefficient, Spearman Rank correlation coefficient, Power and sampling size in correlation and regression.

PART- D **25 Hours**

Fundamentals of computer: Parts of computer, Hardware, BIOS, Operating systems, Binary system, Logic gates and Boolean Algebra. Application software: Spreadsheet applications, Word-processing applications, Presentation applications, Internet browsers, Reference Management, and Image processing applications. Computer language: Basic DOS commands, AutoHotKey scripting language, HTML and basic structure of a webpage, Designing websites. World wide web: Origin and concepts, Latency and bandwidth, Searching the internet, Advanced web-search using Boolean logic, Cloud computing.

Suggested Reading

1. Gupta, S. (2008). *Research methodology and statistical techniques.* Deep & Deep Publications (P) Limited, New Delhi.

2. Kothari, C. R. (2014). *Research methodology (s).* New Age International (p) Limited. New Delhi.
3. Sahay, Vinaya and Pradumna Singh (2009). *Encyclopedia of Research Methodology in life sciences*. Anmol Publications. New delhi
4. Kauda J. (2012). *Research Methodology: A Project Guide for University Students*. Samfunds litteratur Publications.
5. Dharmapalan B. (2012). Scientific Research Methodology. Narosa Publishing House ISBN: 978-81-8487-180-7.
6. Norman, G. and Streiner, D. (2008). *Biostatistics: The Bare Essentials.*3/e (with SPSS). Decker Inc. USA.
7. Rao, P. P., S. Sundar and Richard, J. (2009). *Introduction to Biostatistics and Research Methods.* PHI learning.
8. Christensen, L. (2007). *Experimental Methodology*. Boston: Allyn & Bacon.
9.Clive Opie (2004). *Doing Educational Research- A Guide for First time Researchers.* New Delhi: Vistar Publications.
10. Fraenkel, J.R., Wallen, N.E. (2009). How to Design and Evaluate Research in Education. 7th edition, New York: McGraw Hill.
11. Kumar Ranjit (2011). *Research Methodology: A Step-by-Step Guide for Beginners Field*. Sage Publications.

Course Title: Good Laboratory Practices

Course Code: GDM.702

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective:

PART-A **10 Hours**

Introduction and Principals of Good Lab Practice: Good laboratory practices, Biosafety for human health and environment. Biosafety issues for using cloned genes in medicine, agriculture, industry, and ecoprotection. Biological warfare, Biological containment and physical containment, CDC Biosafety levels, Biosafety in Clinical laboratories and biohazard management.

PART-B **10 Hours**

Bioethics and Biosafety in Molecular Biology: Gene pollution, Biological invasion, Risk and safety assessment from genetically engineered organisms, special procedures for r-DNA based products.

PART-C **12 Hours**

Research and Medical ethics: Ethical theories, Ethical considerations during research, data manipulations, subject consent, Animal testing. Animal rights, Perspectives and methodology, Ethical issues of the human genome project**,** Code of **Ethics** in **Medical/clinical laboratories, h**ealthcare rat**i**oning, ethical issues of xenotransplantation, Ethics involved in embryonic and adult stem cell research, Ethics in Assisted Reproductive Technologies: animal and human cloning and *In-vitro* fertilization, the element of Informed Consent, Ethical issues in MTP and Euthanasia.

PART-D **10 Hours**

IPR: various forms of IP – Patents, Copyright, Industrial Designs, trade secrets, trade Secrets, geographical Indications and Plant breeder's right. Fair use, plagiarism and open access publishing. Criticism of intellectual property, determination of patentability of inventions, filing a patent application in India: timeline, procedure involved in the granting of a patent, various routes of filing patent application abroad, patent co-operation Treaty (PCT), Indigenous intellectual property, Traditional knowledge digital library (TKDL), Gene patent and Ethical issues, patenting of living organisms, Research exemptions.

Suggested reading:

1. Fleming, D. O. and Hunt, D.L. (2006). *Biological Safety: Principles and Practices*. American Society for Microbiology, USA.
2. Rockman, H. B. (2004). *Intellectual Property Law for Engineers and Scientists*. Wiley-IEEE Press, USA.
3. Shannon, T. A. (2009). *An Introduction to Bioethics*. Paulist Press, USA.
4. Vaughn, L. (2009). *Bioethics: Principles, Issues, and Cases.* Oxford University Press, UK.
5. WHO (2005). *Laboratory Biosafety Manual*. World Health Organization.

Related Weblinks:

1. http://www.absa.org/resbslinks.html
2. http://bch.cbd.int/protocol/
3. http://global.oup.com/uk/orc/law/ip/macqueen2e/resources/weblinks/
4. http://www.icgeb.org/~bsafesrv/

Course Title: Trends in Molecular Medicine

Course Code: GDM.703

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective:

PART-A **14 Hours**

Molecular basis of diseases: Human genetics relevant to molecular medicine, human genome organization and variations, single nucleotide polymorphisms, multiple gene polymorphisms, single and multi-gene diseases, gene-environment interactions in disease manifestation, genetic and physical mapping of human genome and identification of diseases gene, gene therapy and recombinant molecules in medicine and therapeutic development. Antiviral therapies, vehicles for genetic therapies, construction of knock-out and transgenic animals.

PART-B **14 Hours**

Signal transduction and its role in human diseases: Cellular and tissue microenvironment in diseases, drug resistance with convention chemotherapies, clinical trials, adjuvant therapies, monoclonal antibodies as drugs, nanobiotechnology and its applications in molecular medicine, next generation sequencing techniques.

PART-C **14 Hours**

Stem cells and regenerative medicine: Stem cells and their properties, classification of stem cells: Hematopoietic Stem Cells, mesenchymal Stem Cells, Embryonic Stem Cells, Fetal Stem Cells, adult stem cells, cancer stem cells, isolation, identification and characterization of stem cells, tissue and organ culture, tissue Engineering and transplantation techniques.

PART-D **14 Hours**

Molecular medicine therapeutics: Gene therapy and recombinant molecules in medicine and therapeutic development. Antiviral therapies, vehicles for genetic therapies, construction of knock-out and transgenic animals, Stem cell research and its application in human health, pharmacogenomics, its application and role in developing novel therapies. RNAi and human diseases, alternate splicing and human disease

Suggested reading:

1. Littwack, G. (2008). Human Biochemistry and Disease.Academic Press.

2. Trent, R. J. (2012). Molecular Medicine, Fourth Edition: Genomics to Personalized Healthcare. Academic Press.

3. Trent, R. J. (2005). Molecular Medicine: An Introductory Text.Academic Press.

4. Elles, R., Mountfield, R. (2011). Molecular Diagnosis of Genetic Diseases.Springer Publication.

5. Lanza, R., Gearhart,J. (2009). *Essential of Stem Cell Biology*. Elsevier Academic Press.

6. Lanza, R., Klimanskaya, I. (2009). *Essential Stem Cells Methods*. Academic Press.

7. Mao, J. J., Vunjak-Novakovic (2008). *Translational Approaches in Tissue Engineering & Regenerative Medicine*. Artech House INC Publications.

8. Lanza, R. (2007). *Principles of Tissue Engineering, 3rd Edition*. Academic Press.
9. Stein. (2011). *Human Stem Cell Technology and Biology: A Research Guide and Laboratory Manual*. Wiley-Blackwell.

Related Weblinks:

1. www.stemcells.wisc.edu
2. http://stemcells.nih.gov/info/scireport/Pages/2006report.aspx
3. *stemcells.nih.gov/*
4. http://instem.res.in/

Course Title: Advanced Techniques in Molecular Biology

Course Code: GDM.704

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective:

PART-A **10 Hours**

Genomics: Chromatin remodeling studies, ChIP and chromatin dynamics, *in-vitro* transcription and translation (IVT and IVTT), Southern, Northern and dot blotting, selection of DNA/ RNA probes, PCR, RT and real time PCR, ChIP on ChIP and cDNA arrays, models to study DNA damage repair and replication, EMSA, reporter assays for finding active regions in DNA, construction of cDNA and genomic libraries.

PART-B **10 Hours**

Proteomics: Protein expression systems: bacterial, yeast and mammalian, tagging of recombinant proteins with His or FLAG tags, fluorescent proteins: green, red or yellow; protein localization studies, performing import-export inhibition assays, recombinant proteins and human health.

PART-C **10 Hours**

Molecular Biology tools for interactomics: DNA-DNA, DNA-protein, RNA-DNA, RNA-Protein, protein-protein interactions and their role in signal transduction, 6-C technique, DNase protection assay, two and three hybrid systems (yeast and mammalian), Immunoprecipitation, pull down assays, FISH and confocal analysis for intracellular interactions, appropriate antibody selection for immune-assays, types and applications of ELISA, confocal and live cell imaging, flow cytometer and cell sorting.

PART-D **12 Hours**

Microscopy: Basics of microscopy, light, compound, phase contrast, dark field, fluorescent and confocal microscopy, SEM, TEM, STEM, atomic force microscopy and live cell imaging, localization studies using microscopy.

Culture techniques: mammalian cell culture, media for animal cell culture, construction of cell lines, transfection, electroporation, cell lines as *in-vitro* model for research, MTT assay, zvmography, cell cycle analysis.

Suggested readings:

1. Fasman, G.D. (1989). Practical Handbook of Biochemistry and Molecular Biology. CRC Press, Taylor and Francis Group, UK.
2. Gupta, P.K. (2005). Cell and Molecular Biology. Rastogi publications, Meerut, India.

3. James, D.W., Baker, T.A., Bell, S.P., Gann, A. (2009). Molecular Biology of the Gene. Benjamin Cummings, USA.
4. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). Lewin's Genes X. Jones & Bartlett Publishers, USA.
5. Johnson, A., Lewis, J., Raff, M. (2007). Molecular Biology of the Cell. Garland Science, USA.
6. Lodish, H., Berk, A., Chris, A.K. and Krieger, M. (2008). Molecular Cell Biology. W.H. Freeman, USA.

Course Title: Computational Tools and Molecular Modeling

Course Code: GDM.705

L	T	P	Credits	Marks
4	0	0	4	100

PART-A **15hours**

Biological databases: Nucleotide Sequence Databases, GenBank, DDBJ, EMBL, Sequence Flatfile and submission process, Protein sequence databases, UniProt in detail, Mapping databases, Genomic databases, Data mining.

Sequence analysis: Gene Prediction methods and programs, Markov and Hidden Markov models in gene prediction, Promoter analysis, RNA secondary structure thermodynamics, Dynamic programming and genetic algorithms for secondary structure prediction, refining multiple sequence alignment based on RNA secondary structure predictions, Vienna RNAfold, Evolution and origins of sequence polymorphisms, SNP discovery methods and databases, Genotyping, International haplotype map project, 1000 genomes project.

Analysis for protein sequences: Predicting features of individual residues, Predicting function, Neural networks, Protein structure prediction, Protein structure databases, PDB in detail, 3D visualization softwares, Pathway and molecular interaction databases, Prediction algorithms for pathways and Molecular Interactions, Integrating gene expression data with pathway information.

PART-B **10hours**

Inferring relationships: Global Vs. local sequence alignments, Dotplots, Scoring matrices, Pairwise sequence alignment, BLAST, Position-Specific scoring and PSI-BLAST, MegaBLAST, BL2SEQ, BLAT, FASTA Vs BLAST, Protein multiple sequence alignments, Multiple structural alignments, Shotgun sequencing, Sequence assembly and finishing.

Phylogenetic analysis: Basics of phylogenetics, Nucleotide substitution models and selection, Distance-matrix-based methods, Neighbor-Joining, Fitch-Margoliash, Outgroups, UPGMA, Minimum evolution, Maximum parsimony, Maximum likelihood, Bayesian inference, Searching for trees, Rooting trees, Bootstrapping, Likelihood ratio tests.

PART-C **15hours**

Genomics: Comparative genomics, Genomic alignments, Gene predictions in genomic alignments, Genome-wide association study, Phylogenetic footprinting, Gene annotation, Gene expression analysis using DNA Microarray, Annotation of array probes, Image processing, Normalizing expression measurements.

Proteomics: Major proteomic approaches, Protein analysis by MALDI and SELDI methods, Time of Flight MS in protein analysis, Protein Identification by Mascot, Peptide Mass fingerprinting, Comparative proteomics, protein docking site, potential interactome prediction, prediction of chemical nature of protein, UniProt, Expassy. Two-Dimensional polyacrylamide gel electrophoresis.

PART-D **16hours**

Modelling and structure: From protein sequence to structure, theoretical and practical aspects of protein sequence alignments, secondary, tertiary structure prediction, comparative modeling, Docking, protein-protein and protein-ligand docking. Techniques for 3-D structure determination like X-ray, NMR, MS/MS analysis.

Computational drug designing: Structure-based drug design, virtual screening, quantitative structure activity relations, Cheminformatics and pharmacophore mapping in therapeutic development.

Suggested reading

1. Baxevanis, A.D. and Ouellette, B.F.F. (2005). *Bioinformatics: A Practical guide to the Analysis of Genes and Proteins*. Wiley-Interscience, USA.

2. Hall, B.G. (2011). *Phylogenetic Trees Made Easy: A How-To Manual*. Sinauer Associates, Inc. USA.

3. Lesk, A.M. (2008). *Introduction to Bioinformatics*. Oxford University Press, UK.

4. Zvelebil, M. and Baum, J. (2007). *Understanding Bioinformatics*, Garland Science, New York, USA.

5. Ramsden, J. (2010). *Bioinformatics: An Introduction* (*Computational Biology*). Springer, India.

6. Ye, S.Q. (2008). *Bioinformatics: A Practical approach*. Chapman & Hall/CRC, UK.

7. Mount, D. (2012). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.

8. Graur, D., Li, W. H. (2000). *Fundamentals of Molecular Evolution*. Sinauer Associates.

9. Tisdall, J. (2001). *Beginning Perl for Bioinformatics*. O'Really Publishers.

10. Orengo, C., Jones, D., Thornton, J. (2005). *Bioinformatics: Genes, Proteins and Computers* (Advanced Texts). Taylor and Francis Publishers.

Course Name: Seminar

Course Code: 706

L	T	P	Credits	Marks
0	0	0	2	100