7. Life Sciences

MDC-1: Basics in Life Sciences

Course objectives:

The paper will provide a comprehensive overview of topics in plant science, anthropology, Zoological Science, and the applications of life science. Students will gain knowledge and understanding of the general features of organisms, the principles and practices in these areas, and the significance of these fields in various contexts.

Learning outcomes:

By completing the paper, students will -

1. Learn the general features of organisms like bacteria, viruses, algae, fungi, bryophytes, pteridophytes, gymnosperms, and angiosperms; about economic botany, disease management, breeding methods, crop domestication, and the role of national institutes in plant breeding; and the importance of agriculture in the national economy.
2. Gather knowledge on the mechanisms of evolution in mammals, primates, modern apes, and human evolution through fossil evidence; explore racial criteria, classification, and elements in India, along with basic concepts in genetics and heredity.
3. Learn about the principles of aquaculture, freshwater aquaculture in India and the North Eastern States, artificial fish breeding, integrated fish farming, and the market potential of aquatic organisms. They will also study sericulture, including races, economic advantages, and types of silk produced, as well as the importance and history of apiculture and bee rearing techniques.
4. Explore biotechnology, including its origin, history, scope, and definition. They will learn about genes, genetic engineering, DNA, RNA, PCR, molecular markers, cloning, and sequencing. The unit also covers the applications of biotechnology in medicine, agriculture, the environment, food, and industry.

THEORY [Total no. of contact classes: 45; Credits: 3]

Unit 1: Basics of Plant science No. of Contact Classes:12

General features of Bacteria, Viruses, Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms; Elements ofeconomic botany; integrated diseases management;Breeding methods for self-pollinated, cross-pollinated and clonally propagated crops; Crop domestication; Objectivesand accomplishments in plant breeding and the role of National institutes; Importance of Agriculture in national economy.

Unit2:Basics of Anthropology No. of Contact Classes:10

Basic concepts: mechanism of evolution of life; Mammal, Primate, Modern apes, Man's place in the animal kingdom,Fossil evidence of human evolution; Racial criteria, Major races, Racial classification, Racial elements in India; Genetics, Heredity.

Unit3:Basics in Economic Zoology No. of Contact Classes:13

Aquaculture:Basic principles of aquaculture; Prospects & Challenges of Aquaculture in North Eastern States; Diversification of Aquaculture,Induced breeding& larval rearing, integrated& composite fishfarming, Pearl Culture, Prawn Culture, Crustacean and Crab Culture, Post harvest Technology, Fish Preservation: principle & practices.

Sericulture:Origin and history; Races & classification of silkworm;economic advantages; scope of sericulture in India; Domesticated and semi domesticated Silk worm of NE Indiaand their economic viability. Culture of Silk worm. Propagation of food plants of Silk worm. Sericulture as an entrepreneurship venture, Natural dye of silk

Apiculture: General morphology& behaviour of honey bee, Importance and history of Honey bee culture in NE India. Diversity &major types of economically important honeybees in NE India. Selection of bee species for apiculture; Artificial Bee Rearing (Newton and Langstroth box).

Unit4: Applications of life science No. of Contact Classes:10

Origin, history, scope and definition of biotechnology, concept of gene, gene manipulation & genetic engineering. Concept of DNA, RNA, PCR, molecular markers, cloning and sequencing. Applications of biotechnology in medicine, agriculture, environment, food, and industry.

Reading list:

1. Ahsan J, Sinha SP (2010) *A Hand Book on Economic Zoology*, S Chand Publishing.
2. Das BM (1980) *Outlines of Physical Anthropology*. Kitab Mahal Publication.
3. Ember CR, Ember M, Peregrine PN (2011). *Anthropology*. Pearson Education Asia, Singapore.
4. Gardner A, Davies T (2012) *Human Genetics*. Viva Books Pvt Ltd., Delhi, India.
5. Graham LE, Graham JM, Wilcox LW (2013) *Plant Biology*, 2nd edition, Pearson Education, Inc., Upper Saddle River, NJ.
6. Harris M (1991) *Cultural Anthropology*, Harper & Row, New York, NY
7. Kochhar SL (2016) *Economic Botany*, Cambridge University Press.
8. Lewin R (1998) *Principles of Human Evolution*. Blackwell Sciences Inc. USA
9. Lewis B (2004) *Genes VIII*, 3rdEdition, Oxford University & Cell Press, NY.
10. Nicholl DST (2008) *Introduction to Genetic Engineering*, 3rd edition, Cambridge Universitypress, UK.
11. Pillay TVR (2005) *Aquaculture - Principles and Practices*, Wiley-Blackwell.
12. Raven PH, Evert RF, Eichhorn SE (2005)*Biology of Plants*, 7th edition, W. H. Freeman and Company, New York, NY.
13. Stanford C, Allen SJ, Anton CS (2013) *Biological Anthropology: The Natural History of Mankind*, 3rdedition. Pearson India Education Services, Noida.
14. Swindler DR (2009) *Introduction to the Primates*. Overseas Press India Pvt. Ltd., New Delhi, India.
15. Thieman WJ, PalladinoMA(2021) *Introduction to Biotechnology*, Pearson publisher, Boston, MA.

MDC-2: Life Sciences and Environment

Course objectives:

This paper will provide a comprehensive understanding of environmental science, from the fundamental principles and composition of different environmental components to the application of biotechnology in addressing environmental challenges.

Learning outcomes:

Upon successful completion of the paper, students will:

1. Understand the definition, principles, and scope of Environmental Science; comprehend the structure and composition of the atmosphere, hydrosphere, lithosphere, and biosphere.
2. Recognize the interaction between Earth, Man, and the environment; grasp the concept of sustainable development.
3. Appreciate the importance of environmental education and awareness and understand the principles of environmental ethics.
4. Gain knowledge of the fundamentals of Environmental Chemistry.
5. Be familiar with the biochemical aspects of heavy metals; understand air pollution and its major regions; chemical reactions; air pollutants; and their effects.
6. Understand ecology as an interdisciplinary science, gain knowledge about the origin of life and speciation, and learn about human ecology and settlement.
7. Understand ecosystem structure and functions; comprehend biogeochemical cycles, ecological succession, niches, and ecosystem stability.
8. Learn about population ecology, including characteristics, carrying capacity, and population growth; understand community ecology, including definitions, types, and interactions.
9. Understand the gene-environment interaction and the impact of climate change on living beings; comprehend the concepts of epigenetics, the evolution of pathogenic microbes, and emerging diseases in animals, plants, and humans.
10. Learn about the role of biotechnology in pollution control, bioremediation, phytoremediation, bioenergy, biofuels, and restoration of degraded lands; and understand the conversion of waste to wealth and waste treatment using biotechnology.

THEORY [Total no. of contact classes: 45; Credits: 3]

Unit 1: Fundamentals of Environmental Sciences No. of Contact Classes: 10

Definition, Principles, and scope of Environmental Science; Structure and composition of atmosphere, hydrosphere, lithosphere, andbiosphere; Interaction between Earth, Man and Environment; Concept of sustainabledevelopment; Environmental education and awareness; Environmental ethics.

Unit 2: Environmental Chemistry No. of Contact Classes: 12

Fundamentals of Environmental Chemistry: Classification of elements, Hydrological cycle, Concept of DO, BOD andCOD; Inorganic and organic components of soils; Biogeochemical cycles - nitrogen, carbon, phosphorus and sulphur; Biochemicalaspects of heavy metals (Cd, Pb, Cr); PAN, VOC and POP; Air Pollution: Major regions of atmosphere,chemical and photochemical reactions inatmosphere;air pollutants: types, sources, particle size and chemical nature; Photochemicalsmog; Ozone depletion; effects of air pollution on living organisms and vegetation; Greenhouse effect and Globalwarming; Water Pollution: sources and natureof water pollutants, Impacts of water pollution onhydrological and ecosystems.

Unit 3: Ecology and Environment No. of Contact Classes: 15

Ecology as an inter-disciplinary science; Origin of life and speciation; Human Ecology and Settlement; Ecosystem Structure and functions: Structures - Biotic and Abioticcomponents. Functions - Energy flow in ecosystems, energy flow models,food chains and food webs; Biogeochemical cycles, Ecological succession; niche; Ecosystem stability and factors affecting stability; Ecosystem services; Biomes: concept, classification and distribution. Characteristics of differentbiomes: Tundra, Taiga, Grassland, Savanna, Tropical Rain forest; Population ecology: Characteristics of population, concept of carryingcapacity, population growth and regulations; population fluctuations; Concept of 'r' and 'k' species; Community ecology: Definition, community concept, types and interaction -predation, herbivory, parasitism and allelopathy.

Unit4: Environmental Biotechnology No. of Contact Classes: 08

Gene environment interaction, impact of climate change on living beings, epigenetics, evolution of pathogenic microbes, deadly viruses, emerging diseases in animals, plants, humans; Biotechnology in pollution control, bioremediation, phytoremediation, bioenergy, biofuels, restoration of degraded lands, conversion of waste to wealth, waste treatment.

Reading list:

1. Bharucha E (2012) *Textbook of Environmental Studies for Undergraduate Courses*. University Grants Commission (UGC) - University Press (India), New Delhi, India
2. Manahan SE (2016) *Environmental Chemistry*. CRC Press, Boca Raton, FL, USA
3. Odum EP (2007) *Fundamentals of Ecology*. Cengage Learning, Belmont, CA, USA
4. Rajagopalan R (2010) *Environmental Studies: From Crisis to Cure*. Oxford University Press, New Delhi, India
5. Scragg A (2005) *Environmental Biotechnology: Principles and Applications*. Springer, Dordrecht, Netherlands.
6. Sharma BK, Misra AK (2019) *Environmental Chemistry: An Analytical Approach*. Springer, Singapore.
7. Sharma PD (2015) *Ecology and Environment*. Rastogi Publications, Meerut, India
8. Thakur IS, Ray M, Sharma P (2021) *Environmental Biotechnology: A Sustainable Approach*. CRC Press, Boca Raton, FL, USA

MDC-3: Bioresources and Traditional Knowledge

Course objectives:

This paper willprovide a comprehensive understanding of biodiversity, conservation practices, bioresources, and traditional knowledge, emphasizing their significance and applications in various fields.

Learning outcomes:

Upon successful completion of the paper, students will:

1. Understand the concept, scope, and laws of biodiversity; identify biodiversity hotspots; and understand the classification of species based on their conservation status.
2. Recognize the direct and indirect uses of biodiversity.
3. Understand the role of Remote Sensing and GIS in biodiversity studies, the Wildlife Protection Act, and the significance of biosphere reserves, national parks, wildlife sanctuaries, wetlands, Ramsar Sites, and mangroves; identify international initiatives for biodiversity conservation, including the IUCN and CoP.
4. Recognize the role of biotechnology in biodiversity conservation, including global environmental facilities, biosafety levels, and cryopreservation.
5. Understand the nutritional value of food supplements from plants, endemic fishes, crustaceans, molluscs, reptiles, and social insects; the role of fermented food and beverages in traditional knowledge.
6. Recognize traditional conservation practices related to plants and pet animals, the role of traditional knowledge in bioprospecting and the issues of biopiracy.

THEORY [Total no. of contact classes: 45; Credits: 3]

Unit 1: Biodiversity No. of Contact Classes: 15

Concept and scope; Laws of biodiversity, biodiversity hotspots, biodiversity classification (rare, threatened, vulnerable, endangered, critically endangered, flagship and keystone species), Levels of biodiversity— organisational (genetic, species and ecosystem), spatial (alpha, beta, and gamma); Biodiversity of northeast India; Valuing biodiversity - direct- and indirect use values; Role of Remote Sensing and Geographical Information System in biodiversity studies.

Unit 2: Conservation Practices No. of Contact Classes:10

International initiatives for biodiversity conservation (including IUCN, CoP), *In-situ* and *Ex-situ* conservation,Biological Diversity Act, National Biodiversity Action Plan(a brief summary), wildlife protection act, biosphere reserves, national parks, wildlife sanctuaries, wetlands and Ramsar Sites, Mangroves; role of biotechnology in biodiversity conservation (global environment facilities, biosafety levels, cryopreservation).

Unit 3: Bioresources No. of Contact Classes: 12

Distribution, parts used and method of use, nutritive value – Food supplements [plants: Bora rice, Bamboo shoot, *Diplazium esculentum* (Dhekia sak), *Houttuynia cordata* (Masundari); Endemic fishes (carps, minnows, shads, barbs, murrels, eels, catfishes, perches, trouts), crustaceans, molluscs, reptiles (snakes and lizards), social insects (bees, wasps, ants)], Sources of beverages (Apong, Judima, Jumai, Sulai), Fibers (*Corchorus olitorius* – Mora paat), Timbers (Holong – *Dipterocarpus retusus*, *Bombax ceiba*), non-timber forest products (bamboos, canes, rattan, wild medicinal plants, wild fruits, lesser-known fruits, ferns, leaves, roots, cones, seeds, wild honey, mushrooms), sacred groves, large ponds and lakes.

Unit 4: Traditional Knowledge No. of Contact Classes: 08

Cuisine diversity, food,ethnozoology, ethnobotany, ethnomedicine, food processing and preservation techniques, fermented food and beverages, conventional animal husbandry, milk and milk products, goods produced from animals; Role of traditional knowledge in bioprospecting;Biopiracy; Traditional Knowledge Digital Library (TKDL) - concept and importance. ITK in Biodiversity conservation, ITK & harvesting of Aquatic Resources.

Reading list:

1. Acharya D, Shrivastava A (2008) *Indigenous Herbal Medicines: Tribal Formulations and Traditional Herbal Practices*. Aavishkar Publishers Distributor, Jaipur, India.
2. Babu NS, Manickam S, Kumar SS (2019) *Biodiversity Conservation and Legal Perspectives*. Springer, Singapore.
3. Bebarta KC, Mohanty AK (2017) *Ethnobiology of India: Volume 1 - Eastern and Northeastern India*. CRC Press, Boca Raton, FL, USA.
4. Gaston KJ, Spicer JI (2014) *Biodiversity: An Introduction*. Wiley-Blackwell, Chichester, UK.
5. Krishnan M (2008) *Plants That Heal*. Rupa Publications, New Delhi, India.
6. PrimackRB (2018) *Essentials of Conservation Biology*. Sinauer Associates, Sunderland, MA, USA.
7. Pushpangadan P, Ramawat KG (2017) *Ethnobotany and Medicinal Plants: India and Nepal*. Springer, Cham, Switzerland.
8. Ramakrishnan PS, SaxenaKG, GuptaU (2010) *Biodiversity: Conservation and Management*. Biotech Books publisher, Delhi, India.