

## Semester-X

### MBTCR 10271T: Virus Structure and Life Cycles & Epigenetics: Health & Disease

**Total Marks** = 100 (Modules A & B – 60 + Module C - 40); CIA (12+8); End Sem (48+32).

#### **Module A: Structure of Viruses: 24 marks** (2 classes)

**Unit I:** Enveloped and naked viruses: Structural insights; Virus Capsid: Icosahedral and helical capsid structures, Examples: Human papillomavirus, rhinovirus, hepatitis B virus; Complex Viral Structures, Examples: Poxviruses,

**Unit II:** Host pathogen interactions, Mechanism of infection from structural point of view: Human papillomavirus, Dengue virus, Coronavirus.

**Unit III:** Virus-like particles: immunogenicity and their roles as nanovaccines and drug nanocarriers.

#### **Module B: Life Cycle of Viruses: 24 marks** (2 classes)

**Unit IV: Bacteriophage Lambda:** structure, lytic or lysogenic, a paradigm of transcriptional regulation; vectors based on bacteriophage  $\lambda$  genome structure - insertional and replacement vectors.

**Unit V: Flavivirus (Dengue):** structure, life cycle, dynamicity of viral structure, four different strains, antibody dependent enhancement (ADE) of infection, hemorrhagic fever, host's immune response and virus's evasion strategies, vaccine.

**Unit VI: Coronavirus (SARS, MERS, nCoV/SARS-2):** structure, life cycle, direct pathogenesis and immuno-pathogenesis (cytokine storm), host's immune response and virus's evasion strategies, variants, treatment – therapeutics (anti-viral drugs) and prophylactic (vaccines) treatment, nCoV-19 pandemic – lessons learned.

**Unit VII: Applications of Viruses in Biotechnology and Therapeutics:** viral vectors – adenoviral and lentiviral vector systems and their applications in vaccine technology, gene therapy and transgenic technology.

#### **Module C:**

#### **Unit VIII: Epigenetics: Health & Disease: 20 Marks** (1.5 classes)

Dynamics of the epigenome- Chromatin domains and higher order interactions; Genomic imprinting- interaction between genome, epigenome and environment; DNA methylation and tumorigenesis; Diet and epigenetic regulations - the concept of nutriepigenomics.

#### **Unit IX: Computational Epigenetics: 12 Marks** (0.5 classes)

**1. Data Repositories:** Human Epigenome Project and Consortium, ENCODE Database and Data formats

**2. Structural Insights:** Using Genome Browsers for identification of CpG islands and MicroRNA targets using integrated bayesian modeling.

**3. Functional Insights:** Identification of lysine crotonylation sites, methylation sites and phosphorylation sites in functional proteins

**4. Artificial Intelligence towards identification of Gene and Taxon set Enrichment:** Multi-Layer Perceptrons and Pathway Analysis; Predicting Pathogenic Load from Gut Microbial Dataset

**Teachers involved:** Module A - JD (2 classes/week), Module B - US (2 classes/week), Module C – RNC (1.5 classes/week) & SG (0.5 classes/week)

#### **Texts & Reading/Reference Lists:**

Modules A, B & C:

Relevant Research Papers

Module B:

Biochemistry - Voet and Voet

Principles of Gene Manipulation & Genomics – Primrose & Twyman.

## **MBTDS10052T/P: Plant Science and Genetic Engineering & Grand Viva**

**Total Marks: 60 marks: [CIA: 10 Marks; End-Sem: 50 Marks]**

**Module A: 25 marks**

**(2 classes)**

**UNIT I: Chloroplast transformation:** chloroplast genome, advantages of chloroplast transformation, marker genes, transformation methods, designing of plastid transformation vectors and expression cassettes, homoplastomic and heteroplastomic lines, applications and limitations

**UNIT II: Engineering for increased shelf life of fruits:** Post-harvest losses, long shelf life of fruits, antisense RNA technology, use of ACC synthase, polygalactouronase, ACC oxidase, ethylene-responsive genes, promoter elements (ERE), MADS box and transcription factors, ethylene signaling and ERFs; stress signaling

**UNIT III: Metabolic engineering:** Advantages and disadvantages of transgenic plants as bioreactors; Engineering for improved nutrition; Metabolic engineering of carbohydrates and lipids; Bioplastics; Production of plantibodies, edible vaccines and other therapeutic proteins; Oleosin technology

**UNIT IV: Regulatory measures and status of transgenic crops:** Socio-economic and ethical considerations for GM crops, Status of Biotech crops in India, National Biosafety Regulatory Framework in India, Safety guidelines for transgenic research; Cartagena Protocol and applications; CBD and its provisions; contribution of CGIAR, IBPGR and NBPGR

**Module B: 25 marks**

**(2 Classes)**

**UNIT V: In vitro natural product formation:** Production of natural products by plant tissue culture methods, transformed root culture, biotransformation; Biodiversity and conservation of germplasm

**UNIT VI: Application of plant transformation for productivity and performance:** Herbicide resistance - glyphosate, glufosinate, atrazine; Insect resistance - Bt genes, protease inhibitors, Virus resistance and pathogen derived resistance; Disease resistance - bacterial and fungal resistance; Transgenic Male sterility using barnase and barstar; Marker elimination from transgenic plants; Genetic Use Restriction Technology (GURT); Genome editing and CRISPR/Cas9 technology.

**UNIT VII: Computational Plant Biology:** Comparing Plant Genomes, Analysing short read and long read sequence data for functional annotation, Pathway databases and analysis of Gene Enrichment. Basics of plant systems biology - identifying gene networks.

**UNIT VIII: Biosafety aspects of transgenic plants:** Global status of approved genetically modified plants - global GM crop database; Discontinued transgenic products, Environmental risk assessment, food safety assessment, substantial equivalence, toxicological assessment, allergenic potential assessment

**Teachers involved:** Dr. Aryadeep Roy Choudhury (Module A); Dr. Sayak Ganguli (Module B)

## **Texts & Reading/Reference Lists:**

### **Module A:**

1. Plant Biotechnology: Adrian Slater
2. Plant Biotechnology: H.S. Chawla
3. Molecular Biotechnology: Principles and Applications of recombinant DNA; Bernard R. Glick and Jack J. Pasternak, Cheryl L. Patten
4. Transgenic Crop Plants: Utilization and Biosafety Editors: Kole, C., Michler, C., Abbott, A.G., Hall, T.C. (Eds.)
5. Plant Biotechnology, Transgenics, Stress Management, and Biosafety Issues; Edited By Sangita Sahni, Bishun Deo Prasad, Prasant Kumar (Eds).
6. Relevant Research and Review Papers.

### **Module B:**

1. Plant Tissue Culture: Theory and Practice; Bhojwani and Razdan
2. Molecular Biotechnology: Principles and Applications of recombinant DNA; Bernard R. Glick and Jack J. Pasternak, Cheryl L. Patten
3. Transgenic Crop Plants: Utilization and Biosafety Editors: Kole, C., Michler, C., Abbott, A.G., Hall, T.C. (Eds.)
4. Plant Biotechnology, Transgenics, Stress Management, and Biosafety Issues; Edited By Sangita Sahni, Bishun Deo Prasad, Prasant Kumar (Eds).
5. Relevant Research and Review Papers.

## **Grand Viva: 40 marks**

## **[MBTDS 10061T]: Disease and Stress Biology**

**Theory: CIA: 20 Marks; End-Sem: 80 Marks**

### **Module A: 40 marks**

**(3 Classes)**

**Unit I:** Cellular stress response: heat shock response or the unfolded protein response, autophagic cell death

**Unit II:** Molecular mechanisms of major neurodegenerative diseases: Alzheimer's disease and tauopathies (the role of specific molecules and cellular pathways that are responsible in neuronal death of these diseases (e.g. amyloid precursor protein or APP, and APP processing in neurons are responsible in the development of Alzheimer's disease); Parkinson's disease; Huntington's disease; amyotrophic lateral sclerosis; prion diseases

### **Module B: 25marks**

**(2 classes)**

**UNIT III: Metabolism and metabolic disorders:** Metabolic division of labour; Homeostatic control of metabolism; Overview of metabolism and metabolic disorders (Clinical case studies and examples from carbohydrate, protein, lipid, nucleic acid, vitamin related disorders).

**UNIT IV: Integrative physiology and associated disorders:** Concept of Integrative physiology, homeostasis and control; Pathophysiology of body systems (System specific examples and case studies).

**Module C: 15 Marks**

**(1 class)**

**Unit V:** Bacterial Mechanisms of Antibiotic Resistance: A structural perspective

**Unit VI:** Multidrug resistance and ABC transporters

**Unit VII:** The Roles of Eukaryotic and Prokaryotic ABC Transporter Families; Failure of Chemotherapy.

**Teachers involved:** Dr. Chandana Barat (Module A); Dr. Priyanka De (Module B); Dr. Jhimli Dasgupta (Module C)

**Texts & Reading/Reference Lists:**

- 1) Textbook of Medical Physiology. A.C. Guyton, J.E. Hall (11th ed.).
- 2) Berne and Levy Physiology. B.M. Koeppen, B.A. Stanton (6th ed.).
- 3) Atlas of Human Anatomy - Frank H. Netter (6th Ed).
- 4) Neurobiology. G.G. Matthews (2nd ed.).
- 5) Lehninger Principles of Biochemistry. M.M. Cox, D.L. Nelson (5th ed.).
- 6) Harper's Illustrated Biochemistry. R.K. Murray, D.K. Granner, V.W. Rodwell, (29th ed.).
- 7) Biochemistry-Mathwes, Van Holde (3rd ed.)
- 8) Review and articles wherever appropriate

**MBTDS 10073D: Dissertation (100 marks)**