Course Description
M.Tech in Medical Biotechnology

Core courses

Course code	**BT6390**
Course name	**Advanced Cell Biology**
Credit	**3**
Semester	**1**

Objective: The course is designed to help learners develop a broad understanding of the fundamental and advanced concepts of cell biology from a human-centred perspective. A major emphasis of the course will be on the recent advances in cell biology and its importance to human health and disease.

Course contents: Introduction to cell biology, Biogenesis and functions of plasma membrane, Cytoskeletal elements, Cell Division: Mitosis and Meiosis, Mitochondrial biogenesis and function, Protein import, Biosynthesis of ER and Golgi, Trans-Golgi Network, Vesicular trafficking, Lysosome biogenesis and pathophysiology, Nucleus- structure and biogenesis of nuclear envelope, Nuclear import and export, Cell cycle and Cell death, Regulation of signalling pathways, Physiological methods to characterize and understand cellular processes.

Suggested reading:

1. Molecular Biology of Cell, Bruce Alberts (2014) 6 th edition. Garland Science
2. Cell Biology, Pollard TD, Earnshaw WC, Schwartz JL. (2016) 3rd Edition Elsevier Publishing Co.

Course code	**BT5010**
Course name	**Biochemistry**
Credit	**3**
Semester	**1**

Objective: This course aims to provide fundamental concepts of biochemistry, starting from simple building blocks to complex metabolism.

Course contents: Basic principles: Biomolecules, Stereoisomers and life, thermodynamics of biochemical reactions; Structural biochemistry: Protein Structure, Protein Folding, Learning Pymol, Enzyme Catalysis, Enzyme Kinetics, Lipid structure and membrane assembly, Carbohydrate structure; Bioenergetics: Glycolysis, Glycolysis of red blood cells and liver, Bacterial Energetics, The citric acid cycle, Electron transport, ATP synthesis, Regulation of blood sugar; Tissue-specific metabolism: Liver metabolism, Muscle metabolism, Brain Metabolism; Synthesis and degradation of Biomolecules: Nucleic acid metabolism, Carbohydrate metabolism, Fatty acid metabolism, Protein metabolism.

Text books:

1. Lehninger Principles of Biochemistry (WH Freeman, 7th Edition, 2017) by David L. Nelson and Michael M. Cox

2. Voet′s Principles of Biochemistry (John Wiley & Sons, 5th Edition, 2018) by Donald Voet, Judith G. Voet, Charlotte W. Pratt

Course code	**BT6183**
Course name	**Molecular Biotechnology**
Credit	**2**
Semester	**2**

Objective: The objective of this course is to provide fundamental concepts of the advances in the biotechnology field including methodologies, applications and the ethical issues involved.

Course contents: Introduction to biomolecular organization. Recombinant DNA technology-methodologies and applications. Genetic methodologies and applications of bacterial and yeast cells in biotechnology. Application of biotechnology in small and large scale production of biopharmaceuticals. Genetically modified plants and application of plant systems for production of medically important biomolecules. Biotechnology-based diagnostic and therapeutic strategies. Ethical issues in genetically modified plant and animal systems.

Reference book:

Molecular Biotechnology by Bernard R. Glick, and Jack J. Pasternak, 5th Edition, 2017.

Course code	**BT6020**
Course name	**Immunology**
Credit	**3**
Semester	**2**

Objective: The learning outcome of this course is an overview of vertebrate immune system and detailed knowledge of the essential components of the immune system

Course contents: Overview of Immunology; Innate and adaptive immunity; Antigen and antibody: Structure and function; Antigen-antibody interactions as tools for research; Generation of antibody diversity: Immunoglobulin genes; Presentation of antigen by major histocompatibility complex molecules, cytokines; complement; Effector mechanisms; T-cell development; B-cell development; AIDS and the immune system; Vaccines. Special topics on advances in immunology

Text books:

1. Goldsby, Kindt, and Osborne. Kuby Immunology 6th ed. Freeman, 2007.
2. Roitt's Essential Immunology. 12th Edition.Peter J. Delves,Seamus J. Martin, Dennis R. Burton,Ivan M. Roitt

Reference book:

3. David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Immunology; Mosby Publisher, 7th ed. 2006

Course code	**BT6040**
Course name	**Bioindustry lecture**
Credit	**1**
Semester	**2**

Instructor/Coordinator	**Dr. Gunjan Mehta**

Objective: The objective of this course is to partially bridge the gap between academia and industry. The course is taught by the leaders of the Research and Development of Biotech industry. In this course students learn latest trends in industrial biotech research directly from the scientists.

Departmental Elective courses (semester 1)

Course code	**BT6113**
Course name	**Structural Bioinformatics**
Credit	**2**
Semester	**1**
Instructor	**Dr T Rathinavelan**

Objective: The overall aim of this course is to provide an outline of the biomacromolecular structures that are the major therapeutic targets and various algorithms used for biomolecular structure prediction

Course contents: Biomolecular Structure & Dynamics: Stereochemistry: configurational & conformational isomers - Internal parameters - Forces stabilizing biomolecular structures - Biomolecular structure visualization tools - Structure & dynamics of nucleic acids: architecture of nucleic acids – analyses of nucleic acids secondary structures - DNA origami - Modeling nucleic acids for biological applications using 3D-NuS - Sequence alignment: Pair-wise alignment method, Dynamic programming: Needleman-Wunsch method; Smith Waterman method - Multiple sequence alignment method - Scoring matrices: PAM and BLOSUM - Heuristic method: BLAST. Construction of phylogenetic tree - Introduction to protein structure prediction: homology modeling and threading.

Text books:

1. Martin Egli, Wolfram Saenger, Principles of Nucleic Acid Structure, Springer, 1983
2. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry, W. H. Freeman, 5th edition, 2008
3. David W Mount, Bioinformatics sequence and genome analysis, CBS publishers & Distributors, Second edition, 2004

Reference book:

G.E. Schulz and R.H. Schirmer, Principles of protein structure, Springer, 1979

Course code	**BT6143**
Course name	**Gene Technology**
Credit	**2**
Semester	**1**
Instructor	**Dr NK Raghavendra**

Objective: Gene technology course is designed to provide details of methods used in molecular biotechnology as well as insights into trends and techniques used in genomics. The course involves

class room teaching of the principles and techniques, hands-on learning of the same in laboratory and presentation of selected articles from literature by students.

Course contents: Genetic manipulation: isolation, cloning, sequencing, annotation and mutagenesis of genes. Expression systems: plasmids and their features for heterologous expression of protein and RNA; *in vitro* and cellular expression systems. Genetic libraries: Genomic library, cDNA Library: generation and analysis. DNA sequencing: Principles of conventional, automated and high throughput sequencing. Microarrays and gene expression profiling. DNA microarray: design, fabrication, analysis. Genetically modified organisms: Generation, analysis and usage of transgenic organisms.

Text books:

1. From genes to genomes: concepts and applications of DNA technology / Jeremy W. Dale, Malcolm von Schantz, and Nick Plant. 3rd Edition. Published by Chichester, West Sussex: John Wiley & Sons. 2011.
2. Molecular biotechnology: principles and applications of recombinant DNA, 4th edition. / Bernard R. Glick and Jack J. Pasternak, Cheryl L. Patten. Published by Washington, DC: ASM Press, 2010

Reference books:

1. Principles of Gene manipulation and Genomics, 7th edition/S. B. Primrose, Richard M. Twyman. Published by Blackwell, 2006.
2. Molecular Cloning, a laboratory Manual, 3rd edition/ Joseph Sambrook and David W. Russell. Published by Cold Spring Harbor, N.Y.: Cold Spring Harbor Laboratory Press, 2001.

Course code	**BT6060**
Course name	**Protein misfolding in Neurodegenerative diseases**
Credit	**2**
Semester	**1**
Instructor	**Dr Basant K Patel**

Objective: This course is designed and intended for the post graduate students of biotechnology. It provides insights into the molecular mechanisms of misfolding of various proteins that are implicated in the pathogenesis of certain diseases where neurons are observed to degenerate.

Course contents: Protein folding & misfolding, Amyloidogenicity, Molecular biology of protein misfolding in: Alzheimer's disease, Parkinson's disease, Huntington's disease, Amyotrophic Lateral Sclerosis (ALS), Creutzfeldt Jacob's disease (Prion disease), and non-neuropathic systemic amyloid diseases. Mechanism of amyloid toxicity. Prion formation, transmission and pathogenesis. Role of Chaperones and other cellular factors in modulating amyloid formation and toxicity. Role of mitochondrial damage in pathogenesis of neurodegenerative diseases. Eukaryotic yeast cell models of neurodegenerative diseases. Therapeutics of neurodegenerative diseases.

Reference books:

1. Prion Biology and Diseases, Stanley B. Prusiner Second Edition; Cold Spring harbour; 2004
2. Protein Misfolding Diseases: Current and Emerging Principles and Therapies. Marina Ramirez-Alvarado, Jeffery W. Kelly, Christopher M. Dobson; John Wiley & Sons inc. 2010.

Review articles:

(1) Huang Y., and Mucke L (2012) Alzheimer Mechanisms and Therapeutic Strategies. *Cell*, 148, 1204-1222. (2) Khurana V & Lindquist S. (2010) Modelling neurodegeneration in *Saccharomyces cerevisiae*: why cook with baker's yeast? *Nat Rev Neurosci*11: 436-449. (3) Rossi, S., Cozzolino,

M. & Teresa Carri, M. (20160 Old versus new mechanisms in the pathogenesis of ALS. *Brain Pathol.*26, 276-286. (4) Selkoe DJ.,& Hardy J. (2016) The amyloid hypothesis of Alzheimer's disease at 25 years. *EMBO Molecular Medicine* Vol 8 (6), 595-608 (5) Jahn, TR., Radford, S.E. (2008) Folding versus aggregation: Polypeptide conformations on competing pathways. *Archives of Biochemistry and Biophysics* 469, 100–117 (6) Liebman SW, Chernoff YO (2012). Prions in yeast. Genetics. 191(4):1041-72. (7) Bates GP, Dorsey R, Gusella JF, Hayden MR, Kay C, Leavitt BR, Nance M, Ross CA, Scahill RI, Wetzel R, Wild EJ, Tabrizi SJ. (2015) Huntington disease. *Nat Rev Dis Primers*.23; 15005

Course code	**BT6123**
Course name	**Cell Technology**
Credit	**2**
Semester	**1**
Instructor	**Prof. Anindya Roy**

Objective: The course will give an overview of eukaryotic cell, describe the structure and functions of the cellular organelles, and review current research techniques used to post-graduate students.

Course contents: Cells and Organelles; Microscopy Techniques; Cell Membranes; Membrane Transport; Electrical Signaling; Signal Transduction; Extracellular Structures; Intracellular Compartments and Trafficking; Chromosomes and the Nucleus; Cell Cycle; Cytoskeleton; Cell Motility; Methods in mammalian Cell Culture; Transfection; Transient & stable Cell-line generation

Text books:

1. Molecular Cell Biology; Authors: Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, 6th Edition 2008; W.H. Freeman and Company.
2. Current Protocols in Cell Biology; John Wiley & Sons, Inc. 2012.

Reference book:

1. Molecular Biology of The Cell -by B. Alberts, 5th edition, Garland Science, New York 2010.

Course code	**BT7280**
Course name	**Pharmacology and physiology of receptors**
Credit	**2**
Semester	**1**
Instructor	**Dr Anamika Bhargava**

Objective: The learning outcome of this course is detailed knowledge about membrane receptors in biological systems and how they have been exploited in the biological and biomedical research.

Course contents: Receptor classification, Fundamental principles of pharmacology, Pharmacodynamics, Pharmacokinetics, Metabolism and toxicity, Techniques used for receptor studies (ranging from old to advanced), Protein targeting and trafficking in mammalian cells, Imaging of receptor trafficking, Voltage gated ion channel superfamily, Ion channels as drug targets, indirect and direct assay technologies available like patch clamp techniques, SICM etc , Channelopathies, Heart failure overview and Principles of cardiovascular pharmacology, Beta adrenergic concept and paradox in heart failure

Text books:

1.Voltage gated ion channels as drug targets-David J. Triggle,Murali Gopalakrishnan,David Rampe, Wei Zheng- John Wiley & Sons-2006.

2.Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy-David E. Golan, Armen H. Tashjian, Ehrin J. Armstrong- Lippincott Williams & Wilkins-2011.

Reference material:

3. Recent articles in various journals.

4.Signal Transduction: Principles, Pathways, and Processes. Lewis C. Cantley, Tony Hunter, Richard Sever, Jeremy Thorner. Cold Spring Harbor Laboratory Pr (31 May 2014)

5.Receptors: Models for Binding, Trafficking, and Signaling: Models for Binding, Trafficking, and Signaling. Douglas A. Lauffenburger and Jennifer Linderman. Oxford University Press (5 August 1993)

Course code	**BT6050**
Course name	**Circadian Clocks: Mechanisms and Functions**
Credit	**2**
Semester	**1**
Instructor	**Dr. Sandipan Ray**

Objective: This course's overall objective is to provide a detailed understanding of circadian clocks and their physiological functions and clinical significance.

Course contents: Introduction to biological oscillators, A brief history of circadian time keeping, Circadian clocks – the rhythms of life, Clock circuits in different organisms, Adaptive significance of rhythms, Molecular mechanisms of transcriptional and non-transcriptional circadian oscillations, Multidimensional regulation of the circadian rhythms, Master and peripheral clocks in mammalian systems, Metabolic oscillations, Timeseries analysis of rhythms - concepts and methods, Physiological functions and importance of time-keeping machinery, Circadian clocks and sleep, Circadian clocks in health and diseases, Human circadian disorders, Clock-infection biology, Chrononutrition- effects of diet on circadian.

Text books:

1. Circadian Rhythms, by Paolo Sassone-Corsi, Michael W. Young, and Akhilesh B. Reddy, A Cold Spring Harbor Perspectives in Biology Collection - 2018, ISBN 978-1-621821-24-3
2. Circadian Rhythms and Biological Clocks, by Amita Sehgal, Academic Press 2015, ISBN: 9780128012185

Reference books:

3. Circadian Clocks: Role in Health and Disease. by Michelle L. Gumz, Springer 2016, ISBN 978-1-4939-3450-8.
4. Circadian Medicine, by Christopher S. Colwell, Wiley & Sons 2015, ISBN:9781118467787

Course code	**BT6303**
Course name	**Proteomics: Techniques and Applications**
Credit	**2**
Semester	**1**
Instructor	**Dr. Sandipan Ray**

Objective: The term proteome describes the protein complement expressed by a genome, and proteomics is the systematic study of the full set of proteins encoded by a genome for their expression, localization, functions, interactions, and post-translational modifications. This course intends to provide a comprehensive understanding of the basic and advanced proteomics techniques and will elaborate on their diverse applications. A basic understanding of proteins and proteomics will be discussed in the initial part of the course. The second part of the course will focus on the principles and technical aspects of current methodologies used in quantitative proteomics analyses. This includes Two-dimensional gel electrophoresis (2-DE), Difference in-gel electrophoresis (DIGE), Label-based and label-free high-resolution mass spectrometry, Database search, and data analysis pipelines. The subsequent part of the course will accentuate the diverse applications of the quantitative proteomics approaches in basic and translational research with case studies derived from the published scientific literature.

Course contents: Introduction to proteomics, Transition from genomics to proteomics - prospects and challenges, Protein purification and separation technologies, Two-dimensional gel electrophoresis (2-DE), Difference in-gel electrophoresis (DIGE), Fundamentals of mass spectrometry, Soft ionization methods [Matrix assisted laser desorption/ionization-Time of Flight (MALDI-TOF), and Electro-spray ionisation (ESI)], Tandem Liquid Chromatography-Mass spectrometry (LC-MS/MS), Next-generation ultra-high resolution mass-spectrometry, Label-based (SILAC, iTRAQ, and TMT) and label-free (LFQ) quantitative proteomics, Applications of proteomics-studying disease pathogenesis, host-pathogen interactions, biomarker discovery, elucidating mechanism of drug actions, analysis of biomolecular interactions, analysis of post-translational modifications (phosphorylation and glycosylation), and study of biological rhythms and sleep. **Practical component:** Mass spectrometry data visualization, Database search and analysis of quantitative proteomics data (MASCOT and MaxQuant), Interpretation of MaxQuant analysis output files, Statistical analysis of MS-MS data.

Text books:

1. Stephen Pennington and Michael J Dunn. Proteomics: From Protein Sequence to Function. Viva Books Private Limited, ISBN: 9789386105998.
2. Nawin C. Mishra and Günter Blobel. Introduction to Proteomics: Principles and Applications. Wiley Publication, ISBN: 978-0-471-75402-2.
3. Josip Lovric, Introducing Proteomics: From Concepts to Sample Separation, Mass Spectrometry, and Data Analysis. Wiley-Blackwell, ISBN-13: 978-0470035245.

Reference books:

4. Reiner Westermeier and Tom Naven. Proteomics in Practice: A Laboratory Manual of Proteome Analysis. Wiley VCH, ISBN: 978-3527303540
5. Reinders Jörg and Sickmann, Albert. Proteomics: Methods and Protocols (Methods in Molecular Biology), Springer, ISBN: 978-1-60761-156-1.
6. Rune Matthiesen. Mass Spectrometry Data Analysis in Proteomics (Methods in Molecular Biology), Humana; 3rd ed. 2020 edition, ISBN: 978-1493997435

Course code	**BT6053**
Course name	**Advanced Microscopy and Image Processing**
Credit	**2**
Semester	**1**
Instructor	**Dr. Gunjan Mehta**

Objective: Fluorescence microscopy makes the cellular processes and structures visible. Recent advancements in the field made it possible to visualize a cell in 5D, visualize cellular structures with super-resolution, quantify the dynamics of DNA and proteins at the single-molecule level, and measure the cellular forces at the piconewton level with optical tweezers. This course offers the basics of fluorescence microscopy and its applications in life science research, digital images and camera technologies used in microscopy, and the quantification of biological information from fluorescence microscopy images.

Course contents: Introduction to fluorescence microscopy and its applications; design of a fluorescence microscope and its optics; various illumination strategies such as wide field, confocal, TIRF/HILO, light sheet; fluorescent proteins, dyes, and fluorescence labeling strategies; 3D imaging; live cell imaging; time-lapse imaging; super-resolution microscopy (SIM, STED, STORM/PALM); single-molecule imaging; optical tweezers and traction force microscopy; high content imaging; techniques such as FRET, FRAP, FLIM, immunofluorescence, Fluorescence In-situ Hybridization (FISH), Spatial mapping of gene expression (RNAscope); digital images and camera technologies; introduction to Fiji/ImageJ, application of artificial intelligence/machine learning and virtual reality in image analysis. The **practical component** of this course includes image processing, data analysis, quantification, and visualization using Fiji/ImageJ. Quantification of biological information from the microscopic images, intensity measurement, image segmentation, colocalization, quantification, and visualization of 3D images, deconvolution, 3D rendering, and reconstruction.

Reference books:

1) Microscope Image Processing by Qiang Wu, Fatima Merchant and Kenneth Castleman, Academic Press, ISBN: 012372578X

2) Fundamentals of Light Microscopy and Electronic Imaging by Douglas Murphy and Michael Davidson, Second Edition, Wiley-Blackwell publisher, ISBN: 047169214X.

3) Introduction to optical microscopy by Jerome Mertz, Cambridge University Press, 2nd Edition, doi: 10.1017/9781108552660, ISBN: 9781108552660

4) Fluorescence Microscopy: From Principles to Biological Applications by Ulrich Kubitscheck, 2nd edition, John Wiley & Sons publisher, eBook ISBN 9783527687725

Online resources:

e-resource: https://www.microscopyu.com/
e-resource: https://www.ibiology.org/online-biology-courses/microscopy-series/
e-resource: http://zeiss-campus.magnet.fsu.edu/index.html
e-resource: https://www.leica-microsystems.com/science-lab/topics/basics-in-microscopy/
e-resource: https://www.olympus-lifescience.com/en/microscope-resource/
e-resource: https://imagej.nih.gov/ij/docs/examples/index.html

Course code	BT6330
Course name	RNA Biology and Therapeutics
Credit	**2**
Semester	**1**
Instructor	**Dr. Ashish Misra**

Objective: The course aims to bridge fundamental aspects with the cutting-edge new discoveries in the field of RNA Biology. Due to ongoing rapid advances in the field, the course will integrate classroom teaching with discussions and will rely heavily on discussing scientific papers critically.

Course contents: The course will cover metabolism and functions of RNA including synthesis, structure, processing, function and degradation of mRNAs, miRNAs, snoRNAs, rRNAs, tRNAs and long noncoding RNAs. A significant portion of the course will focus on the recent advances in RNA biology field including RNA interference, the role of RNAs in human diseases and RNA-based therapeutics. The course will also cover the role of long noncoding RNAs and RNA modifications in regulating gene expression.

Reference books:

1. Molecular Biology of Cell, Bruce Alberts (2014) 6 th edition. Garland Science
2. RNA Worlds: From Life's Origins to Diversity in Gene Regulation, by John F. Atkins (Editor), Raymond F. Gesteland (Editor), Thomas R. Cech (Editor) 1 st edition."

Course code	BT6240
Course name	Structural Biology
Credit	**2**
Semester	**1**
Instructor	**Dr. Rajakumara Eerappa**

Objective: The course emphasis on techniques used to determine and analyze the macromolecules organization and interactions. The course aims on case studies which enable students to use the information obtained from macromolecular structures and interactions studies for understanding a biological process.

Course contents: Quantification and characterization of interactions, involving proteins with other molecules termed as ligands (proteins, nucleic acids, carbohydrate, peptide, inorganic molecules etc), using appropriate biophysical techniques. Characterization of macromolecular assembly using principal techniques. Principles of protein and nucleic acid structures: Three-dimensional conformations of proteins and nucleic acids. Covalent, non-Covalent and van der Waals interactions role in protein and nucleic acids structure and folding. Use of Ramachandran plots and other tools for structure validation. Graphics tools to visualize and analyze atomic structure of macromolecules. Bioinformatics tools for analyzing motifs and folds. Protein and nucleic acids folding problem. Case study for understanding biological phenomena with structures.

Text books:

1. Protein-Ligand Interactions: hydrodynamics and calorimetry (A Practical Approach): S. E. Harding and B. Z. Chowdhry (2001) , Oxford University Press
2. Introduction to Protein Structure: C. Branden and J. Tooze (1999) 2nd edition, Garland Science
3. Biophysical Chemistry: Part II: Techniques for the Study of Biological Structure and Function by Charles R. Cantor, Paul R. Schimmel

Reference books:

1. Biophysics: An Introduction: R. Glaser (2010, 2012) Springer
2. Textbook of Structural Biology: A. Liljas, L. Liljas, J. Piskur, G. st Lindblom, P. Nissen and M. Kjeldgaard (2009) 1st edition, World Scientific Publishing Company

Departmental Elective courses
(semester 2)

Course code	**BT6150**
Course name	**Molecular Basis of Cancer**
Credit	**2**
Semester	**2**
Instructor	**Prof. Anindya Roy**

Objective: This course is designed to give molecular level understanding of cancer to post-graduate students.

Course contents: Etiology of cancer, oncogenes, Signaling pathways in cancer, Tumor suppressor genes, Cell cycle control and cancer, DNA Damage, and Cell Cycle Checkpoints, Immune system and cancer, Multistep process of carcinogenesis.

Text books:

1. The Biology of Cancer (3rd edition). Robert Weinberg; Garland Science; 2017
2. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics (3rd edition); Lauren Pecorino, Oxford University Press; 2016

Course code	**BT6670**
Course name	**Stem cell Biology and Regenerative Medicine**
Credit	**2**
Semester	**2**
Instructor	**Dr. Ashish Misra**

Objective: The course aims at providing students a solid foundation in stem cell biology and human diseases connected to stem cell biology. The course will also cover the stem cell therapies that are currently being used in clinics and discuss the future treatments that lie on the horizon. Due to the ongoing advances in the field, students will be expected to read and present seminal research literature on stem cell biology.

Course contents: The course will include basics of stem cell biology, induced pluripotent stem (iPS) cells, biochemistry of pluripotency, stem cell epigenetics, embryonic and adult stem cells, tumor stem cells, cloning and stem cell reprogramming, stem cell research methodologies and clinical applications of stem cell research. The course will also cover ethical and legal issues raised by embryonic stem cell work.

Suggested reading:

1. Lanza R et al. Essentials of Stem Cell Biology. Elsevier Inc.
2. Marshak DN et al. Stem Cell Biology. Cold Spring Harbor Laboratory Press
3. Rex Turner. Stem Cells: Biology and Diseases

Course code	**BT6133**
Course name	**Protein Technology**
Credit	**2**
Semester	**2**
Instructor	**Dr. Basant K Patel**

Objective: The course aims at providing required knowledge of advances in protein research for industrial and medical applications to post graduate students.

Course contents: Over-view of Protein structure and function. Recombinant protein expression systems: *E.coli, Pichia*, Insect-cells, cell-free protein expression systems. Protein purification techniques: Ion-exchange chromatography; Gel-filtration; Affinity chromatography; FPLC; HPLC. Small and large scale purification; Protein characterization: Two-dimensional Gel electrophoresis; Mass spectrometry; Proteomics; Fluorescence Spectrometery; Circular Dichroism, Isothermal Titration Calorimetry. Protein folding-misfolding; Inclusion bodies; Mutant design and site-directed mutagenesis; Therapeutic proteins.

Text books:

1. Introduction to Protein Structure; Carl brendon & John Tooze2nd edition, Garland Publishing; 1999.
2. Molecular Biotechnology Bernard R. Glick, Jack J. Pasternak; 4th Edn; 2010.
3. The protein protocol handbook; John M Walker, Humana press; 2009.

Reference books:

1. Introducing Proteomics; Josip Lovric Wiley press; 2011.
2. Therapeutic Proteins: Methods and Protocols (Methods in Molecular Biology) C. Mark Smales David C. James Edn; Humana Press; 2005.
3. Exploring proteins: Nick Price & Jacqueline Narin; Oxford University Press; 2009.

Course code	**BT6290**
Course name	**Molecular Machines: DNA interacting proteins**
Credit	**2**
Semester	**2**
Instructor	**Dr. NK Raghavendra**

Objective: The course provides detailed view of nature engineering a multicomponent system. The students will understand the processes carried out by the molecular machines, structural details of components making up the system, coordination of functions among the components and techniques available to characterize the microscopic machines.

Course contents: Introduction: DNA-protein interactions; DNA polymerase: A multifunctional molecular machine; Endonuclease: Mechanisms of cleaving DNA; DNA repair: Recognition and rectification; Recombination: Homologous and non-homologous; Transposition: Jumping genes; Topoisomerase: Unwrapping DNA; Telomerase: Maintaining the DNA ends; Modification: Epigenetic changes

Reference books:

1. Lewin's Genes X. *Authors*: Jocelyn E. Krebbs, Elliott S. Goldstein and Stephen T. Kilpatrick. Published by Oxford University Press (2011).
2. Molecular Biology of Cell, 5th Edition. *Authors*: Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Published by Garland Science (2008).

Course code	**BT7053**
Course name	**Biomolecular NMR**
Credit	**2**
Semester	**2**
Instructor	**Dr. T Rathinavelan**

Objective: The objective of the course is to provide the fundamental concepts in NMR and applications of NMR in understanding the biomolecular structure & dynamics

Course contents: Properties of electromagnetic radiation - Magnetic properties of nuclei - The nucleus in a magnetic field - Spin populations at thermal equilibrium and the NMR phenomenon - The classical vector model - Chemical shift - J coupling - FID - A simple one-pulse experiment - Relaxation - Inversion-recovery method - Spin-echo method - Chemical exchange - Instrumentation - Setting up an NMR experiment - NOE- 2D and 3D NMR experiments & Sequential assignment strategies.

Text books:

1) Understanding NMR spectroscopy, James Keeler, 2011, Wiley
2) Fundamentals of Protein NMR Spectroscopy (Focus on Structural Biology), Gordon S. Rule, T. Kevin Hitchens, 2006, Springer
3) Biomolecular NMR spectroscopy, Jeremy N. S. Evans, 1995, Oxford

Reference books:

1) NMR of proteins and nucleic acids, Kurt Wuthrich, 1986, Wiley-Interscience
2) Modern NMR Spectroscopy: A Guide for Chemists, 2nd edition, Jeremy K. M. Sanders, Brian K. Hunter, 1993 (reprinted 2009), Oxford University Press

Course code	**BT6180**
Course name	**Macromolecular Crystallography**
Credit	**1**
Semester	**2**
Instructor	**Dr. Rajakumara Eerappa**

Objective: This course is designed to give insights on macromolecules crystallization and resolving their structure by X-ray crystallography.

Course contents: Art of macromolecules crystallization: The course deals with the rational approaches and methods in protein-protein and protein-nucleic acids crystallization. 7

X-ray Crystallography: Crystal symmetry and systems. X-ray diffraction, Structure factors and Phase problem in crystallography. Electron density equation and Phasing methods in crystallography. Model building and Refinement. Use of Ramachandran plots and other tools for structure validation. Graphics tools to visualize and analyze atomic structure of macromolecules. Case study for understanding biological phenomena with structures.

Text books:

1. Protein crystallography : T. L. Blundell, L. N. Johnson (1976), Academic Press
2. Outline of Crystallography for Biologists: D. Blow (2002), Oxford University Press

Reference book:

Biomolecular Crystallography: Principles, Practice, and Application to Structural Biology: B. Rupp (2009) 1st edition, Garland Science

Course code	**BT5050**
Course name	**Medical Microbiology and Infectious Diseases**
Credit	**2**
Semester	**2**
Instructor	**Dr. Sandipan Ray**

Objective: This course's overall objective is to provide a detailed understanding of the nature, distribution, and activities of microbes and how they impact health and well-being, most particularly as the agents of clinical infectious diseases.

Course contents: Introduction to Medical Microbiology; Observing Microorganisms through a Microscope; Morphology and nature of microorganisms; Classification, Identification, and Diversity of Bacteria; Bacterial Growth, Physiology and Death; Microbial Metabolism; Sterilization and Disinfection; Antimicrobial Agents; Human Microbiome in Health and Disease; Pathogenicity of Microorganisms; Basic Principles of Adaptive Immunity and Immunization; Interaction Between Microbes and Hosts; Human Diseases Caused by Bacteria; Human Diseases Caused by Viruses and Prions; Human Diseases Caused by Fungi and Protists; Microbial Diseases of the Skin and Eyes, Microbial Diseases of the Nervous System, Microbial Diseases of the Cardiovascular and lymphatic Systems; Microbial Diseases of the Respiratory System; Microbial Diseases of the Oral and Gastrointestinal Systems; Microbial Diseases of the Urinary and Reproductive Systems; Coronavirus disease 2019 (COVID-19); Infection Control and Epidemiology; Systems Level Approaches to Study Infections

References:

1. Jacquelyn G. Black and Laura J. Black. Microbiology Principles and Explorations, Wiley, 10th Edition (2018), ISBN: 978-1119390039.
2. Joanne Willey, Kathleen Sandman and Dorothy Wood. Prescott's Microbiology. McGrawHill11th Edition (2020). ISBN: 9781260211887.
3. Patrick R. Murray, Ken S. Rosenthal, and Michael A. Pfaller. Medical Microbiology. Elsevier; 9th edition (2020), ISBN: 978-0323673228.
4. David Greenwood, Richard Slack, Michael Barer, and W L Irving. Medical Microbiology. Churchill Livingstone; 18th Edition (2012), ISBN: 9780702040894.
5. William F. Wright. Essentials of Clinical Infectious Diseases. Springer Publishing Co Inc., 2nd edition (2018), ISBN: 978-0826127273.
6. Michael R. Barer and Will L. Irving, Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory. Elsevier; 19th edition (2018). ISBN: 978-0702072000.

Course code	**BT6083**
Course name	**Programming for biomacromolecular data analysis**
Credit	**2**
Semester	**2**
Instructor	**Dr. T Rathinavelan**

Objective: This course is designed to provide knowledge about the interdisciplinary approach to address biological problems.

Course contents: Linux commands: ls, vim, emacs, grep, sed, awk etc., shell scripting: if condition, while loop *etc.* and their application in editing, organizing and transferring Protein Databank (PDB) files towards modeling and analyses of biomacromolecular structures. Python scripting for genomic/proteomic sequence analysis.

Text books:

1. Computational Biology: Unix/Linux, Data Processing and Programming by Röbbe Wünschiers, 2004, Publisher: Springer.

2. A practical guide to Linux, Commands, Editors and Shell programming by Mark G Sobell, 2014, Pearson
3. Learning python (5th Edition) by Mark Lutz, O'Reilly Media, Inc.

Reference book:

1. Beginning Linux Programming by Neil Matthew, Stones Richard, 2004, Publisher: New Delhi Wiley Dreamtech India Pvt. Ltd.

Course code	**BT6223**
Course name	**Pharmaceutical biotechnology**
Credit	**2**
Semester	**2**
Instructor	**Dr. Rajakumara Eerappa**

Objective: Deals with the principles of biotechnology are applied to the development of drugs.

Course contents: Introduction and history of biologics and biopharmaceuticals; Macromolecular structure relevance to biologics/biosimilars; Stereoisomers and drugs, Biotechnology in rational biodrug design; Role of Biotechnology in vaccine design: Virus like particles and protein nanocages; Synthesis and downstream processing of bioformulations; determining the product shelf life, stability, toxicity and immunogenicity and product analysis; Pharmacogenetics and chemical genetics in drug discovery; Effect of protein post translational modifications on protein formulations and methods/technology for their production in the laboratory.

Text books:

1. Pharmaceutical biotechnology: concepts and applications, gary walsh, wiley publications, 2007
2. Biopharmaceuticals biochemistry and biotechnology, second edition, gary walsh, wiley publications, 2003

Course code	**BT6063**
Course name	**Animal models in medical research**
Credit	**1**
Semester	**2**
Instructor	**Dr. Anamika Bhargava**

Objective: The learning outcome of this course is knowledge about use of animal models in medical research. This course has a hands-on module.

Course contents: Various animals as models and their advantages and disadvantages, Animal research in medicine: modelling heart damage, autoimmune diseases, tuberculosis, Parkinson's, Upcoming vertebrate animal model: zebrafish, Practical session using animal model zebrafish

Text books:

1. Animal models in cardiovascular research. David Gross, Springer 2009
2. The laboratory zebrafish. Claudia Harper and Christian Lawrence. CRC Press. Dec 2010.

Reference literature:

1. Animal models of human cardiovascular disease, heart failure and hypertrophy. Gerd Hasenfuss. Cardiovasc Res (1998) 39 (1): 60-76.
2. Classic and New Animal Models of Parkinson's Disease. Javier Blesa, Sudarshan Phani, Vernice Jackson-Lewis,and Serge Przedborski. Journal of Biomedicine and Biotechnology. Volume 2012 (2012).

3. Animal Models in Autoimmune Diseases: Lessons Learned from Mouse Models for Sjögren's Syndrome. Byung Ha Lee,1 Adrienne E. Gauna,1 Kaleb M. Pauley,2 Yun-Jong Park,1 and Seunghee Cha. Clin Rev Allergy Immunol. 2012 Feb; 42(1): 35–44.
4. Various recent articles

Course code	**BT4020**
Course name	**Essential Fatty acids-Biochemistry, physiology and Clinical significance**
Credit	**1**
Semester	**2**
Instructor	**Prof. UN Das**

Objective: The objective of this course is to make the students aware about how the Bioactive lipids play an important role in energy homeostasis, cell proliferation, metabolism, inflammatory homeostasis, and process regulation.Essential fatty acids (EFAs).

Course contents: Essential fatty acids (EFAs) and their metabolism, Metabolites formed from EFAs and their role in inflammation, Relationship between cytokines and eicosanoids, EFAs and free radicals and nitric oxide, EFAs and eicosanoids in chronic inflammation, Eicosanoids in cancer, Role of eicosanoids in the shift from acute inflammation to chronic inflammation, Immune check point inhibitors and eicosanoids and EFAs, Tumoricidal action of EFAS and other metabolites, EFAs and eicosanoids in autoimmune diseases, EFAs and eicosanoids in health and disease.

Further studies/references:

1. DasUN. Clinical laborator tools to diagnose inflammation. Adv Clin Chemistry 2006; 41: 189-229.
2. Poorani R, Bhatt AN, Dwarakanath BS, Das UN. COX-2, aspirin and metabolism of arachidonic, eicosapentaenoic and docosahexaenoic acids and their physiological and clinical significance. Eur J Pharmacol
3. Das UN. Current and emerging strategies for the treatment and management of systemic lupus erythematosus based on molecular signatures of acute and chronic inflammation. *J Inflammation Res* 2010: 3: 143–170.
4. Das UN. Lipoxins, resolvins, protectins, maresins and nitrolipids: Connecting lipids, inflammation, and cardiovascular disease risk. *Current Cardiovascular Risk Reports* 2010; 4: 24–31.
5. Das UN. Lipoxins, resolvins, protectins, maresins and nitrolipids and their clinical implications with specific reference to cancer: Part I. *Clin Lipidol* 2013; 8: 437–463.
6. Das UN. Arachidonic acid and lipoxin A4 as possible endogenous anti-diabetic molecules. Prostaglandins Leukot Essent Fatty Acids. 2013 Mar;88(3):201-10.
7. Das UN. Bioactive lipids in intervertebral disc (IVD) degeneration and its therapeutic implications. BioSci Rep, in press.
8. Das UN. Bioactive Lipids in Shoulder Tendon Tears. Am J Pathol, in press.
9. Das UN. Saturated Fatty Acids, MUFAs and PUFAs regulate ferroptosis. Cell Chem Biol 2019; 26: 309-311.

Course code	**BT5060**
Course name	**Genome Organization and Gene Regulation**
Credit	**2**
Semester	**2**
Instructor	**Dr. Gunjan Mehta**

Objective: How the eukaryotic genome is organized in the cell nucleus during interphase and packaged into chromosomes during mitosis, and how its packaging affects gene regulation? This is currently an active area of research worldwide. This course makes students familiar with this research area, its significance in human diseases, and the advanced technologies (Chromosome Conformation Capture (3C/4C/5C/Hi-C), Next Generation Sequencing, and Fluorescence In Situ Hybridization) used to study 3D genome organization.

Course contents: How the eukaryotic genome is organized in the cell nucleus and packaged into chromosomes during cell division? Spatial genome organization, dynamics of genome organization, chromosome territories, nuclear architecture and gene regulation, chromosome dynamics during mitosis and meiosis, mitotic bookmarking/epigenetic transcription memory, chromatin remodeling and transcription, 3D genome organization (topologically associated domains (TADs)) and transcription regulation, the 4D Nucleome project, role of phase separation and loop extrusion in 3D genome organization, human diseases (cancers, aging, cohesinopathies) associated with defects in genome organization, role of 3D genome organization in development and cell differentiation, techniques to study chromosome dynamics/genome organization (Chromosome Conformation Capture (3C), immunofluorescence, chromatin spread, FISH, chromatin immunoprecipitation (ChIP), live cell imaging, Fluorescence recovery after photobleaching (FRAP)) and gene regulation (RT-qPCR, smFISH, live transcript analysis, single-molecule imaging).

Text books:

1. Nuclear Organization and Function by Terri Grodzicker, David Spector, and David Stewart, Cold Spring Harbor Laboratory Press, ISBN: 1936113082
2. The Nucleus by Tom Mistelli and David Spector, Cold Spring Harbor Laboratory Press, ISBN: 0879698942
3. Genome Organization and Function in the cell nucleus by Karsten Rippe, Wiley-VCH Verlag GmbH, ISBN: 9783527639991

Research/Review Articles:

1. Dekker, J., Belmont, A., Guttman, M. et al. The 4D nucleome project. Nature 549, 219–226 (2017).
2. Zheng, H., Xie, W. The role of 3D genome organization in development and cell differentiation. Nat Rev Mol Cell Biol 20, 535–550 (2019). https://doi.org/10.1038/s41580-019- 0132-4
3. Rowley, M. J., & Corces, V. G. (2018). Organizational principles of 3D genome architecture. Nature reviews. Genetics, 19(12), 789–800. https://doi.org/10.1038/s41576- 018-0060-8

Course code	**BT5020**
Course name	**Sequencing Technologies and Precision Medicine**
Credit	**1**
Semester	**2**
Instructor	**Dr. Rahul Kumar**

Objective: Objective of this course is to impart knowledge on sequencing technologies and its application in precision medicine.

Course contents: DNA sequencing technologies (first and next generation), short and long read DNA sequencing, rise of precision medicine, application of sequencing technologies in precision medicine, precision oncology, impact of precision medicine on human health, application of precision medicine in rare disease, future of precision medicine, role of bioinformatics in precision medicine, digital medicine and its relation to precision medicine, industrial opportunities in precision medicine

Text books:

1. Clinical precision medicine; Editor Judy Crabtree; ISBN: 9780128198346; 1st Edition 2019
2. Precision Medicine: A Guide to Genomics in Clinical Practice by Bryce Mendelsohn; ISBN 9781259644139; 1st Edition; 2017
3. Genomic and Precision Medicine by Geoffrey Ginsburg ISBN: 9780128006849; 3rd Edition; 2016

Course code	**BT6010**
Course name	**Critical analysis and presentation of biological literatures**
Credit	**2**
Semester	**2**
Instructor	**Dr. Indranil Malik and Dr Gaurav Sharma**

Objective: This course is designed to enhance critical thinking and communication skills of students – majorly focusing on design, organisation, and oral presentation of scientific literatures. Students will learn how to give and receive critical feedbacks both on their science and communication skills from the course instructors, available faculty, and their peers. Further, the students will learn how to defend their presentation with appropriate scientific temper and incorporate insights from their peers to improve their presentation.

Course contents: By surveying the published journal articles, this course will enable the students to critically analyze and interpret the results of biological experiments, present the data in effective and visually appealing ways, and communicate their science to an expert and layman audience.

providing relevant examples, this course will explain how to present and communicate difficult experimental procedures and complex results for the audience, and possibly suggest better experimental approaches to address the same question. This course will encompass the principles governing the effective design and delivery of seminars on biotechnology and bioinformatics topics. It will also emphasize on the identification of deficiencies in presentation slide design and organization, fostering a culture of constructive criticism and critical feedback for the continual refinement of peer presentation skills. Teaching students these skills are highly relevant because it equips them with the tools and competencies necessary to excel in the dynamic and interdisciplinary fields of biotechnology and bioinformatics. These skills are not only essential for their academic success but also for their future careers and contributions to the scientific community.

Text books/references:

1. How to give a great scientific talk (2018). by Nic Fleming; Nature. 2018 Dec;564(7736):S84-S85. doi: 10.1038/d41586-018-07780-5.

2. Beware 'persuasive communication devices' when writing and reading scientific articles (2023). Olivier Corneille et al., Elife. 2023 May 25;12:e88654. doi: 10.7554/eLife.88654.
3. Ten common statistical mistakes to watch out for when writing or reviewing a manuscript (2019). Tamar R Makin et al., Elife. 2019 Oct 9;8:e48175. doi: 10.7554/eLife.48175.
In addition -
We will discuss carefully curated recent and/or landmark articles from peer-reviewed high-impact journals encompassing the field of Molecular Biology, Biotechnology and Bioinformatics.