

Semester IX

[MBTCR 9231T]: Advanced Genetics, Biostatistics

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

Module A: Advanced Genetics (40 marks)

(3 classes per week)

UNIT I: Population Genetics: Genetic variation in populations, the Hardy-Weinberg law, determination of allelic frequencies and testing a locus for Hardy-Weinberg equilibrium, effects of mutation, migration, genetic drift and natural selection on allele frequencies, heterozygote superiority, assortative mating.

UNIT II: Genetic Screening & Gene Therapy: Screening for genetic diseases: prenatal testing and newborn screening, molecular markers, testing using RFLP analysis and PCR based approaches. Gene therapy: types of gene therapy, delivery vehicles for gene therapy, gene therapy in humans.

UNIT III: The Genetics of Cancer: Cancers as genetic diseases, proto-oncogenes, cellular oncogenes and retroviral oncogenes, tumour suppressor genes, the roles of pRb and p53, tumour suppressor genes in breast cancer.

UNIT IV: Genetics in Conservation: Importance of genetic diversity in conservation, effects of genetic erosion, inbreeding and reduction in gene flow. Population augmentation strategies.

Module B: Biostatistics and Quantitative Genetics (40 marks)

(3 classes per week)

UNIT V: Biostatistical Methods: Biostatistical terms, Sampling methods, statistical errors; χ^2 tests: degrees of freedom, simple, and contingency χ^2 , application of χ^2 test; t-test: unpaired t-test (large sample and small sample), paired t-test; ANOVA: one way and two way, Correlation and Regression. Basic R commands for statistical analysis.

UNIT VI: Quantitative genetics: Nature and inheritance of continuous traits, polygene hypothesis, quantitative genetic analysis, heritability and its measurements, broad sense and narrow sense heritability. Role of Genome Wide Association Studies (GWAS).

Teachers involved: Dr. Aniruddha Banerji (Module A), Dr. Sayak Ganguli (Module B)

Texts & Reading/Reference Lists:

Module A:

- 1) P. J. Russell. iGenetics- A Molecular Approach.
- 2) A.J.F. Griffiths, S.R. Wessler, R.C. Lewontin S.B. Carroll. An Introduction to Genetic Analysis.
- 3) B.K. Hall, B. Hallgrimsson. Strickberger's Evolution.
- 4) S. Rastogi, N. Pathak. Genetic Engineering.
- 5) S.B. Primrose, R.M. Twyman. Principles of Gene Manipulation & Genomics.
- 6) R.A. Weinberg. The Biology of Cancer.
- 7) Relevant scientific literature.

Module B:

- 8) P.J. Russell. Quantitative genetics: iGenetics – A Molecular Approach.
- 9) N.G. Das. Statistical methods Vol I & II.
- 10) Basic Biostatistics 2nd Edition B. Burt Gerstman
- 11) Basic Biostatistics for Geneticists and Epidemiologists; Elston Robert C

MBTCR 9242T/P: Animal Biotechnology

Theory: CIA: 10 Marks; End-Sem: 50 Marks

Practical: 40 Marks

Module A: (25 marks)

(2 classes per week)

UNIT I: Animal Cell and Tissue Culture: Standard techniques and equipment for animal cell and tissue culture, culture media and its components, the role of serum, serum free cultures, primary cultures, cell lines, maintenance of attached and suspended cell types in culture, measurement of cell growth and viability, sub culturing.

UNIT II: Cancer Biology: Cancer and tumour progression: stages of cancer and tumour progression, carcinogens and carcinogenesis, metastasis, role of proteases in cancer with reference to matrix metalloproteinases (MMPs), signal transduction cascades in cancer, models for cancer propagation. Molecular diagnosis of haematological cancers and carcinomas. Cancer therapy: Chemotherapy, radiotherapy, gene therapy strategies, use of signalling pathway inhibitors and natural products in cancer therapy, resistance to cancer therapy.

UNIT III: Cloning in Animals: Strategies and methods for nuclear transfer and animal cloning.

Module B: (25 marks)

(2 classes per week)

UNIT IV: Biotechnology and Applied Zoology: (i) Culture of economically significant insects: Lac culture, Sericulture, Apiculture (Overview of culture methodologies, breed management and improvement), (ii) Poultry and dairy farming (Overview of farming techniques, breed management and improvement), (iii) Fisheries (culture systems, induced breeding in fish, fish hybridization), (iv) Pharmaceuticals from animals

UNIT V: Pest Control and Management: Concept of injury level, Integrated pest management, Genetic manipulation and new generation pesticides in pest management.

UNIT VI: Bioethics and animal biotechnology: Bioethical concerns in cell culture biotechnology, animal handling, maintenance of animal house and care of animals, clinical trials.

Teachers involved:

Dr. Aniruddha Banerji (Module A)

Dr. Priyanka De (Module B)

Practical (40 Marks)

1. Animal Cell and Tissue Culture Techniques: Maintenance of cell cultures, cell count and determination of viability.

2. Analysis of Proteins and Enzymes: Extraction and visualization of proteins, determination of enzyme activity.

3. Analysis of Nucleic acids: Isolation and visualization of nucleic acids.

4. Histochemistry: Histochemical detection of physiologically important substances.

5. Chromosome and Genetic Studies: Study of meiotic chromosomes, *Drosophila* as model organism for genetics, polytene chromosomes (from photographs).

6. Water quality parameters for culture of aquatic organisms.

7. Applied Zoology: Study of animals of economic and ecological importance.

8. Report on educational tours/ laboratory visits for study of topics relevant to animal biotechnology.

Teachers involved:

Dr. Aniruddha Banerji

Dr. Priyanka De

Texts & Reading/Reference Lists:

- 1) R.I. Freshney. Culture of Animal Cells – a Manual of Basic Techniques.
- 2) R.A. Weinberg. The Biology of Cancer.
- 3) G.M. Cooper, R.E. Hausman. The Cell – A Molecular Approach.
- 4) S. Rastogi, N. Pathak. Genetic Engineering.
- 5) S.B. Primrose, R.M. Twyman. Principles of Gene Manipulation & Genomics.
- 6) R.L. Metcalf, W.H. Luckmann. Introduction to Insect Pest Management.
- 7) D. Dent. Insect Pest Management.
- 8) P.V. Jabde. Text Book of Applied Zoology.
- 9) Fish and fisheries of India, V. G. Jingran, Hindustan Pub. Corp. New Delhi.
- 10) Fisheries & Aquaculture Biotechnology. Yawn Mehta, Campus Books International, Prahalad street, Ansari Road, Durga Ganj, New Delhi.
- 11) K. C. Ghose, B. Manna. Practical Zoology.
- 12) T.K. Poddar, S. Mukhopadhyay, S.K. Das. An Advanced Laboratory Manual of Zoology.
- 13) Relevant scientific literature.

MBTCR 9252T/P: Structural Biology and Protein Misfolding & Aggregation

Theory: CIA: 10 Marks; End-Sem: 60 Marks

Module A: (70 Marks)

(4 Classes per Week)

Structural Biology

UNIT I: Protein crystallography: Principle of crystallizations and crystal growth, X-ray scattering by atoms and UNIT cells of crystals, Review of Fourier transforms, Bragg's Law, Point groups, Bravais lattices, indexing of lattice planes, space groups, Phasing- Isomorphous replacement, Molecular replacement, Difference electron density maps-2Fo-Fc, Fo-Fc, omit maps, Refinement, model accuracy.

UNIT II: Small and Wide-Angle X-ray Scattering SAXS & WAXS: Brief overview on principles and applications.

UNIT III: Cryo-electron microscopy of biological macromolecules and complexes: Introduction to electron microscopy and structural biology, The electron microscope and image formation process, Negative staining and cryo-electron microscopy, sample preparation, image reconstructions and available software.

UNIT IV: Structure – function Paradigm: Recent development

Practical: (30 Marks)

(2 Classes per Week)

Protein Misfolding & Aggregation

The fundamentals of protein folding, Thermodynamics and kinetics of protein folding,

Spectral properties (absorbance, fluorescence, CD), Molecular chaperone,

Heat Shock Proteins and their role in human disease,

α -Crystallin as molecular chaperone: a review of its structure and function,

GroEL-GroES as molecular chaperone: Structure and function in GroEL-mediated protein folding and folding mechanism,

Protein misfolding, intrinsically unstructured protein, protein aggregation and its role in neurodegenerative disease.

Teachers involved: Dr. Jhimli Dasgupta (Theory); Dr. Chandana Barat, Dr. Sudipa Saha (Practical)

Texts & Reading/Reference Lists:

1. Crystallography made crystal clear by Gale Rhodes: Chapter 1-7
2. Atomic and Nuclear Physics by SN Ghoshal: Chapter- X-rays
3. Crystallization of Nucleic Acids and Proteins: A Practical Approach by Arnaud Ducruix and Richard Giegé: Chapters: Crystallization of protein.
4. Relevant Research Papers

MBTCR 9261T: Developmental Biology and Neuroscience

Theory: CIA: 20 marks; End-Sem: 80 marks

Module A (40 marks)

(3 classes per week)

UNIT I: Reproductive Health and Modern trends in Reproduction

Reproductive System and health: (a) Basic patterns of reproduction, Functional anatomy of human reproductive system and accessory reproductive glands, concept of reproductive cycle. (b) Reproductive Endocrinology (c) Reproductive Health: Male and female Infertility, Semen analysis.

Gametogenesis: (a) Spermatogenesis and Oogenesis (b) Ultrastructure of sperm and ovum (c) Egg membranes.

Fertilization: (a) Capacitation, (b) Mechanism of fertilization, Prevention of polyspermy.

Cleavage: (a) Types, Role of yolk in cleavage (b) Blastulation, Fate map in chick blastula.

Modern trends in Reproduction: (a) Assisted Reproduction Techniques in human (examples: IVF, GIFT, ICSI, ZIFT) (b) Prenatal and Postnatal diagnosis (example: Amniocentesis) (c) Reproductive toxicology.

UNIT II: Neuro-ethological Perspectives

Neuroethology: Concept of neuro-cognition and metacognition, neural control of emotion, modern neurocognitive aspects.

Learning and memory: Instinctive and learning behavior, fixed action pattern, memory, synaptic plasticity.

Chronobiology & Biological Rhythm: (a) Types of biological rhythms (b) Physiological basis of biological clock, Human circadian rhythms, Applications of circadian rhythm principles (Jet-lag/shift work, Depression, sleep disorders, Chronotherapy) (c) circadian clock in *Drosophila*.

Neurological disorders and stress: (a) Overview of neurological disorders and neurodegenerative disorders. (b) Neurohormonal regulation of stress, Neuroimmunoendocrinology, mind-body therapeutics.

Neurotransmitters: Importance of neurotransmitters in neurological health and neurological disorders.

Module B (40 marks)

(3 classes per week)

UNIT III: Morphogenesis and Organogenesis

Morphogenesis: Morphogenetic movements, gastrulation and formation of germ layers in amphibians, birds and mammals. The Organizer Concept: Spemann's experiments, embryonic induction and organization of the organizer, competence, potency and differentiation.

Organogenesis and Development: (a) Cell aggregation in *Dictyostelium* (b) Paracrine signalling and vulva formation in *C. elegans* (c) Gene regulation during development: Segmentation in *Drosophila*, homeotic gene complexes and the *Hox* genes (d) limb development in vertebrates (e) Development of the brain, formation and differentiation of the neural tube and tissue architecture of the CNS (f) Development of the vertebrate eye (retina, lens and cornea).

Environmental regulation of development: Environmental regulation and disruption of normal development, polyphenism, endocrine disruptors and teratogenic agents.

UNIT IV: Regeneration and Senescence

Stem Cell Biology: Embryonic and adult stem cells, induced pluripotent stem cells, general and cell lineage markers, self renewal factors in stem cells. Stem cell therapies: cell based therapies, therapeutic cloning, cord blood stem cells. Ethical issues related to stem cell research.

Regeneration: Epimorphosis, morphallaxis and compensatory regeneration with examples.

Ageing: ageing and biology of senescence, mitochondrial control of ageing, insulin pathway in ageing, environmental control of ageing.

UNIT V: Genetic and Molecular Basis of Behaviour: Neural pathways and molecular basis of learning, brain mapping.

Teachers involved: Dr. Priyanka De (Module A)

Dr. Aniruddha Banerji (Module B)

Texts & Reading/Reference Lists:

- 1) A.C. Guyton, J.E. Hall. Textbook of Medical Physiology.
- 2) B.M. Koeppen, B.A. Stanton. Berne and Levy Physiology.
- 3) G.G. Matthews. Neurobiology.
- 4) M.M. Cox, D.L. Nelson. Lehninger Principles of Biochemistry.
- 5) B.I. Balinsky. An Introduction to Embryology.
- 6) B.M. Carlson. Foundations of Embryology.
- 7) S.F. Gilbert. Developmental Biology.
- 8) L.A. Dugatkin. Principles of Animal Behaviour.
- 9) J. Alcock. Animal Behaviour.
- 10) Relevant scientific literature.