RAJIV GANDHI CENTRE FOR BIOTECHNOLOGY
Syllabus for PhD Course work (2021)

Ph.D. Program Course work

Total Number of Credits required: 16

Compulsory Courses - 12 Credits

This course has different modules comprising of lectures, demonstrations, hands on training, seminars and workshops. All modules of this course are mandatory for all students. As part of this course the students are also expected to attend all events organized by the institution such as invited talks, PhD open defense, seminars and workshops. RGCB faculty, external faculty and senior PhD students will handle classes.

RGC 431: Research Methodology (2 Credits)
RGC 430: Biostatistics and Data Analysis (2 Credits)
RGC 432: Scientific Communication (Research and Publication Ethics, 2 Credits)
RGC 601: Biochemical and Biophysical techniques (4 Credits)
RGC 602: Seminar Presentations- 2 Seminars (2 Credit)

Optional Courses -4 Credits

The students are expected to select any two courses (RCB 701- RCB 711) for a total of 4 credits related to their area of research in consultation with their mentor

RGC 701: Infection Biology (2C)
RGC 702: Pathophysiology and disease biology (2C)
RGC 703: Applied Neurobiology (2C)
RGC 704: Reproductive Biology (2C)
RGC 705: Advanced Immunology (2 C)
RGC 706: Advances in Plant Biotechnology (2C)
RGC 707: Advances in Molecular Genetics (2 C)
RGC 708: Stem Cell Biology and Regenerative Medicine (2C)
RGC 709: Cardiovascular system disorders and Diabetes (2C)
RGC 710: Advances in Chemical Biology (2C)
RGC 711: Advances in Cancer Biology (2C)
RGC 712: Certification courses (Animal Handling and Safe use of radioactivity) (10 Lectures, No credits)

RGC 431: Research Methodology- 2Credits (30hrs)
(Course Coordinator: Dr. Devasena Anantharaman)

Course core Faculty: Dr. Aparna Shankar, Dr. Mahesh Krishna, Dr. Rajeswari G, Dr. Lekshmy Srinivas, Dr. KB Harikumar, Dr. Saji George

This course is designed to enable the student to understand the basic principles and practices of common methods used for research in Life Science & Biotechnology. The course deals with contemporary research methodologies, experimental design, data analysis and presentation.

Name of the course	**Name of Faculty**	**Teaching Hours**
Unit I**:** Research Methodology- An Introduction, Research Design, Formulating the Research Topic/Question, Defining the Research Topic/Question, Approaches and Methodology for Research, Formulation of Hypothesis, Research Design, Hypothesis as a framework for scientific projects, Experimental design, taking measurements, Data Analysis, sampling, statistical tests with excel, handling data, hypothesis testing, Documentation and presentation of data, Analysis and interpretation of data, Elements / Types of Analysis.	Dr. Aparna Shankar/Dr. Mahesh Krishna	8hrs
Writing of manuscript, Research Paper, Research Project, Thesis, Book chapter, Reviews,		5hrs
Criteria of Good Research. Laboratory behavior, Biosafety and IT usage policy, Regulatory issues in Biotechnology		3hrs
Unit II: Literature Search, Use of Databases and Experimental Design Databases for literature search, Bibliometrics, Citation, Impact factor,	Dr. Rajeswari G/Dr. Lekshmy Srinivas	3hrs
Unit III: Good Laboratory Practices Responsibilities of a researcher, handling and storage of biological material, laboratory waste disposal.	Dr. KB Harikumar	3hrs
Management of personnel, facilities, buildings and equipment.		2hrs
Unit IV: Bio-entrepreneurship and IP management in Biotechnology Bio-entrepreneurship, Funding options.	Dr. Saji George	3hrs
Introduction to Intellectual Property Rights, Types of IP, Patent search, IP management, Technology transfer.	Dr. KB Harikumar	3hrs
Total Hours		**30hrs**

Suggested reading:

1. Katz, M. J. (2009). From research to manuscript: a guide to scientific writing. Springer Science & Business

Media.
2. Holmes, D. , Moody, P., Dine, D. and Trueman, L. (2016). Research Methods for the Biosciences. Oxford University Press.
3. Glass, D.J. (2014). Experimental Design for Biologists, Cold Spring Harbor Laboratory.
4. Ruxton, G.D. and Colegrave, N. (2016). Experimental design for the Life Sciences 4th Edition Oxford University Press.
5. https://www.who.int/tdr/publications/documents/glp-trainer.pdf
6. http://www.w3.org/IPR/http://www.wipo.int/portal/index.html
7. http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
8. http://www.cbd.int/biosafety/background.shtml
9. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

RGC 430: Biostatistics and Data Analysis (2 Credits)
(Course Coordinator: Dr. Shijulal Nelson Sathi)

Course core Faculty: Dr. Shijulal Nelson Sathi Dr. Jamshed Ali, Mr. K Sivakumar, Dr. Jissa VT (SCTIMST)

This module will introduce Biostatistics and Bioinformatics methods, and software's used for analysis of biological data. The students will also analyze example data sets using different tools and learn to interpret the outputs.

Name of the course	Name of Faculty	Teaching Hours
Unit 1: Scope of Statistics in Biological Research Applications of statistics in biology, definitions (populations, samples), Basic concepts, type of data, various data collection methods, Diagrams and graphs; Measures of averages and location; Measures of dispersion; Probability and probability theory, Use of statistical packages on biological data.	Dr. Ramesh Nair (Rubber Board, Kottayam)	3 hrs
Unit II: Types of Data Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Population Vs Sample, Discrete Vs Continuous, Levels of Measurement, Types of sampling.	Dr. Ramesh Nair (Rubber Board, Kottayam)	3 hrs
Unit III: Statistical Methods Descriptive: Graphical representation on various type of data, Use of each measure of location; Measures of spread: Variance and Standard Deviation, Standard Error, Level of significance, Chi square, t and F-tests, ANOVA, Correlation and Regression, Skewness, Kurtosis; Quantiles, Outliers; Inferential: Framing hypothesis, Hypotheticodeductive method, Definition & Concept of types of hypothesis, types of errors, Power, Level; Storing Data in public repositories, Statistical Hypothesis; Null and Alternative Hypothesis, Testing of Hypothesis. Data Analysis with Statistical Packages: R, R Bioconductor packages for Biostatistics Quantification and statistical analysis of qPCR data, Western blots, Microscope images. Software's used for analysis of scientific data-SAS, Medcalc, Sigmaplot, etc.	Dr. Ramesh Nair (Rubber Board, Kottayam)	4 hrs
Unit IV: Introduction to biological databases Bioinformatics Resources: NCBI, EBI, ExPASy, RCSB, DDBJ: The knowledge of databases and bioinformatics tools available at these resources. Sequence databases: Nucleic acid sequence databases: GenBank, EMBL, DDBJ; Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL, UniParc; Structure Databases: PDB, NDB, PubChem, ChemBank Protein and nucleic acid properties: Various tools at the ExPASy server, GCG utilities and EMBOSS, Computation of various parameters.	Dr.Shijulal Nelson-Sathi	5hrs
Unit V: Fundamentals of sequence analysis Sequence Analysis: Basic concepts of sequence	Dr. Jamshaid Ali	5 hrs

similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues; Scoring matrices: basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, matrix derivation methods and principles. Sequence alignment: Measurement of sequence similarity; Similarity and homology. Pairwise sequence alignment: Basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties, use of pairwise alignments for analysis of Nucleic acid and protein sequences and interpretation of results.		
Unit VI**:** Next Generation Sequencing Data Analysis Introduction to Microarrays and RNA-Seq: Data acquisition & Analysis. Data analysis using TopHat and Cuffflinks, Functional annotation of Rna-seq data.	Dr. Shijulal Nelson-Sathi	5hrs
Unit VII: Structural Bioinformatics Introduction to Protein analysis & prediction; Basics of Protein Structure Prediction (Homology Modeling, Fold Recognition, Ab-Initio Prediction); Fundamentals of molecular docking, MD simulations using gromacs; Proteomic resources;	Dr. KC Sivakumar	5hrs
Total Hours		30h

Unit 1-III – Theory and exercises
Unit IV-VII – Theory and Practicals (2hr lecture & 2 hr practical)

Suggested reading:

1. J Pevsner (2015) Bioinformatics and Functional Genomics 3rd Edition, Wiley-Blackwell.
2. Arthur Lesk (2019) Introduction to Bioinformatics (5th Edition), OUP.
3. Mann, P. S. (2007). Introductory statistics. John Wiley & Sons.
4. Rice, J. A. (2006). Mathematical statistics and data analysis. Cengage Learning.Campbell, A. M., & Heyer, L. J. (2003). Discovering genomics, proteomics, and bioinformatics (No. QH447 C35 2007). San Francisco: Benjamin Cummings.

RGC 432: Scientific Communication (Research and Publication Ethics, 2 Credits)
(Course Coordinator: Dr. Kartika Rajeeve)

Course core Faculty: Dr. John B Johnson, Dr. Karthik Subramanian, Dr. Mahendran KR, Dr. Shijulal Nelson Sathi, Dr. Tessy Thomas, Dr. Ani V Das, Dr. Ananda Mukherjee, Dr. Radhika Nair, Dr. Ram Mohan Ram Kumar

The aim of this module is to train and make the students aware of scientific writing and ethical procedures used in scientific research.

Name of the course	**Name of Faculty**	**Teaching Hours**
Unit I: Scientific Communication: • Maintenance of laboratory notebooks, Grant/Fellowship/Report writing, • Manuscript Writing, Preparing for seminar presentations.	Dr. Karthik S Dr. Radhika Nair	3 hrs
Unit II: PHILPHY AND ETHICS • Introduction to philosophy: definition, nature and scope, concept, branches • Ethics: definition, moral philosophy, nature of moral judgments and reactions	Dr. Ananda Mukherjee	3hrs
Unit III: SCIENTIFIC CONDUCT Ethics with respect to science and research • Intellectual honesty and research integrity • Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP) • Redundant publications: duplicate and overlapping publications, salami slicing • Selective reporting and misrepresentation of data	Dr. Ani V Das Dr. John B johnson	3hrs 2hrs
Unit IV: PUBLICATION ETHICS • Publication ethics: definition, introduction and importance • Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. • Conflicts of interest • Publication misconduct: definition, concept, problems that lead 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	Dr. Tessy Thomas	4 hrs
Unit V: OPEN ACCESS PUBLISHING • Open access publications and initiatives	Dr. Karthika Rajeeve	3hrs

• SHERPA/ROMEO online resource to check publisher copyright & self-archiving policies • Software tool to identify predatory publications developed by SPPU • Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer, Journal Suggester, etc.		
Unit VI: Institutional committees for ethical research: • Research using animals, Institutional Animal ethics committee (IAEC) • Research with Human Subjects, Institutional ethics committee (IEC) • Research with Stem Cells, Institutional committee for stem cell research (IC-SCR) • Patents and Intellectual property rights • GLP and Guidelines for Biosafety, Institutional Biosafety committee	 Dr. Archana Dr. Devasena Dr. Jackson James Dr. Harikumar	 1h 1h 1h 1h
Unit VII: PUBLICATION MISCONDUCT A. 1. Subject specific ethical issues, FFP, authorship 2. Conflicts of interest 3. Complaints and appeals: examples and fraud from India and abroad B. Software tools (2hrs) Use of plagiarism software like Turnitin, Urkund and other open-source software tools	Dr. Ram Mohan Ram Kumar	3hrs
Unit VIII: DATABASES AND RESEARCH METRICS A. Databases (2hrs) 1. Indexing databases 2. Citation databases: Web of Science, Scopus, etc. B. Research Metrics (1 hrs.) 1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score 2. Metrics: h-index, g index, i10 index, altmetrics	Dr. Shijulal Nelson	3hrs
Unit IX: Grant writing	Dr. Mahendran	2hrs
Total Hours		30h

Suggested reading:

Fundamental Principles of Writing a Successful Grant Proposal. Chung *et al,* 2008

1. Grant writing 101, Jason et al, 2013
2. The development of open access journal publishing from 1993 to 2009., Laakso et al 2011.
3. Publication ethics., Sabyasatchi et al., 2017
4. An author's guide to publication ethics: a review of emerging standards in biomedical journals. Jason Roberts., 2009.

RGC 601: Biochemical and Biophysical techniques- (4C)
(Course Coordinator: Dr. TR Santhoshkumar)

Course core Faculty: Prof. Chandrabhas Narayana, Dr. Asha Nair, Dr. S Manjula, Dr. Ani V Das, Dr. Ananthalakshmi, Dr. Jackson James, Dr. Manoj, Dr. Shantanu, Dr. Radhakrishnan Nair, Dr. Harikrishnan, Dr. T.R Santhoshkumar, Dr. GS Vinodkumar, Dr. Abdul Jaleel, Dr. Tessy Thomas, Dr. Suparna Sengupta, Dr. Mahendran

The aim of this module is to familiarize the students to the latest techniques used in modern biology. The module will also include application level demonstrations in using the advanced equipment's. The students are also expected to undertake practical training in their respective laboratories.

Name of the course	Name of Faculty	Teaching Hours
Unit I: (15h + Demo): Cell biology and Genomics		
Cell biology, General Approaches in cell cycle and cell death	Dr. Asha Nair	**1h**
Molecular biology, genetic engineering techniques	Dr. S Manjula	**2h**
Cell culture- Culture and maintenance of cell lines, Primary cell culture	Dr. Ani V Das	**2h**
Primary Cell culture methods in Cardiovascular research	Dr. Ananthalakshmi	**1h**
Transgenics and KOs	Dr. Jackson James	**2h**
Real Time PCR and droplet digital PCR (Lecture + demo - 2 hrs) Microarray applications (1 hr), Microarray demo-(1hr) Sanger sequencing & genotyping (1hr)	Dr. Manoj	**5h**
Next generation sequencing, various platforms and applications, Ilumina, Nanopore, etc	Dr. Shantanu	**2h**
Introduction to Molecular Diagnostics, Diverse Diagnostic platforms and applications	Dr. Radhakrishnan Nair	**2h**
Metagenomics: Introduction to metagenomics, Standard conventional steps in metagenomic analysis (Isolation of metagenomic DNA, Generation of metagenomic libraries, Functional screening of libraries), Benefits of metagenomics in various fields	Dr. Harikrishnan	**2h**
Unit II: Microscopy and applications (15 h + Demo)		
Microscopy: History , Light Microscopy	Dr. T.R Santhoshkumar	**12h**

Techniques , Compound Microscopes, Dark Field, Phase contract and DIC Techniques (2h) Fluorescence Microscopy: Techniques and Applications (2 h), Confocal microscopy (2h), Atomic force microscopy (1 h) Live cell imaging approaches (1h), FACS Application and techniques (2) FRET , FRAP , FLIM (2h). Electron Microscopes: Histology and histochemistry: Fixation and sectioning of tissue, embryos and cells. Immunohistochemistry, immunofluorescence, histochemical staining for characterization of cell types.	Dr. GS Vinodkumar Dr. Jackson James	**1h** **2h**
Unit III: Proteomics (15 h + Demo) 1. Introduction to mass spectrometry: History, principles, types of ionizations, components of mass spectrometer, mass spectrum, mass resolution & accuracy, types of mass spectrometers and uses. 2. Proteomics: History, two dimensional gel electrophoresis, protein identification by peptide mass fingerprinting and by MS/MS sequencing, databases and search engines in proteomics and applications of proteomics. 3. Post translational modifications and its determination by MS 4. Quantitative proteomics: Principles, ICAT, ITRAQ, SILAC & TMT, Proteolytic 18O labeling and label-free quantification. 5. Absolute quantification by MS: Types of fragmentation, selective reaction monitoring (SRM) and multiple reaction monitoring (MRM). 6. Understanding the mechanism of pathogenesis & biomarker discovery 7. Protein Microarray & 8. Metabolomics 9. Techniques used for purification and characterization of biomolecules: Centrifugation, Ultrafiltration, Chromatography, electrophoresis	Dr. Abdul Jaleel & Dr. Tessy Thomas Dr. Suparna Sengupta & Dr. GS Vinod Kumar	**12h** **3h**

Unit IV: (15 h) : Spectroscopy		
Overview of spectroscopy, Electromagenitic and quantum theory of radiation, Wave particle duality, Photons, Interaction of light with matter, Transition dipole moment, Jablonsky diagram, Beer-Lamberts law, IR & Raman Spectroscopy and its application in biology	Prof. Chandrabhas Narayana	**4h**
UV-visible absorption spectroscopy, application of UV-visible for estimation of protein. DNA and RNA, enzyme kinetics: protein-ligand interaction	Dr. Suparna Sengupta	**2h**
Fluorescence spectroscopy of Biomolecules: quantum yield, static and dynamic quenching of fluorescence, energy transfer, polarization, anisotropy, time resolved fluorescence, application to biomolecule structure and dynamics	Dr. Suparna Sengupta	**3h**
Circular dichroism spectroscopy and its application for studying the secondary and tertiary structure of proteins	Dr.GS Vinod Kumar	**1h**
Surface Plasmon spectroscopy, Electron Microscopy, and Cryo-EM of Biomolecules	Dr. Mahendran	**5h**
Total Hours		**60h**

References

An Introduction to Microscopy, By Suzanne Bell, Keith Morris, CRC Press

Fournier, M. (1996). The fabric of life: Microscopy in the seventeenth century. Johns Hopkins University Press.

Tortora, G.J et al. 2010. Microbiology- An introduction, Pearson Benjamin Cummings, 10th ed.

Maier, R.M et al . 2006. Environmental microbiology. Elsevier – India

Frans J. de Bruijin. 2011. Molecular Microbial Ecology 2-metagenomics in different habitats,, Wiley-Blackw

RGC 602: Seminar Presentations- 2 Seminars (2 Credit)
(Course Coordinator: Dr. Mahendran KR)

This course will consist of 2 Seminars and will carry 2 credits. A panel of faculties will evaluate the presentation of each student.

Evaluation Panel:
1) Dr. Mahendran KR- Chemical Biology
2) Dr. Shijulal Nelson Sathi-Computational biology
3) Dr. Radhika Nair- Cancer Biology
4) Dr. Saraswati Nayar- Plant disease and biotechnology
5) Dr. Karthik Subramanian-Pathogen Biology
6) Dr. Ananthalakshmy Sundararaman- Cardiovascular Diseases & Diabetes Biology
7) Dr. Ram Mohan Ram Kumar- Cancer Biology

Optional Courses -4 Credits

The students are expected to select any two courses (RCB 701-RCB 711) for a total of 4 credits related to their area of research in consultation with their mentor

RGC 701: Infection Biology (2C)
RGC 702: Pathophysiology and disease biology (2C)
RGC 703: Applied Neurobiology (2C)
RGC 704: Reproductive Biology (2C)
RGC 705: Advanced Immunology (2 C)
RGC 706: Advances in Plant Biotechnology (2C)
RGC 707: Advances in Molecular Genetics (2 C)
RGC 708: Stem Cell Biology and Regenerative Medicine (2C)
RGC 709: Cardiovascular system disorders and Diabetes (2C)
RGC 710: Advances in Chemical Biology (2C)
RGC 711: Advances in Cancer Biology (2C)
RGC 712: Certification courses (Animal Handling and Safe use of radioactivity) (10 Lectures, No credits)

RGC 701: Infection Biology- 2 Credits
(Course Coordinator: Dr. E. Sreekumar)

Course core Faculty: Dr. Sabu Thomas, Dr. John B Johnson, Dr. Karthika Rajeeve, Dr. Karthik Subramanian, Dr. Iype Joseph, Dr. Sara Jones, Dr. Krishna Kurthkoti, Dr. Santanu Chattopadhyay)

	Topics	Instructor	No. of hrs
Microbiology -Introduction	• Microorganisms and Humans: A Dynamic Relationship	Dr. Krishna Kurthkoti	1 h
	• Recognition of the infectious agents by human body	Dr.Santanu Chattopadhya	1 h
Virology	• Classification of viruses • Virus structure and virus replication • Isolation, detection and characterization of viruses • Emerging viruses, viral diagnosis • Identification of vectors associated with viral diseases	Dr. E. Sreekumar	6 h
	• Epidemiology of viral diseases	Dr. John B. Johnson	2 h
	• Viral immunology • Antivirals, viral vaccines	Dr.Sara Jones	3h
Bacteriology	• Classification of bacteria	Dr. Karthik	1h
	• Structure, growth and control of growth • Bacterial genetics	Dr. Karthika Rajeeve	3h
	• Virulence factors	Dr.Santanu Chattopadhya	2h
	• Bacterial Diseases in Humans • Bacterial Biofilms	Dr.Sabu Thomas	3h
	• Drugs, drug resistance	Dr. Krishna Kurthkoti	1h
Human Microbiome	• What are microbiome, virome and mycobiome? • Methods of studying microbiome, virome and • mycobiome. • Significance of microbiome, • virome and mycobiome in human health and diseases.	Dr.Santanu Chattopadhyay	3h
Neglected Tropical Diseases -	• Overview of diseases in the WHO list. • Brief clinical aspects.	Dr.Iype Joseph	4 h

WHO	• Global Epidemiology • Setting of priorities • Strategies adopted • Research priorities from a population perspective • International cooperation on NTD management.		
	Total Duration		**30 hrs**

Suggested Reading:

1. Prescott Microbiology
2. Biology of Microorganisms-Brock
3. Principles of Virology by Vincent R. Racaniello , Glenn F. Rall , Anna Marie Skalka, S. Jane Flint , Lynn W. Enquist
4. Fields Virology by David M. Knipe and Peter Howley | 25 June 2013
5. Medical Microbiology: Murray, Rosenthal and Pfaller

6. The Gut Microbiome in Health and Disease; **Editors: Haller, Dirk 2018**

7. Ending the neglect to attain the Sustainable Development Goals: a road map for neglected tropical diseases 2021–2030. World Health Organization, 2020

RGC 702: Pathophysiology and disease biology – 2 Credits, 30 hrs.

(Course Coordinator: Dr. KB Harikumar)

Course core Faculty: Dr Radhakrishnan R Nair, Dr KB Harikumar, Dr VV Asha, Dr Ananda Mukherjee, Dr. Arya Aravind

Name of the course	**Name of Faculty**	**Teaching Hours**
Unit I: Introductory pathology and disease markers Definition of Pathology, describe the major divisions of pathology, application in health, disease, and medicine research Biomarkers in disease biology	To be decided Dr Radhakrishnan R Nair, RGCB	2 hrs 2hrs
Unit II: Altered cellular and tissue biology Mechanisms, manifestations and morphology of cellular injury, general mechanisms of cell injury, hypoxic injury, free radicals and reactive oxygen species - oxidative stress, chemical injury, unintentional and intentional injuries and infectious injuries. Chronic cell injury and cell adaptations and types of cell death	To be decided Dr KB Harikumar, RGCB	2 hrs 2 hrs
Unit: III Cellular ageing Genetic basis of ageing, senescence, structural and biochemical changes associated with cellular aging, pathological ageing	To be decided	2 hrs

Unit IV: Inflammation and human defense mechanisms		
First Line of defense: Innate resistance, Physical, mechanical, and biochemical barriers and protective role of normal flora	Dr VV Asha, RGCB	1 hr
Second line of Defense: Inflammation Plasma Protein Systems and Inflammation, Cellular Components of Inflammation, Acute and Chronic Inflammation, Local and systemic Manifestations of Acute Inflammation and mechanisms to resolve acute inflammation.	Dr VV Asha, RGCB	2 hrs
Chronic Inflammation, mechanism, major cellular pathways involved, and major diseases arising due to chronic inflammation	Dr KB Harikumar, RGCB	2 hrs
Systemic lupus erythematous	Dr KB Harikumar, RGCB	1 hr
Inflammation and cancer	Dr KB Harikumar, RGCB	1 hr
Inflammatory lung diseases	Dr KB Harikumar, RGCB	1 hr
The in vitro, ex vivo and in vivo approaches to study inflammation	Dr KB Harikumar, RGCB	1 hr
Unit V: Inflammation, tissue repair and wound healing Proliferation and new tissue formation, phase, remodeling and maturation, dysfunctional wound healing, tissue repair mechanisms	Dr. Arya Aravind	2 hrs
Unit VI: Immunodeficiency disorders Primary (congenital) immune deficiencies, secondary (acquired) immune deficiencies, evaluation, and care of those with immune deficiency, replacement therapies for immune deficiencies, Acquired Immunodeficiency Syndrome (AIDS)	Dr. Iype Joseph	3 hrs
Unit VII: Genes and genetic diseases		
Chromosomes, DNA, RNA, and Proteins: heredity at the molecular level: definitions, from genes to proteins, chromosome aberrations and associated diseases	Dr Ananda Mukherjee, RGCB	2 hrs
Genetic diseases: Autosomal dominant inheritance, autosomal recessive inheritance, X-linked inheritance, evaluation of pedigrees	Dr Moinak Banerjee, RGCB	2 hrs
The human genome project and future prospects	Group discussion	1 hr
Inflammasomes and diseases	Group discussion	1 hr
Total Hours		**30h**

References/suggested materials for references

1. Robbins & Cotran Pathologic Basis of Disease, 10th Edition, Elsevier.Inc.
2. “Free Radicals in Biology and Medicine” By Barry Halliwell and John M. C. Gutteridge, Oxford university press.
3. Harrison's Principles of Internal Medicine, McGraw Hill publications.
4. Human Genetics: Concepts and Application - 12th edition by Ricki Lewis, McGraw-Hill Publishing Company

RGC 703: Applied Neurobiology -2 Credits
(Course Coordinator: Dr.Moinak Banerjee)

Course core Faculty: Dr. R. V. Omkumar, Dr. Jackson James, Dr. Ani V Das, Dr. Rashmi Mishra, External faculty

Name of the course	**Name of Faculty**	**Teaching Hours**
Unit I: The Nervous System a. Introduction to the structure and function of the b. nervous system c. Anatomy of Central nervous system d. Anatomy of peripheral nervous system e. Comparative Neuroanatomy	External Faculty	**4h**
Unit II: Cellular and molecular biology of the neuron a. Neuron- structure and types of neurons b. Synthesis and trafficking of neuronal proteins c. Ion channels d. Membrane potential	Dr. RV Omkumar Dr. Rashmi Mishra	3h
Unit III: Signaling in the Nervous system a. Local signalling: Passive electrical properties of the neuron b. Propagated signalling: The action potential c. Synapse d. Neurotransmitters e. Modulation of synaptic transmission – Synaptic Plasticity f. Synaptic plasticity as a cellular model of learning and memory	Dr. RV Omkumar External Faculty	3h
Unit IV: Developmental Neurobiology *(Focus will be towards understanding neural development in terms of its relevance to facilitating regeneration and recovery of* function *following disease).* a. Basic principles of developmental neurobiology b. Neural induction, regional specification c. Neural stem cell biology d. Differentiation: neurogenesis, gliogenesis, e. Neural migration, axon growth and guidance f. Synaptogenesis and plasticity	Dr. Jackson James	**2h**
Unit V: Neurobiology of Vision a. Anatomy of retina b. Physiology of vision c. Development of retina and visual centres d. Progenitors in retina: Fate specific differentiation e. Guidance of axons to visual targets f. Retinal regeneration: Transplantation techniques, activation of endogenous progenitors	Dr.Ani V Das	2h
Unit VI: Techniques in Neurobiology with demonstration a. Neuron culture b. Slice culturing c. *In Utero* electroporation d. Electrophysiological recording e. EEG recording f. Behavioral techniques g. MRI and CT scanning h. Stereotaxic surgical techniques i. Vertebrate animal models as discovery tools to investigate the fundamental principles of mammalian	Dr. Jackson James, Dr. RV Omkumar External faculty	10h

brain development.		
Unit VII: Neurobiology of disease *(Pathophysiology and genetics)* a. Pathophysiological Mechanisms 1. Oxidative stress 2. Excitotoxicity 3. Imbalance between excitation and inhibition 4. Protein misfolding and neurodegeneration b. Developmental anomalies c. Genetic basis of neurological diseases 1. Aneurism 2. Autism 3. Schizophrenia 4. Epilepsy 5. Glaucoma	Dr. RV Omkumar Dr.Moinak Banerjee Dr. Jackson James Dr.Rashmi Mishra	3h
Unit VIII: Systems and Cognitive Neuroscience a. Systems Neuroscience - Importance of Neural circuits in CNS functions b. Cognitive functions and mechanisms c. Computational Neuroscience	Dr. Moinak Banerjee External faculty	3h
Total Hours		**30h**

Suggested Reading:

RGC 704: Advances in Reproductive Biology – *2 Credits (30 hrs)*
(Course Coordinator: Dr. Malini Laloraya*)*

Course Core Faculty : Dr. Pradeep Kumar G, RGCB, Dr. Malini Laloraya, Scientist G, RGCB, Dr. Deepak N. Modi, Scientist F, NIRRH, Dr. Debasree Dutta, RGCB, Dr. Karthika Rajeeve, RGCB, Dr. Ananda Mukherjee, RGCB, Dr. Renjini AP, Pool Scientist, RGCB

This course will address the biological mechanisms underlying reproduction and how the normal biological processes are disrupted to cause reproductive health issues. A range of specific disorders of reproduction (contraception, infertility, maternal health) will be discussed. Attention will be given to the recent advances in understanding of disease at a molecular level and how they translate to become a clinical disorder.

Name of the course	Name of Faculty	Teaching Hours
Unit I: Mammalian Reproduction Overview • Male and female reproductive systems – An introduction • Development of male and female reproductive system I (Gonads, genital ducts, glands, external genitalia, descent of testis& ovaries) • Sex determination • Disorders of sex development	Dr. Deepak N. Modi, Scientist F, NIRRH	2hrs
Unit II: Spermatogenesis and Fertilization • Gametogenesis: Conversion of germ cells into male gametes • Germ-line stem cells • Spermatogenesis • Endocrine Control of Spermatogenesis. • Acquisition of fertilizing ability - Capacitation and Acrosome Reaction • Fertilization • Epigenetics of reproduction. Male Infertility – Classification, diagnosis and management	Dr. Pradeep Kumar G, RGCB	3hrs
Invited talks by: ○ Professor *Gerald Schatten* is Director of the Pittsburgh Development Center, Professor of Obstetrics, Gynecology and Reproductive Sciences, Cell Biology, Bioengineering and Director of the Division of Developmental and Regenerative Medicine**. (Title to be decided)**	Prof. Gerald Schatten, Director of the Pittsburgh Development Center.	1 hr
○ PRABHAKARA P. REDDI, Associate Professor, Department of Comparative Biosciences, College of Veterinary Medicin, University of Illinois, Urbana, Illinois 61802, USA on Transcriptional Regulation of Spermatogenesis	PRABHAKARA P. REDDI, Associate Professor, Department of Comparative Biosciences, College of Veterinary Medicin, University of Illinois	1 hr

Unit III: Oogenesis and Embryo development Gametogenesis: Conversion of germ cells into female gametes and Oogenesis • Ovulation (ovarian cycle, menstrual cycle) • Endocrine Control of Ovulation • Menstrual disorders – Precocious, delayed or absent puberty; • Amenorrhea Fertility disorders – o POF, PCOS • Embryonic development and Organogenesis– o Early embryo development , embryo arrest, embryonic stem cells embryo gastrulation and organogenesis;	Dr. Renjini AP, Pool Scientist, RGCB Dr. Malini Laloraya Dr. Debasree Dutta	2 hrs 3 hrs 2 hrs
Unit IV :(Pregnancy and Female Reproductive Disorders) – • *Mechanism of Embryo Implantation,* o Hormonal control and Embryo activation o Uterine reprogramming and decidualization o Immune regulation of pregnancy. o Early pregnancy loss (RIF, Habitual abortion, recurrent miscarriage or recurrent pregnancy loss (RPL) • Development of placenta and Fetal membranes • Placental disorders (Pre-eclampsia and eclampsia, IUGR, placental abruption and abnormal (velamentous) cord insertion. • Miscarriages, Preterm births, and stillbirth • Gestational Diabetes Mellitus • Endometrial Hyperplasia and Endometriosis • Reproductive Tract Infections in Women Invited talks by 1. Dr. Surendra Sharma, MD, PhD, Professor of Pediatrics, Women and Infants Hospital and The Warren Alpert Medical School of Brown University, USA. (Talk on Novel findings in Preeclampsia) 2. Dr. Fazleabas, Asgi T., PhD, University Distinguished Professor and Associate Chair of Research, Department of Obstetrics, Gynecology & Reproductive Biology, Director, Center for Women's Health, Co-Director, Reproductive and Developmental Sciences Program, Michigan State University, MI ,USA *(Talk on Recent Advances in Endometriosis.*	Dr. Malini Laloraya Dr. Deepak N. Modi, Scientist F, NIRRH Dr. Malini Laloraya Dr. Ananda Mukherjee Dr. Karthika Rajeeve Dr. Surendra Sharma Prof of Pediatrics, Women and Infants Hospital and The Warren Alpert Medical School of Brown University, USA Dr. Fazleabas, Asgi T., PhD Director, Center for Women's Health,Co-Director, Reproductive and Developmental Sciences Program, Michigan State University, MI ,USA	2 hrs 2hrs 1 hr 1hr 2 hr 1 hr 1 hr

Unit V: (Assisted Reproductive Techniques and Fertility Regulation) • Semen analysis • Ovulation induction; Oocyte retrieval; In vitro maturation • In vitro fertilization ICSI, GIFT etc. • Ethical issues in assisted reproductive technologies.	Dr. Pradeep Kumar G, RGCB	1 hr
• Cryopreservation of gametes & embryos; Vitrification • Embryo biopsy; Embryo hatching, Pre-implantation genetic diagnosis (PGD)	Dr. Debasree Dutta	1 hr
• Methods of fertility regulation in male and female	Dr. Deepak N. Modi, Scientist F, NIRRH	1 hr
<u>Invited talk</u> on "Immuno Contraception" by Dr. Satish Kumar Gupta, President, International Society for Immunology of Reproduction, Emeritus Scientist, Indian Council of Medical Research, New Delhi, India, Former Deputy Director, National Institute of Immunology, New Delhi, India	Dr. Satish Kumar Gupta, President, International Society for Immunology of Reproduction	1hr
SEMINAR / GROUP DISCUSSION		2 hrs
Total Hours		30h

Suggested Reading Materials:

TO BE PROVIDED

RGC 705: Advanced Immunology – 2 Credits
(Course Coordinator: Dr. John B Johnson)

Course core Faculty: Dr. T.R. Santhosh, Dr. E. Sreekumar, Dr. K.B. Harikumar, Dr. Karthika R, Dr. Karthik S, Dr. Ajay Kumar R, Dr. Debasree Dutta, Dr. Malini Laloraya

Name of the course	Name of Faculty	Teaching Hours
Unit I: The immune system – an overview, evolution and organs and cells; innate immunity (cells of the innate immune system, complement and other components), humoral responses (B-cell origin, types, receptors and VDJ rearrangement), T-cell dependent responses (T-cell origin and subsets, memory T-cell responses), macrophages, dendritic cells and their subsets, overview of cytokines, chemokines and Toll like receptors	To be decided.	4h
Unit II: Vaccines: History, key principle of vaccinology, herd immunity, adjuvants, type of adjuvants, function of adjuvants, classification of vaccines, type of vaccines.	Dr. John B. Johnson	3h
Unit III: New approaches to vaccine design, mRNA vaccines, bacterial vaccines, viral vaccines, T-cell based vaccines, vaccine against parasitic diseases, T cell and B-cell epitope mapping, adverse effects of vaccines	Dr. John B. Johnson	4h
Unit IV: Antibodies: Generation of monoclonal and polyclonal antibodies, recombinant approaches to generate monoclonal antibodies, Application of antibodies, abzymes (Catmab), immunotoxins, Single domain antibodies (Nanobody), bivalent and bi-specific antibodies.	Dr. John B. Johnson	2h
Unit V: Transplantation immunology: History, principles and discovery of immunogenetics, donor antigens, mechanism of graft rejection, graft versus host diseases, physiological interaction that modulates graft rejection, manipulations to prevent graft rejection (strategies to induce central and peripheral tolerance), transplantation of specific organs (kidney, liver, heart, lung, pancreas), hematopoietic cell transplantation, xenogeneic transplantation, immunological issues in clinical transplantation	Dr. K.B. Harikumar	3h
Unit VI: Tumor Immunology: Tumor recognition by immune cells, tumor antigens and its identification, Immunosuppression in tumor microenvironments, tumor escape mechanism, influence of immune system on tumor development, immunoediting, cancer immunotherapies. NK cell and dendritic cell	Dr. K.B. Harikumar	3h

therapy; CAR T cell therapy.		
Unit VII: Biologics and molecular medicine in immunology (cytokines, chemokines, cell-adhesion molecules, co-stimulatory molecules and surface receptor and ligands as therapeutic targets).	Dr. Karthik S	**2h**
Unit VIII: Role of non-coding RNA in immune regulation	Dr. Karthika Rajeeve	2h
Unit IX: Advanced immunological techniques: Flow cytometry, Magnetic sorting, MHC tetramer technology, muliplex assays, antibody purification and protein conjugations, spectra-typing, surface plasmon resonance (SPR).	Dr. TR Santhoshkumar	3h
Unit X: Autoimmunity and tolerance: General principle of autoimmune diseases, mechanism of peripheral and central tolerance, regulatory circuits in autoimmune processes, systemic autoimmune diseases, organ-specific autoimmune diseases (Central nervous system, gastrointestinal, Endocrine, Hepatic, cutaneous and rheumatoid arthritis). Unit X: Animal model of immunological diseases (Transgenic and knockout animals), generation of bone-marrow chimeras, humanized mice, parabiosis.	Dr. Malini Laloraya Dr. Debasree Dutta	3h 1h
Total Hours		30h

Suggested Reading:

1. Cellular and Molecular Immunology 9th Ed. Abbas et al.
2. Fundamental Immunology 7th Ed. William E. Paul
3. Clinical Immunology- Principles and Practice 5th Ed. Rich et al.
4. Immunology 8th Ed. Male et al.
5. Tumour immunology and Immunotherapy Robert C. Ross
6. Plotkin's Vaccines 7th Ed. Plotkin et al.
7. Monoclonal Antibodies 3rd Edition Principles and Practice. James Goding

RGC 706: Advances in Plant Biotechnology – 2 Credits

(Course Coordinator: Dr. S. Manjula)

Course core Faculty: Dr. S Manjula, Dr. E.V. Soniya, Dr. George Thomas, Dr. Saraswati Nayar

Name of the course	**Name of Faculty**	**Teaching Hours**
Plant Growth and Development • Introduction to plant growth and development- Cell wall, Cell division and cell growth, embryogenesis, determination, differentiation and dedifferentiation in plants • Hormonal regulation of plant development- Introduction to plant hormones, Molecular basis of hormone action & Regulation of developmental processes. • Genes controlling flower development- ABCDE model, floral transition, floral initiation, floral meristem identity, floral organ identity	Dr. Saraswati Nayar	8 hrs
Plant-pathogen interactions • Pathogens & Pathosystems – Major pathogens, necrotrophs, biotrophs; Mechanism of infection & colonization process- pre-formed defense, structural and bio chemical. • Molecular basis of host pathogen interaction and plant innate immunity against fungi, oomycetes, bacteria and virus in model systems; pathogen recognition and signal transduction, PTI, ETI. • Induction of defense responses-Pathogenesis Related proteins, Reactive oxygen species, Hypersensitive Response, Systemic Acquired resistance, Virus Induced gene silencing • Effector biology-Understanding the roles and functions of fungal 'effectors', molecular mechanisms of effector -host interactions and identification of effector targets for crop improvement • Approaches to enhance plant crop protection- transgenic and non-transgenic (defense priming) approaches, genome editing.	Dr. S. Manjula	11 hrs
Genetics and genomics in crop improvement for disease resistance • Construction of molecular maps: linkage maps and association maps; gene tagging; quantitative traits (QTLs); SNP analysis. • Backcross breeding and marker assisted selection (MAS). Positional cloning of defence related genes by knowing map position. • Transcriptomics: determining key genes and pathways in governing resistance and susceptibility reactions against pathogens in crops	Dr. George Thomas	7 hrs

Genetic Transformation • Transformation Techniques in Plants, Transgene silencing and stability. • Metabolic Engineering in Plants, Transgenic Plants as Biofactories: Biopharming in plants for the production of industrial enzymes, edible vaccines • Transgenic technology for the development. Viral, bacterial and fungal resistance plants.	Dr.E.V.Soniya	4 hrs
Total Hours		30 hrs

Suggested Reading

Plant Growth and Development. 2002. L M Srivastava. Oxford Academic Press.

Plant Physiology and Development, Sixth Edition 2015. Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy. Sinauer Associates, Inc., Publishers.

Dale R. Walters. Plant Defense: Warding off Attack by Pathogens, Herbivores, and Parasitic Plants(2010).PrintISBN:9781405175890|OnlineISBN:9781444328547 DOI:10.1002/9781444328547. Blackwell Publishing.

Jones and Dangl. 2006. The Plant Immune System. Vol.444; doi:10.1038/nature05286

Pastor et al. 2013. Primed plants do not forget. Environmental and Experimental Botany. 94: 46-56.

Saijo et al. 2018. Pattern recognition receptors and signaling in plant–microbe interactions. The Plant Journal. **https://doi.org/10.1111/tpj.13875**

RGC 707: Advances in Molecular Genetics – 2 Credits

(Course Coordinator: Dr. E.V. Soniya)

Course core Faculty: Dr. EV Soniya, Dr. Moinak Banerjee, Dr. R. Laishram, Dr. K Harikumar, Dr. Jackson James, Dr. Krishna Kurthkoti, Dr Ani V Das, Dr. Manoj P, Mr. Sivakumar

Name of the course	Name of Faculty	Teaching Hours
Unit I: Principles of Genetics: Principles of genetics and inheritance, developmental and human molecular genetics and associated genetic disorders, epistasis, quantitative genetics, population and evolutionary genetics, Genome mapping- Genetic mapping, Physical mapping, Resolution of mapping**,** Defects in Genome Maintenance	Dr. Moinak Banerjee	3hrs
Unit II: Human Genetics: Recent advances in human molecular genetics, introduction to the human genome, pedigree analysis, gene mapping and linkage analysis, Genome Organisation and application, Chromosomes and their role in inheritance, chromosomal aberrations	Dr. Moinak Banerjee	3hrs
Unit III: Gene therapy: Introduction, vectors in gene therapy, advances in gene therapy, safety assurances	Dr. Ani V Das	2hrs
Unit III: PCR techniques: Principles of PCR, RT PCR, Primer design, Types of PCR, T-vectors, proof reading enzymes; Isolation of DNA and RNA, reverse transcriptase and cDNA synthesis; cDNA and genomic libraries, sequencing technologies and methods, Phylogenetic analysis Blotting techniques: Southern, Northen, Western :	Dr. Manoj P	4hrs 2hrs
Unit IV: Molecular forensics: DNA fingerprinting, - genetic identification, Use of technology in anthropological studies	Dr. EV Soniya	2hrs
Unit V: Pervasive Transcription and concept of junk DNA Non - coding RNAs (regulatory and functional RNAs, miRNA, lncRNA, piRNA, ceRNA, and other RNA species)	Dr. R. Laishram	4hrs

Unit VI: Global expression profiling: Whole genome analysis of mRNA and protein expression, microarray analysis and their applications, Genome sequencing: Strategies for Sequencing whole genome and sequence data analysis, Comparative Genomics	Dr. Harikumar Mr. Sivakumar	3hrs 4hrs
Unit VII: DNA analysis and diagnostics: Methods of DNA analysis, PCR in molecular diagnostics, diagnosing infectious diseases, Identifying genetic disease	Dr. Krishna Kurthkoti	2hrs
Unit VII: Gene editing : Gene silencing technologies, Genome editing by CRISPR-Cas	Dr. Jackson James	1hrs
Total Hours		30h

Suggested Reading

1. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2015). Concepts of Genetics. 11th Edition. Pearson Higher Ed.
2. Snustad, D. P. & Simmons, M. J., (2015). Principles of genetics. 7th Edition. John Wiley & Sons.
3. Pierce, B. A. (2017). Genetics: A conceptual approach. 6th Edition Macmillan.
4. Green, M. R., & Sambrook, J. (2012). Molecular cloning. A Laboratory Manual, 4 th Edition, CSHL Press.
5. Watson, J. D, Baker, T. A., Bell, S. P., Gann, A., Levine, M. & Losick, R.M. (2013). Molecular biology of the gene. 7th Edition. Pearson.

Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). Lewin's Genes XII. 12th Edition, Jones & Bartlett Learning

RGC 708: Stem Cell Biology and Regenerative Medicine – 2 Credits (30hrs)

(Course Coordinator: Dr. Jackson James)

Course core Faculty: Dr. Jackson James, Dr. Debasree Dutta, Dr. Umasankar PK, Dr. Ani V Das, Dr. Anoop Kumar T (SCTIMST, TVM), Dr. Jishy Varghese, IISER, Tvm

Name of the course	Name of Faculty	Teaching Hours
Unit I: Stem Cells Overview of stem cell biology, culture, derivation, Differentiation of embryonic /iPSCs/adult/fetal stem cells, differentiation to different lineages, clinical applications, stem cell niches, organoids; and cancer stem cells.	Dr. Debasree Dutta	2hr
Unit II: Developmental hematopoiesis, Epigenetic regulation of stem cell fate, Niche biology: regulation of hematopoiesis by the nice-mediated signaling mechanisms.	Dr. Debasree Dutta	1 hr
Unit III: Neural stem cells: Maintenance of neural stem cell niche, Neural stem cell differentiation	Dr. Jackson James	1hr
Unit IV: Cryopreservation of cells (general), Cord blood banking and long-term storage of stem cells, FACS and its application in stem cell research	Dr. Jackson James	1hr
Unit V: Stem Cell Disorders Overview of stem cell dysfunctions and disorders, stem cell aplasia (aplastic anemia), monoclonal hematopoietic stem cell proliferative syndrome (leukemia and myelodysplastic syndrome), and polyclonal hematopoietic stem cell proliferative syndrome (systemic and organ- specific autoimmune diseases), mesenchymal stem cell disorders (Alzheimer's disease, osteoporosis, and lung fibrosis) and organ-specific stem cell disorders (carcinosarcoma in the lung and adeno-endocrine cell carcinoma in the stomach), pathogenesis and treatment.	Dr. Jackson James	2hr
Unit VI Therapeutic applications of stem cells Clinical and experimental applications of stem cells, tissue engineering approaches for stem cells, ethical issues of using these cells, clinical facilities required for human stem cell transplantation. Current therapeutic use of stem cells in disease: neural disorders, hematopoietic disorders and cardio vascular diseases, use of embryonic stem cells. Therapeutic application of iPSCS	Dr. Ani V Das Dr. Debasree Dutta	2hr 1hr

Unit VII: Cell and Developmental Biology: Shaping the embryo Molecular logic of life, Fundamental aspects of Cells, Flow of information in biological systems- **Model organisms** C. elegans: Drosophila: Zebrafish: How cells form tissues and organs: Zebrafish- gastrulation, morphogens, morphogen gradients, axis formation, Fate maps, lineage tracing, transplantation experiments, developmental anomalies Tissue/ Organ Development, Damage and Regeneration. KO Mouse models	 Dr. Umasankar . P K Dr. Anoop Kumar T (SCTIMST, TVM) Dr. Jishy Varghese, IISER, Tvm Dr. Umasankar . P K Dr. Jackson James	 1hr 1hr 2hr 3hr 1hr
Unit IX: Techniques in Stem Cell Biology: 1. Neural/Cancer stem cell isolation and culture techniques 2. Neurosphere/Tumorsphere assay 3. Mouse ES Cell generation and culture 4. Human ES/iPSC culture 5. Organoid generation and maintenance 6. Zebrafish: maintenance, breeding, *in situ* hybridization, microinjections- morpholino/ mRNA 7. Generating transgenic and knockout zebrafish	 Dr. Ani V Das Dr. Jackson James Dr. Jackson James Dr. Debasree Dutta Dr. Jackson James Dr. Umasankar Dr. Umasankar	 1hr 1hr 1hr 1hr 1hr 2hr 3hr
Invited talks related to current developments in the field of stem cell Biology	Invited Faculty	2hr
Total Hours		**30hr**

Suggested Reading

Molecular Biology of the Cell by Bruce Alberts

Principles of Development by Lewis Wolper

RGC 709: Cardiovascular system disorders and Diabetes – 2 Credits,
30 hour class
(Course Coordinator: Dr. Rakesh Laishram)

Course core Faculty: Dr. Abdul Jaleel, Dr. Surya Ramachandran, Dr. Sumi S, Dr. Ananthalakshmy Sundararaman, Dr. Rakesh Laishram

Name of the course	**Name of Faculty**	**Teaching Hours**
Unit I: Physiology cardiovascular system, Anatomy of heart	Dr. Surya Ramachandran	2 hr
Molecular basis of cardiac growth and development	Dr. Rakesh. S Laishram	2 hr
Cardiac hypertrophy (physiological and pathological hypertrophy	Dr. Rakesh. S Laishram	2 hr
Angiogenesis, development of vasculature, molecular mechanism of normal and pathological angiogenesis	Dr. Ananthalekshmi Sundararaman	4 hr
Unit II: Introduction to cardiovascular diseases	Dr. Surya Ramachandran	1 hr
genetics of cardiovascular diseases	Dr. Ananthalekshmi Sundararaman	2 hr
Cardiomyopathies and Congenital heart defects	Dr. Sumi.S	3 hr
Atherosclerosis	Dr. Surya Ramachandran	1 hr
Peripheral arterial and venous diseases, Pulmonary hypertension and pulmonary embolism	Dr. Sumi.S	3 hr
Heart failure (heart failure with preserve and reduced ejection fractions)	Dr. Rakesh. S Laishram	2 hr
Unit III: Diabetes Mellitus: History, Symptoms, Classification, Epidemiology and Diagnosis, Type-I diabetes, Monogenic forms and Gestational diabetes	Dr. Abdul Jaleel	3 hr
Unit IV: Type-2 diabetes: Genetic considerations, Mechanism and Pathophysiology, Insulin resistance & Impaired insulin secretion, Increased hepatic glucose and lipid production	Dr. Abdul Jaleel	3 hr
Complications of diabetes mellitus and current research		2 hr
Total Hours		30h

Reference books:
Harrison's Internal Medicine

RGC 710: Advances in Chemical Biology

(Course Coordinator: Dr. GS Vinod Kumar)

Course core Faculty: Dr. Suparna Sengupta, Dr. Mahendran. K R, Dr. G. S. Vinod Kumar, Dr.K.B Harikumar, Dr. Tessy Thomas Maliekal

Name of the course	Name of Faculty	Teaching Hours
Unit I: Basics of chemistry Acids, alkali, Normality, Molarity and preparation of solutions. Buffers; preparation, pH and determination. Centrifugation Techniques-Ultracentrifugation and principles	 Dr. Suparna Sengupta Dr. Suparna Sengupta	 2 hrs 1 hr
Unit II: Engineering membrane proteins for chemical biology, Synthetic pores, Pore-forming toxins, Nanopore technology, Fundamental properties of ion channels, Single-molecule chemistry and catalysis, DNA origami and applications, Liposomes and applications of liposomes in chemical biology, Liposome assays.	Dr. Mahendran. K R	5 hrs
Unit III: Basics and principle of IR spectroscopy and sample characterization and illustration, Differential Scanning Calorimetry (DSC), Dynamic Light Scattering (DLS), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM,ESEM) and its applications in material chemistry and biomedical applications Demonstration of IR, DLS, DSC and TEM	Dr. G. S. Vinod Kumar Dr. G. S. Vinod Kumar	3 hrs 2 hrs
Unit IV: Nanotechnology and its applications in biomedical field, characterization of particles, different targeting mechanism in internalization, Role of peptides in drug targeting, Different techniques used for preparation	Dr. G. S. Vinod Kumar	2 hrs
Unit V: Applications of biomaterial in biomedical science and tissue engineering , different techniques used in biocompatible material synthesis and characterization, cell differentiation, role of spectroscopic techniques in material characterization	Dr. G. S. Vinod Kumar	2 hrs
Unit VI: Physics and Chemistry behind important biological systems function, Dynamics in different parts of a cell movement and function, biomedical applications of biophysics Bioimaging techniques	Dr. Suparna Sengupta Dr.K.B Harikumar	3 hrs 2 hrs
Unit VII: Natural peptides- peptide hormones, host defense peptides- their mode of action, role in therapy. Synthetic peptides- antagonist	Dr. Tessy Thomas Maliekal	3 hrs

peptides-their role in biology, applications in therapy Biotin tagging- applications; Fluorescent tagging-applications; Radiolabeling-applications	Dr. Tessy Thomas Maliekal	2 hrs

Suggested Readings:

1. 3D Bioprinting and nanotechnology in tissue engineering and regenerative medicine
Author : Zhang, Lijie Grace; Fisher, John P
Publisher : Elsevier - Academic Press

2. Nanomaterials and nanosystems for biomedical applications
Author : Mozafari, Reze
Publisher : Springer

3. Scanning microscopy for nanotechnology: Techniques and applications
Author : Zhou, Weilie; Wang, Zhong Lin, ed.
Publisher : Springer Publishing Co., New York

4. Transmission Electron Microscopy and diffractometry of materials
Author : Fultz, Brent; Howe, james
Publisher : Springer-Verlag, Berlin

5. Biomaterials, artificial organs and tissue engineering
Author : Hench, Larry L; Jones, Julian R., Ed.
Publisher : CRC Press, Wood Head Publishing Ltd, Cambridge, England.

6. Principles of tissue engineering; Edition 4
Author : Lanza, Robert; Langer, Robert
Publisher : Elsevier - Academic Press

RGC 711: Advances in Cancer Biology – 2 Credits (30H)
(Course Coordinator: Dr. Priya Srinivas)

Course core Faculty: Dr. Devasena Ananthanarayan, Dr. Ananda Mukherjee, Dr. Ani V Das, Dr. Ananda Mukherjee, Dr. S. Asha Nair, Dr. Tessy Thomas Maleikal, Dr. Priya Srinivas, Dr. Radhika Nair, Dr. Harikumar K B, Dr. Suparna Sen Gupata, Dr. Ruby John Anto, Dr. Ram Mohan Ram Kumar, Dr. T.R. Santoshkumar, Dr. Sreejith G Nair [Professor of Medical Oncology, RCC], Dr. R. Sankaranarayanan [Special Advisor on Cancer Control, International Agency for Research on Cancer, WHO], Dr. Yadev.I, Professor, Department of Surgery (Oncology), Government Medical College, Trivandrum

This course will provide detailed understanding of cancer biology.

Name of the course	**Name of Faculty**	**Teaching Hours**
Unit I: Fundamentals of cancer		
Introduction to cancer as a disease and essentials of cancer management, classification of cancers and tumors,	Dr. Sreejith G Nair [Professor of Medical Oncology, RCC]	2 hrs
Cancer epidemiology,	Dr. R. Sankaranarayanan [Special Advisor on Cancer Control, International Agency for Research on Cancer, WHO]	2 hrs
Unit II: Etiology of cancer		
Etiology of cancer, Tobacco and cancer development, Cancer Prevention	Dr. R. Sankaranarayanan [Special Advisor on Cancer Control, International Agency for Research on Cancer, WHO]	2 hrs
Viruses and cancer (RNA and DNA viruses)	Dr. Devasena Ananthanarayan [RGCB]	1 hr
Cancer susceptibility syndromes, inflammation and cancer,	Dr. Ananda Mukherjee[RGCB]	1 hr
Chemical & physical carcinogens, carcinogenesis, types of carcinogenesis, diet and cancer.	Dr. Ani V Das [RGCB]	1 hr

Unit III: Molecular Biology of Cancer		
Cellular Oncogenes, tumor suppressor genes, signaling,	Dr. Ananda Mukherjee [RGCB]	1 hr
cell cycle regulation, programmed cell death, autophagy, senescence, telomeres	Dr. S. Asha Nair [RGCB]	3 hrs
Gene Regulation and Epigenetics in Cancer	Dr. Tessy Thomas Maleikal [RGCB]	3 hrs
Unit IV: Invasion and Metastasis		
Genomic Instability, Angiogenesis and its implication in tumor progression, evolution and pathogenesis of metastasis,	Dr. Priya Srinivas[RGCB]	1 hr
Models for metastasis, cancer stem cells	Dr. Radhika Nair [RGCB]	2 hrs
Unit V: Tumor Immunology and Immunotherapy		
Anti-tumor immune response of regulatory T cells, NK cells, immune surveillance theory, tumor associated antigens, evasion of immune surveillance by cancer cells,	Dr. Harikumar K B [RGCB]	2hrs
Principles of immunotherapy, CART cells.	Dr. Harikumar K B [RGCB]	1 hr
Unit VI: Translational Cancer Research		
use of cell kinetics to optimize cancer treatment,	Dr. Suparna Sen Gupata [RGCB]	1 hr
Principles of Clinical drug trials for new cancer treatment,	Dr. Yadev.I, Professor, Department of Surgery (Oncology), Government Medical College, Trivandrum	1 hr
Natural Products as a platform for anti cancer drug development	Dr. Ruby John Anto[RGCB]	1 hr
monoclonal antibodies as anti cancer agents, new modalities in cancer treatment, personalised therapy, Biomarkers for Cancer Diagnosis,	Dr. Ram Mohan Ram Kumar[RGCB]	2 hr
Unit VII: Experimental Techniques in Cancer Research		
Cancer cell culture techniques, Cell Proliferation assays,	Dr. S. Asha Nair [RGCB]	1hr
Cancer cell immortalization, Immuno assays & Radiolabelling Techniques Gene silencing/ over expression	Dr. T.R. Santoshkumar[RGCB]	1 hr
Animal models for cancer	Dr. KB. Harikumar[RGCB]	1 hr

Total Hours		30h

SUGGESTED READING MATERIALS

1. The Biology of Cancer- R.Weinberg (Full PDF can be downloaded - (PDF) The Biology of Cancer-R.Weinberg | Vet Help - Academia.edu)
2. Title : Molecular cell biology; Author : Lodish, Harvey; Berk, Arnold; Year : 2016; Publisher : Macmillan Education
3. Title: Advances in cancer reseaerch, Vol.93; Author: vande Woude, George F; Klein, George, Ed. Year : 2005; Publisher : Elsevier Academic Press, New York
4. Title : An introduction to the use of anticancer drugs; Author : Rafi, Imran Year : 2006; Publisher : Elsevier Publishing Co., New York
5. Title : Anticancer drug toxicity: Prevention, management, and clinical pharmacokinetics; Author : Hans- Peter Lipp; Year : 1999; Publisher : Marcel Decker, Inc
6. Title : Anticancer: A new way of life; Author : Servan - Schreiber, David; Year : 2011; Publisher : Penguin
7. Title : Breast cancer research protocols; Author : Brooks Susan A; Harris Adrian; Year : 2006; Publisher : Humana Press, New Jersey
8. Title : Cancer bioinformactics: From therapy design to treatment Author : Nagt, Sylvia, Ed. Year : 2006; Publisher : John Wiley & Sons Inc., England
9. Title : Cancer Biology; Author : King, Roger J B; Robins, Mike,W; Year :2006; Publisher : Pearson Education Asia
10. Title : Cancer cell culture: Methods and protocols; Author : Langdon, Simon P; Year : 2004; Publisher : Humana Press, New Jersey
11. Title : Cancer cell signalling: Methods and protocols Author : Terrian, David M; Year : 2003; Publisher : Humana Press
12. Title : Cancer microenvironment and therapeutic implications: Tumor pathophysiology mechanisms and therapeutic strategies
13. Author : Baronzio, Gianfranco; Fiorentini, Giammaria ; Year : 2009 Publisher : Pringer
14. Title : Clinical oncology; Author : Abeloff, Martin D., Armitage, James O Year : 2004; Publisher : Elsevier
15. Title : DNA repair genetic instability, and cancer; Author : Wei, Qingyi; Li Lei; Year : 2007; Publisher :World Scientific
16. Title : Estrogens, estrogen receptor and breast cancer; Author :Parl, Fritz, F; Year : 2000; Publisher : Ios Press, Amsterdam
17. Title : Hand book of metastatic breast cancer; Author : Johnson, Stephen RD; Swanton, Charles; Year : 2006; Publisher : Informa healthcare, UK
18. Title : Metastasis of breast cancer; Author : Mansel, Robert E; Fodstad, Oystein; Year : 2007; Publisher : Springer

RGC 712: Certification courses -10 Lectures

The certification courses will take care of certification requirements for using radioactive materials and laboratory animal handling.

Name of the course	Name of Faculty	Teaching Hours
• Certification course for using Radioactive materials		2hrs
• Certification course in Animal handling		8hrs
Total Hours		10hrs