

**M.Phil. GENETICS AND GENOMICS
DEGREE PROGRAMME – CSS**

SYLLABUS

(w.e.f 2016 Admissions)

**DEPARTMENT OF BIOCHEMISTRY
UNIVERSITY OF KERALA**

University of Kerala
Department of Biochemistry

M.Phil Degree in Genetics and Genomics

Distribution of marks

GAG 711	Research methodology	(Credits : 4)	: 100
GAG 712	Advanced biological techniques	(Credits : 4)	: 100
GAG 713	Special Paper in Genetics and Genomics	(Credits : 4)	: 100
GAG 714	M Phil Dissertation in biochemistry	(Credits : 20)	: 250
	Viva voce		: 50
			Total : 600

(Dissertation work can be theoretical/computer based, experimental or both)

GAG 711 - Research Methodology

Credits : 4

Max Marks : 100

Module I - Foundations of Research

Definition, purpose - relevance and scope, Motivation and objectives -Research methods vs Methodology. Types of research- pure versus applied, incremental versus innovative; multidisciplinary research.

Module II - Research Process and design

Steps involved in research process; Identifying and defining research problems; Importance of literature review in defining a problem, Formulation of research objectives; Hypothesis, Research design- Meaning and need- induction - deduction. Features of good design-important concepts and different types; basic principles of experimental design.

Module III- Data Collection and analysis

Observation and Collection of data - Methods of data collection – Sampling Methods- Data Processing and Analysis strategies – Measures of central tendency, standard deviation and standard error, ANOVA, Correlation, T test, Data Analysis with Statistical Packages, Bioinformatics tools (an outline)–Generalisation and interpretation of results.

Module IV - Scientific reporting

Types of scientific reports – journal articles – Presentation at conferences- Thesis and dissertations – Books. Structure and components of scientific reports – Layout, Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication. Publication of scientific reports, Impact factor of Journals, h-index, i10-Index, g-index.

Module V –Application of results and Research ethics

Commercialization – Copyright and Copyleft – royalty - Intellectual property rights and patent law – Ethical issues - Ethics in human and animal experimentation. Guidelines for using animals in biological research- The Prevention of Cruelty to Animals Act, India. Scientific misconduct such as Fabrication, Falsification, Plagiarism and Self-Plagiarism; software for checking plagiarism. Conflicts of interests; Citation and acknowledgement - Reproducibility and accountability.

References

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. *An introduction to Research Methodology*, RBSA Publishers.
2. Kothari, C.R.,1990. *Research Methodology: Methods and Techniques*. New Age International. 418p.
3. Trochim, W.M.K.,2005. *Research Methods: the concise knowledge base*, Atomic Dog Publishing. 270p
4. Sinha, S.C. and Dhiman, A.K., 2002. *Research Methodology*, EssEss Publications. 2 volumes.
5. Wadehra, B.L. 2000. *Law relating to patents, trademarks, copyright designs and geographical indications*. Universal Law Publishing.

Additional reading

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. *Research Methods: A Process of Inquiry*, Allyn and Bacon.
2. Carlos, C.M., 2000. *Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options*. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, "*Proposal Writing*", Sage Publications.
4. Day, R.A., 1992. *How to Write and Publish a Scientific Paper*, Cambridge University Press.
5. Fink, A., 2009. *Conducting Research Literature Reviews: From the Internetto Paper*. Sage Publications
6. Leedy, P.D. and Ormrod, J.E., 2004 *Practical Research: Planning and Design*, Prentice Hall.
7. Satarkar, S.V., 2000. *Intellectual property rights and Copy right*. EssEss Publications.

GAG 712 - Advanced Biological Techniques

Credits : 4

Max Marks : 100

Module I: Techniques in Biochemistry

Centrifugation:- Principle; Types - Preparative, Analytical; Ultra centrifugation. Microscopy – Light microscopy, Bright field microscopy, phase contrast microscopy; Electron Microscopy – Transmission and Scanning electron microscopy; Confocal Microscopy; Fluorescent Microscopy; Preparation of samples for different microscopic techniques. Separation Techniques: Chromatography – Paper, TLC, HPTLC, Affinity, HPLC; Electrophoresis - Native PAGE, SDS PAGE, AGE, Blotting techniques, 2D-gel electrophoresis, Isoelectric focusing; Flow cytometry

Module II: Cell Culture

Principles of cell culture; Aseptic techniques, Sterilization, Equipment and materials, Media Preparation; Types of culture, primary culture - isolation and maintaining cells in culture, subculture; cell lines; Microbial contamination-monitoring and eradication. Cell quantitation-counting, DNA estimation, protein estimation. Estimation of cell viability by Trypan blue exclusion method and cytotoxicity by MTT assay, Cryopreservation of cells; Applications primary and cell line culture techniques

Module III : Techniques in Molecular Biology

Isolation, characterization and analysis of nucleic acids. DNA fingerprinting and PCR - Types of PCR. Primer designing. Cloning and Expression Vectors. Gene expression studies- Transformation and Transfection. Gene Library. Reporter genes in expression studies. Protein–nucleic acid interaction studies-Gel shift Assay, DNA footprinting, ChIP assay. Transgenic animals as research models- Knock out and Knock in of specific genes.

Module IV : Immunological and Histochemical Techniques

Production of antibodies; Immunoprecipitation techniques, Immunoassay – RIA, ELISA, Immunofluorescence. Histochemical Techniques – Enzyme histochemistry, Immunohistochemistry, *in situ* hybridization; staining – Basic, Acidic, Metachromasia (toluidine blue staining), Preparation of tissues – Fixation techniques, Tissue Sectioning, Smear and spread preparation; Freeze etching.

Module V: Spectrometry

Mass spectrometry – Working principle; types of ionizations, Mass analysers, Detectors; Tandem Mass spectrometry, Quadrupole and Time of Flight Mass spectrometry; MALDI-ToFIR and NMR spectrometry. {NMR, FTIR, HPLC, HPTLC, GCMS, LCMS, MSMS, Flow cytometry,

References

1. Keith Wilson and John Walker (2010) Principles And Techniques Of Biochemistry And Molecular Biology Seventh Edition Cambridge University Press, New York
2. Rajan Katoch (2011) Analytical Techniques In Biochemistry And Molecular Biology. Springer -Verlag New York
3. Rodney Boyer (2011) Biochemistry Laboratory: Modern Theory And Techniques 2nd Edition. Pearson Publishers.
4. R. Ian Freshney (2010) Culture of animal cells : A Manual of Basic Technique. Sixth edition. John Wiley & Sons
5. Avinash Upadhyay, Kakoli Upadhyay, Nirmalendu Nath(2014) Biophysical Chemistry Principles & Techniques. Himalaya Publishing House

Additional reading

1. Mather, Jennie P., Roberts, Penelope E. (1998) Introduction to Cell and Tissue Culture: Theory and Techniques. Springer publications US
2. John Masters(2000) Animal Cell Culture **3rd edition Oxford University Press**
3. Olivier Cochet, Jean-Luc Teillaud and Catherine Sautès (1998) Immunological Techniques Made Easy. Wiley publications.
4. J. Throck Watson, O. David Sparkman. (2007) Introduction to Mass Spectrometry: Instrumentation, Applications, and Strategies for Data Interpretation 4th Edition. Wiley publications.
5. Marvin McMaster. (2005) LC/MS: A Practical User's Guide. Wiley Interscience.
6. R K Sharma and S P S Sangha (2008) Basic Techniques in Biochemistry and Molecular Biology I K International Publishing House

GAG 713 -Special Paper in Genetics and Genomics

Credits : 4

Max Marks : 100

Module I : Chromosomes and Mendelism

Chromosomes; Chromosomal organization of genes; Higher order chromatin structure; chromosome abnormalities. Mendelian genetics; Dominance, segregation, independent assortment, deviation from Mendelian inheritance. Codominance, incomplete dominance, multiple alleles, Pedigree patterns; Characteristics of Mendelian pattern of inheritance.

Module II : Replication, Transcription and Translation

Replication - Prokaryote and eukaryotes; events at the replication fork; details of enzymes; protein factors – cellular control. Mechanisms of repair.

Transcription - Prokaryote and eukaryote RNA polymerases; transcription factors; post transcriptional modifications; splicing; small RNAs; regulation of gene expression.

Translation - Biosynthesis of proteins, role of RNAs in protein biosynthesis; genetic code; post translational modification; protein targeting; regulation of protein biosynthesis.

Module III : Genetic and Computational Analysis

Genetic Analysis : Physical mapping, restriction mapping; sequence tagged mapping; molecular markers for mapping; marker sequences: RFLPs, microsatellites and SNPs. Linkage analysis; Hybridization mapping, DNA microarrays, SAGE and cluster analysis; Nucleic acid sequencing methods; Human genome project.

Bioinformatic tools : Sequence and structure databases; Sequence Analysis; Scoring matrices, Pair wise sequences alignments and multiple sequence alignments (MSA); Tools for the analysis of phylogenetic trees;

Module IV : Genomics

Functional genomics : Techniques involved at DNA, RNA, Protein levels. Loss of function techniques, functional annotation of genes. Transcriptomics, Proteomics. Structural Genomics : *De novo* methods, Modeling based - *Ab initio* modeling, Sequence-based modeling, threading methods

Module V : Optional Unit (Any one from the following)

a) Bacteremia and Acute Inflammation

Bacterial endotoxins: lipopolysaccharide (LPS) and lipoteichoic acid (LTA). LPS-biochemistry and signalling mechanism. LPS mediated acute inflammatory response. Signaling pathways of LPS mediated activity. Acute inflammatory mediators – macrophage response. G-protein coupled receptors- structure and functional features. G-protein- types. Adenylate cyclase and cAMP mediated signalling. Adenosine Receptors:

Role in extracellular signaling and cytokine cascade. Common agonists and antagonists.

b) Nutrition in Health and Disease

Major nutrients- Macro and Micro nutrients. Biological value and dietary sources. Nutritional disorders – Pathogenesis, Biochemical changes and Managements. Dietary modifications for Obesity, Diabetes and Hypertension. RDA of micronutrients. Anti-nutritional factors of plant origin.

c) Phytohemagglutinins

Agglutinins, agglutination assay, Lectins: Animal and plant, Isolation, Purification and characterization of lectins, Biological properties of Lectins: Antitumor, Antibacterial, Antiviral, Antioxidant, Antilipidemic activities, Phytohemagglutinins- Sources, biological functions and applications in medical and research field.

d) Tissue Engineering and Biocomposites

Principle, definition and biomaterials used in tissue engineering, Definition for scaffolds and implants, biodegradable polymeric scaffolds, hydrogels, Bioceramics and biocomposites. Design, synthesis and applications of Biomaterials, Cell- Biomaterial Interaction; Biocompatibility. Applications of tissue engineering.

e) Nanoscience and Nanobiotechnology

Nanomaterials- Definition, Types- Carbon based, Metal based; Nanocomposites, Nano rods, Gold Nano rods; Polymeric nanocapsules, Nano-films, quantum dots; Classification based on dimension of nanomaterial; Synthesis of nanomaterial- Chemical, Physical and Green methods; Characterization methods of nanomaterials; Nanotoxicology

f) Inflammatory Diseases

Cells and organs of immune system, innate immunity, Phagocytosis, Complement system, Acute and chronic inflammatory reaction, Adaptive immunity – B cell, T cell activation, proliferation, differentiation, and effector function. Lipid mediators, Cytokines, Cell adhesion molecules, MMPS, oxidative stress, Clinically important inflammatory biomarkers, Toll like receptors, Scavenger Receptors, nuclear Factor Kappa B, JAK/STAT, IRF, MAPK, Akt, RANKL, Molecular biology of Chronic Inflammatory Diseases

g) Cancer Biology

Neoplasia, causes of cancer, properties of cancer cells, classification of cancer, oncogenes and tumor suppressor genes, tumor markers, chemical carcinogenesis, physical carcinogenesis, viral carcinogenesis, cancer stem cells, diagnosis of cancer, current cancer treatment modalities, modern approaches in the treatment of cancer.

h) Cataract Biology

Structure of eye, Lens- structure and function, Lens fibers, Composition of lens, Lens proteins, Crystallins, Types of cataract- Nuclear cataract, cortical cataract, Symptoms and causes of cataract, Oxidative stress and cataract, Calcium and cataract, Lenticular antioxidants, Diabetic cataract, Treatment of cataract- phacoemulsification, extracapsular cataract extraction, intracapsular cataract extraction, complications of cataract surgery, Experimental models of cataract studies.

i) Diabetes

Diabetes Mellitus – classification, pathophysiology, glucose homeostasis, hormonal regulation of diabetes mellitus, insulin synthesis and secretion, insulin receptors, insulin signaling pathways, glucose transporters, insulin resistance. Metabolic changes in diabetes.

Reference Books

1. Robert Lanza, Robert Langer, Joseph Vacanti (2014) Principles of Tissue Engineering 4th edition, Elsevier Publications
2. VR Gowariker, NV Viswanathan, Jayadev Sreedhar (2015) Polymer Science. 2nd Edition. New age International Publishers, New Delhi
3. Carroll, Sean B., Jennifer K. Grenier, and Scott D. Weatherbee. *From DNA to diversity: molecular genetics and the evolution of animal design*. John Wiley & Sons, 2013.
4. Alberts, Bruce, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. *Essential cell biology*. Garland Science, 2013.
5. Lewin, Benjamin, Jocelyn E. Krebs, Elliott S. Goldstein, and Stephen T. Kilpatrick. *Lewin's Genes XI*. Jones & Bartlett Publishers, 2014.
6. Devlin, Thomas M. *Textbook of biochemistry: with clinical correlations*. John Wiley & Sons, 2011.
7. Snustad, D. P., and M. J. Simmons. *Principles of genetics. 6th edition*. John Wiley & Sons, Hoboken (2012).
8. Guttman, Burton. *Genetics: The Code of Life*. The Rosen Publishing Group, 2011. *Molecular Genetics: Klug and Cummings*
9. Karp, Gerald, and Nancy L. Pruitt. *Cell and molecular biology: concepts and experiments*. J. Wiley, 2002.

Additional reading

1. David W Mount (2005) Bioinformatics: Sequence and Genome Analysis -CBS publishers; 2nd edition

2. SC Rastogi, N Mendiratta, P Rastogi (2013) *Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery* - Prentice Hall India Learning Private Limited; 4th Revised edition
3. T Pradeep. *Nano: The Essentials Understanding Nanoscience and Nanotechnology* Tata Mc Graw Hill Publishing Company limited Second Edition
4. *Introductory Nanoscience, Physical & Chemical Concepts*, MsaruKuno GS: Garland Science, Taylor & Francis group
5. Sandra J Rosenthal, David W Wright *Nanotechnology Protocols*, Second edition, Springer Protocols.
6. Bamji, Mahtab S., Kamala Krishnaswamy, and G. N. V. Brahmam. (2009) *Textbook of human nutrition*. Oxford & IBH.
7. Bishop, Michael L., Edward P. Fody, and Larry E. Schoeff, eds. 2013. *Clinical Chemistry: Principles, Techniques, and Correlations*. Lippincott Williams & Wilkins,
8. Swaminathan, M. S. 1987. *Food science, chemistry and experimental foods*. Bangalore Print. & Publishing Company
9. Sreeram Ramakrishna, Kazutoshi Fujihara, wee Eong Teo, Teik cheng Lim, Zuwei ma (2005) *An introduction to Electrospinning and Nanofibres*, World Scientific, Singapore
10. A. Pusztai (2012) *Chemistry and Pharmacology of Natural Products*, Cambridge University Press
11. Harsh Mohan, *Textbook of Pathology*, seventh edition. Jaypee Brothers Medical Publishers.
12. Harding J. *Cataract: Biochemistry, Epidemiology and Pharmacology*, Chapman - Hall, London, 1991, pp-83-124.