Semester-VIII

MBTCR 8191T: Ecology and Evolution

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

Module A: 27 marks **(2 classes)**

Unit I: Environment and Biodiversity: physical and biotic environment; biotic and abiotic interactions with model examples; alpha, beta and gamma biodiversity; ecads, ecotypes, ecospecies and coenospecies; biodiversity hotspots and terrestrial biomes

Unit II: Succession and Community ecology: Types; mechanisms; changes involved in succession; seral types; concept of climax; community structure and attributes; approaches for community study and statistical parameters: edges and ecotones

UNIT III: Evolutionary history and consequences: origin of universe and Hubble constant; frozen accident and evolution backward hypothesis; palynology and fossilization processes, dating of fossils, index fossil; form genus and reconstruction of fossil genera; evolutionary time scale and major events; evolution of seed habit and origin of angiosperms; Telome Theory

UNIT IV: Speciation: biological species concept, allopatric and sympatric species, quantum speciation, mechanisms of speciation, types of isolating mechanisms; co-evolution (including mimicry); adaptive radiation

UNIT V: Theories and evidences of evolution: Lamarckism, Darwinism and De Vries' theory – propositions and criticisms; embryological evidences including Haeckel's Biogenetic Law; missing links

Module B: 27 marks **(2 classes)**

UNIT VI: Population ecology: Characteristics of a population, survivorship and growth curves, r and K selection models, deme, Levin's model of metapopulation and relevant theories. Population regulation, role of density dependent, density independent, extrinsic and intrinsic factors, dominance diversity curves

UNIT VII: Species interactions & Conservation: Competition, predation, mutualism, detritivory. Principles and practice of conservation biology,IUCN and the Red Data Book, Project Tiger and conservation of Olive Ridley turtles as case studies, wetland management

UNIT VIII: Origin and Evolution of Life: Concept of Oparin, Miller's experiment, the first cell, RNA world, the evolution of metabolism, prokaryotes, eukaryotes and the origin of multicellular organisms. Extinction events: oxygen holocaust, Permo-Triassic and K-T extinctions

UNIT IX: Origin and Evolution of Vertebrates: Origin of vertebrates, reptilian evolution and dinosaur evolution timeline, mammalian evolution, origin and evolution of man, adaptive radiation

Module C: 26 marks **(2 classes)**

UNIT X: Ecosystem and Conservation: (a) Ecosystem services, Ecosystem metabolism and Ecosystem dynamics (b) Types and models of food chain and food web (c) Concept of Apex Predator, keystone species, umbrella species, flagship species, Invasive species (d) Ecological limiting factors, ecological footprint, ecological pyramids (d) Ecologically sensitive areas, Corridors, Protected areas, Modern conservation approaches (in situ and ex situ strategy, etc.)

UNIT XI: Habitat and Niche: (a) Concept of habitat and niche, Types of niche (b) Functional dynamics of niche (niche overlap, niche width, competitive exclusion principle, Resource partitioning, character displacement)

UNIT XII: Pollution and management: (a) Current issues of global climate change (b) Air quality management (b) Eutrophication, Arsenic pollution

UNIT XIII: Molecular Evolution and Systematics: (a) Concept of microevolution and macroevolution (b) Phylogenetic systematics, phylogenetic trees, cladistics and phenetics (c) Concept of molecular clocks, neutral theory of molecular evolution (d) Phylogeography, Paralogs and orthologs. (d) Neo Darwinism and modern synthetic theory

Teachers involved

Module A: Dr. Aryadeep Roy Choudhury
Module B: Dr. Aniruddha Banerji
Module C: Dr. Priyanka De

Texts & Reading/Reference Lists:

1) M.C. Dash. Fundamental of Ecology.
2) J.L. Chapman, M.J. Reiss. Ecology: Principles and Applications.
3) P.D. Sharma. Ecology and Environment.
4) P.S. Verma, V.K. Agarwal. Environmental Biology.
5) E.P. Odum. Ecology.
6) B.K. Hall, B. Hallgrimsson. Strickberger's Evolution.
7) D.J. Futuyma. Evolution.
8) M.P. Arora. Evolutionary Biology.
9) Relevant scientific literature.

MBTCR 8201T: Advanced Immunology

Total Marks: [CIA-20 + End Sem – 80]

Module A: (24 marks) **(2 Classes per week)**

Unit I: **Allergy, Hypersensitivities, and Chronic Inflammation:** Gell and Coombs Classification; Allergy or Type I Hypersensitivity; Antibody-Mediated Cytotoxic (Type II) Hypersensitivity; Immune Complex-Mediated (Type III) Hypersensitivity; Delayed-Type (Type IV) Hypersensitivity (DTH); Chronic Inflammation.

Unit II: **Infectious Diseases:** Bacterial infections: Immune Responses to Extracellular and Intracellular Bacteria; Bacterial Evasion of Host Defense Mechanisms; Emerging and Re-emerging Infectious Diseases.

Unit III: **Immunodeficiency Disorders:** Primary Immunodeficiencies, including Combined Immunodeficiencies; Secondary (acquired) Immunodeficiencies, including AIDS.

Unit IV: Cancer and the Immune System: terminology and common types of cancer; malignant transformation of cells; tumor antigens; the immune response to cancer; cancer immunotherapy.

Module B: (56 marks)

Section A: **(24 marks)** **(2 Classes per week)**

Unit V: **Cytokines:** general properties of cytokines and chemokines, six families of cytokines and associated receptor molecules, cytokine antagonists, cytokine-related diseases (cytokine storm), cytokine-based therapies.

Unit VI: **T-cells:** development, activation, differentiation and memory; T cell effector responses; Treg cells; alloreactive T cells.

Unit VII: **Tolerance, Autoimmunity and Transplantation:** establishment and maintenance of central and peripheral tolerance; autoimmunity – organ-specific and systemic autoimmune diseases, proposed mechanisms of onset of autoimmune disorders, immune-suppression treatments of autoimmune diseases; transplantation –

immunological principles leading to graft rejection, target-specific or general immune-suppressive therapy for prevention of graft rejection.

***Section B* : Viruses and Immunity (32 marks) (2 Classes per week)**

Unit VIII: General immune responses to viral infection: innate immune response (intracellular nucleic acid sensors and interferons, NK cells), adaptive immune response (neutralising antibodies, cytotoxic T cells), other cell-mediated immunities important for viral control and clearance, different immune evasion strategies adopted by viruses.

Unit IX: Human viral pathogens: their structure, replication, mechanisms of transmission, and interaction with the immune system – Adenovirus, Herpes virus, Lentivirus, Influenza virus, Ebola virus

Unit X: Treatment for viral diseases: therapeutic (antiviral drugs), prophylactic (vaccines – active immunisation), immunotherapy (cytokine-based therapies, monoclonal antibodies - passive immunisation)

Teachers involved: Dr. Souvik Roy (Module A), Dr. Uma Siddhanta (Module B)

Textbooks:

1. Owen JA, Punt J, Stranford SA. (2013). Kuby Immunology. 7th edition W.H. Freeman and Company, New York.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
4. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
5. Introduction to Modern Virology. Dimmock, Easton and Leppard (6th ed.)
6. Basic Virology. Wagner & Hewlett (2 nd ed.)
7. Principles of Virology. Flint, Enquist, Racaniello & Skalka (3 rd ed.)

MBTCR 8212T/P: Plant Biotechnology

Theory: [CIA: 10 marks , End Sem: 50 marks**], Practical:** 40 marks

Module A: 25 marks (2 Classes per Week)

UNIT I: Gene transfer methods: constitutive and inducible promoters; Chimeric gene vectors; Vector mediated plant transformation by *Agrobacterium*; features of Ti and Ri plasmid; disarmed, cointegrate and binary vectors; particle bombardment; intron-mediated enhancement of gene expression, gene pyramiding and co-transformation; molecular analysis of transgenic plants

UNIT II: Applications of plant tissue culture: Somatic embryogenesis and application; Anther and pollen culture for production of haploids; Somaclonal variation; Protoplast culture and somatic cell hybridization

UNIT III: Engineering abiotic-stress tolerant plants: Abiotic stress (water, temperature and salt) resistance (response & tolerance): *LEA* genes, promoters (ABRE, DRE and coupling elements), transcription factors, osmolytes, antioxidants and antioxidative enzymes, polyamines, membrane transporters and SOS pathway, channel proteins and symporters/antiporters, heat shock proteins, cross talk between ABA-dependent and ABA-independent pathway, kinases in stress signaling, C4 pathway engineering in C3 plants

Module B: 25 marks (2 Classes per Week)

UNIT IV: Plant Breeding: Mass selection and Pure line selection; Bulk method, Pedigree method and Back cross method; Heterosis; Male sterility and its use in plant breeding; Molecular Marker Assisted Breeding and Selection

UNIT V: Concepts of plant tissue culture: History, concept, scope and culture media, Plant Growth Regulators, Aseptic techniques and laboratory safety; Concept of plant stem cells, totipotency Micropropagation – methods, stages, commercial applications and clonal fidelity; Aspects of cellular differentiation, Shoot-tip culture - production of virus free plants; Callus culture - growth and maintenance; suspension culture - growth, maintenance and use; Single cell culture – methods and applications; Embryo culture and embryo rescue – procedures and applications; Endosperm culture and triploid plants – methods and applications; Cryopreservation

UNIT VI: Transgene regulation: Electroporation; microinjection; Viral vectors and their applications; T-DNA insertional mutagenesis; Transgene stability and transgene silencing; Use of scaffold attachment regions in transgenic plant development

Teachers involved: Dr. Aryadeep Roy Choudhury (Module A), Dr. Sayak Ganguly (Module B)

Practical: 40 marks **(4 classes per week)**

Practical Syllabus (ARC + SG - 4 classes)

1. Isolation of genomic DNA from plant specimens
2. Extraction of protein from plant specimens
3. Preparation of plant tissue culture media
4. Surface sterilization of explants
5. Preparation of different explants and initiation of culture, study of organogenesis

Teachers involved: Dr. Aryadeep Roy Choudhury, Dr. Sayak Ganguly

Recommended Texts:

1. Plant Tissue Culture: Basic and Applied - T.B. Jha and B. Ghosh
2. Introduction to Plant Biotechnology – H. S. Chawla
3. Plant Biotechnology – P. K. Gupta
4. Introduction to Plant Tissue Culture – Razdan
5. Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Reinert, J. and Bajaj, Y.P.S.
6. The Genetic Manipulation of Plants - Adrian Slater, Nigel W. Scott, Mark R. Fowler
7. Plant Breeding: Principles and Methods – B. D. Singh
8. Review articles will be provided

MBTCR 8222T/P: Advanced Animal Biology & Advanced RDT Practical

Theory: Advanced Animal Biology [CIA: 10 Marks; End-Sem: 50 Marks],
Practical: Advanced Recombinant DNA Technology [40 marks]

Module A: (38 marks) **(3 classes per week)**

UNIT I: **Animal Taxonomy and Bauplan concept**

(a) Basic principles of zoological taxonomy and zoological nomenclature, Levels of taxonomy, Scope of taxonomy.

(b) Bauplan concept, symmetry and coelom, deuterostomes and protostomes.

(c) General characters and outline of classification of non-chordates (upto class) and vertebrates (upto subclass), classification of mammals (upto orders).

(d) Overview of larval forms in non-chordates.

UNIT II: Special Topics in Animal Biology

(a) Protozoa: Conjugation in *Paramoecium*, pathogenic protozoa and host-parasite interaction.

(b) Porifera: Canal system in sponges

(c) Coelenterata: Polymorphism in Cnidaria, Coral reefs (types, formation, conservation).
(d) Platyhelminthes and Aschelminthes: Pathogenic forms, Parasitic adaptations.
(e) Annelida: Metamerism in Annelida.
(f) Arthropoda: Neuroendocrine control of metamorphosis in insects, Role of insects as vectors of human diseases. Social insects and social systems (concept of eusociality, characteristics of an insect society with reference to ants and termites).
(g) Pisces: Concept of parental investment and various strategies of parental care in fish.
(h)Amphibians: Various strategies of parental care in amphibians, Concept of heterochrony and paedomorphosis (with special reference to *Axolotl* larva).

Module B: (12 marks) (1 class per week)

UNIT III: Animal Behaviour

Communication in Animals: mechanisms of communication with reference to bees (bee dances, chemical communication) and birds (song and song development).
Altruism: Prisoner's dilemma, group and kin selection, reciprocal altruism, inclusive fitness.
Aggressive behaviour: Game theory models of aggression, winner, loser, bystander and audience effects.
Sexual Selection: mating systems, intra and intersexual selection and role in determination of mate quality, runaway sexual selection.

Teachers involved:
Dr. Priyanka De (Module A), Dr. Aniruddha Banerji (Module B)

Texts & Reading/Reference Lists

1) J.Z. Young. The Life of Vertebrates.
2) E.E. Ruppert, R.S. Fox, R.B. Barnes. Invertebrate Zoology.

5) B.J. Bogitsh, C.E. Carter, TN. Oeltmann. Human Parasitology.
6) Bhatia. Medical Parasitology.
7) Kindt, Goldsby & Osborne. Kuby Immunology.
8) J. Alcock. Animal Behaviour.
9) L.A. Dugatkin. Principles of Animal Behaviour.
10) M.W. Strickberger, B.K. Hall, B. Hallgrimsson. Strickberger's Evolution.
11) Relevant scientific literature.

Practical: Advanced Recombinant DNA Technology Practical: 40 marks (4 classes per week)

1. λDNA-Hind III Digestion followed by ligation

2. Ni-NTA protein purification (from cell extract, SDS PAGE)
3. Transformation: pBluescript vector/ XL1 Blue i) Recombinant/ non-recombinant vector ii) Linearised/ Circular vector
4. a) Plasmid DNA preparation from recombinant vector b) Release of insert: i) Single digestion ii) Gel extraction c) PCR from purified recombinant vector

Teachers Involved: Dr. Ronita Nag Chaudhuri, Dr. Jhimli Dasgupta

**End-sem marks are shown with the theory modules.*

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