**PG 1st Semester**

**Paper: EWS701C (Core)**

# NATURAL HISTORY, BIOGEOGRAPHY AND EVOLUTION

CREDITS: 4 (3+1+0)

## Unit 1: Art and Science of Natural History (12 lectures)

History of natural history; natural history as a descriptive and inductive science, the relationship between natural history, ecology and wildlife; how to become a good naturalist: the skill of observation, illustrations, taking field notes and journal writing; basic map reading; basic geology, natural history of Guwahati city; natural history collections; basic principles and concepts in systematics and taxonomy; what is a species; developing skills at field identification of plants, insects, birds, herpetofauna, fishes and mammals.

## Unit 3: Ecology's Evolutionary Backdrop (8 lectures)

Evolution by natural selection; theories of evolution; natural selection; genetic and geographic variation; Evolution within species; the ecology of speciation; effects of climatic change on the evolution and distribution of species; effects of continental drift on the ecology of evolution; interpreting the results of evolution: convergent and parallels; the history of life.

## Unit 2: Organisms and Their Environments (10 lectures)

Ecological niches; responses of individuals to temperature; correlations between temperature and the distribution of plants and animals; pH of soil and water; salinity; physical forces of winds, waves and currents; environmental pollution; global change; radiation; oxygen; organisms as food resources; a classification of the resources and ecological niche; physiological ecology: plant and animals

## Unit 4: Biogeography and Macroecology (10 lectures)

What are biogeography and macroecology? What is biodiversity? How do we measure it; Biodiversity concepts and measures; What limits species distributions? Species traits and niches; What limits species distribution: Vicariance and dispersal; Phylogeographic and landscape genomics; speciation and extinction; Niche evolution; Island biogeographic: ecological and evolutionary perspective; Macroecology and global biodiversity; Scaling; biogeographical realms, provinces and ecoregions; geography of biome; the biogeographic affinities of the fauna and flora of the Indian sub-continent; India's biogeographic classification

**Unit 5**: **Basic Mathematics (8 lectures)**

Measurement and units: fractions, decimals and percentages; ratio and proportion: amounts, volumes; exponents and prefixes: scientific notation, conversion of units functions; solving equations and evaluating expressions; logarithms; functions, limits and derivatives; probability distribution.

**Suggested Readings**


1. Begon M, Townsend CR and Harper (2006). *Ecology: From Individuals to Ecosystem (4th Edition)*. Blackwell
2. Townsend CR, Begon M, Harper JL (2008). *Essential of Ecology* (3rd Edition). Blackwell Publishing
3. Molles Jr MC (2016). *Ecology: Concepts and Applications (7th Edition)*. Mc Graw Hills Higher Education
4. Lomolino MV, Riddle BR and Whitakker RJ (2016). *Biogeography (5th Edition)*. Sinauer Associates
5. Mani MS (1974). *Ecology and Biogeography in India*. Springer Netherlands
6. Batschelet E (1979). *Introduction to Mathematics for Life Scientists* (3rd Edition). Springer-Verlag Berlin, Heidelberg
7. Foster PC (1998). *Easy Mathematics for Biologists*. Hardwood Academic Publishers


**Paper: EWS702C (Core)**

**ECOLOGY AND BEHAVIOUR**

CREDITS: 4 (3+1+0)

**Unit 1: Population Ecology (10 lectures)**

Properties of populations; density-independent growth; density-dependent growth and intraspecific competition; population regulation; populations with age structure; metapopulation ecology; life-history strategies; fundamental's of predator-prey interactions; interspecific competition: simple theory; beneficial interactions in communities: mutualism and facilitation; host-parasite interactions; multi-trophic interactions

**Unit 2: Communities and Ecosystem Ecology (10 lectures)**

Community Ecology's roots; patterns of biological diversity; the commonness and rarity of species; biodiversity and ecosystem functioning; species interactions in ecological network; food chains and food webs: controlling factors and cascading effects; metacommunity and neutral theory; species co-existence in variable environments; evolutionary community ecology; the evolution of ecosystem

ecology; the flux of energy through ecosystems; the flux of matter through ecosystem, thermodynamic approaches to ecosystem behaviour; stable isotopes and trophic position; diversity and stability debate

**Unit 3: Behavioural Ecology (10 lectures)**

Natural selection, ecology and behaviour; testing hypotheses in behavioural ecology, Genes, environments and learning; finding foods and avoiding predators; communications, sexual selection and sperm competition, mating system and sex allocation, parental care and conflict

**Unit 4: Plant-animal Interaction (8 lectures)**

Species interactions and the evolution of biodiversity; the history of associations between plants and animals; plant insect interactions in terrestrial ecosystems; mammalian herbivory in terrestrial environments; granivory; pollination by animals; seed dispersal by vertebrates, ant-plant interaction

**Unit 5: Introduction to Statistics (10 lectures)**

Statistics and samples; displaying data; describing data; estimating with uncertainity; probability; hypothesis testing; analysing proportion; fitting probability models to frequency data; contingency analysis: association between categorical variables; the normal distribution; inference for a normal population; comparing two means; handling violations of assumptions; correlation between numerical variables; regression; three frameworks for statistical analysis

**Suggested Readings**


1. Rockwood LL (2015). *Introduction to Population Ecology (2nd edition)*. Wiley-Blackwell
2. Mittelback (2012). *Community Ecology (1st Edition)*. Sinauer Associates, Inc
3. Levin SA (ed) (2009). *The Princeton Guide to Ecology*. Princeton University Press
4. Davies NB, Krebs JR and West SA (2012). *An Introduction to Behavioural Ecology (4th Edition)*. Wiley-Blackwell
5. Begon M, Townsend CR and Harper JL (2006). *Ecology: From Individuals to Ecosystems (4th Edition)*. Blackwell Publishing
6. Raffaelli DG and Frid CLJ (ed) (2010). *Ecosystem Ecology: A New Synthesis*. Cambridge University Press
7. Herrera CM and Pellmyr O (2002). *Plant-Animal Interactions: An Evolutionary Approach*. Wiley-Blackwell
8. Whitlock MC and Schluter D (2015). *The Analysis of Biological Data*. Roberts and Company Publishers

**Paper: EWS703C (Core)**

## ENVIRONMENTAL CHEMISTRY AND POLLUTION

CREDITS: 4 (3+1+0)

### Unit 1: Introduction to Environmental Chemistry (6 lectures)

Concept and scope of environmental chemistry; acid base reactions; pH and pOH; buffer solutions; solubility and solubility product; chemical kinetics; chemical equilibrium; laws of thermodynamics; redox reaction; concept of green chemistry

### Unit 2: Aquatic Chemistry and Pollution (12 lectures)

Characteristics of water; water quality parameters and their significance; criteria and standards; distribution of chemical species in water; concept of oxygen demand; solubility of gases in water; the carbonate system; types and sources of water pollution; effects of water pollution; ecological aspects of water pollution; water quality indices; arsenic and fluoride contamination in groundwater of northeast and other parts of India

### Unit 3: Soil Chemistry and Pollution (12 lectures)

Weathering of rocks and soil formation; physical, chemical and biological properties of soil: texture, porosity; bulk density, permeability, soil water, pH, acidity, salinity, enzymes, organic matter, cation exchange capacity, macro and micronutrients; types and sources of soil pollution: agrochemicals, industries and urban discharges; radioactive pollution; land degradation; effects of soil pollutants

### Unit 4: Atmospheric Chemistry and Air Pollution (14 lectures)

Chemical composition of atmosphere-particles; ions and radicals; stratospheric and tropospheric ozone; chemistry of ozone layer depletion; types and sources of air pollutants; indoor air pollution; air pollution monitoring; air quality criteria and standards; air quality indices; reaction of pollutants in air forming smog; PAN (Peroxy-Acyl-Nitrate); acid rain; transport and dispersion of air pollutants; air quality model; trans-boundary movement of pollutants; impacts of air pollutants on flora, fauna and human health

### Unit 5: Noise Pollution (4 lectures)

Definition; types; permissible limits; sources of noise pollution and noise monitoring; effects of noise pollution on animals and human health

**Suggested Readings**


1. Manahan SE (2001). *Fundamentals of Environmental Chemistry (2nd Edition*). CRC Press, Inc., USA
2. Sawyer CN, McCarty PL, Parkin GF (2003). *Chemistry for Environmental Science and Engineering*, Tata-McGraw-Hill Edition
3. De AK (2000).*Environmental Chemistry (4th Edition)*. New Age International (P) Ltd., New Delhi, India
4. Dunnivant FM, Anders E (2006). *A Basic Introduction to Pollutant Fate and Transport:An Integrated Approach With Chemistry, Modeling, Risk Assessment, and Environmental Legislation*, Wiley
5. Connell DW (1997). *Basic Concept of Environmental Chemistry*, Lewis Publication
6. Pepper, IL, Gerba CP, Brusseau ML (2006). *Environmental and Pollution Science*, Elsevier


**Paper: EWS704C (Core)**

## GLOBAL WARMING AND CLIMATE CHANGE

CREDITS: 4 (3+1+0)

### Unit 1: Climatology, Meteorology and Climate Change (6 lectures)

Atmospheric processes and climate; meteorological parameters – temperature, pressure, humidity; cloud formation and precipitation; Earth's radiation balance and albedo; fronts and weather systems; wind belts; cyclones, anticyclones; monsoons; El Nino, La Nina, ENSO; general circulation, jet stream; history of climate change; natural and human-induced climate change; future climate scenarios

### Unit 2: Causes of Climate Change (12 lectures)

Changes in the sun's activity; changes in the earth's reflectivity; greenhouse gases-sources and sinks; greenhouse effect – natural and anthropogenic; global warming potential, radiative forcing; land use land cover change (deforestation, expansion of concrete cover and agricultural lands, retreating glaciers)

### Unit 3: Agriculture and Climate Change (6 lectures)

Components of the agricultural sector; Green Revolution; $CO_2$ emissions from agricultural machinery, fossil fuel and power consumption; methane and nitrous oxide emissions from rice-wheat cultivation, biomass burning, ruminant livestock etc.; microbial production of $CO_2$, methane and nitrous oxide in soil and their transport mechanisms

**Unit 4: Consequences of Climate Change (12 lectures)**

Changes in precipitation patterns; extreme weather events; frequent natural calamities; melting ice caps and glaciers; rising sea levels; shift in climatic belts; warming of lakes and oceans; ocean acidification; impact on global water resources; land degradation, desertification, soil erosion; threats to global food security; impact on ecosystem goods and services; impact on biodiversity with special reference to northeast India

**Unit 5: Climate Change Adaptation and Mitigation (12 lectures)**

Difference between adaptation and mitigation; local and urban planning; development of climate resilient crops; managing water and forest resources; geo-engineering; energy conservation and efficiency; adoption of renewable energy technologies; agricultural management; terrestrial carbon sequestration; carbon farming and trading; organizations and policies dealing with climate change

**Suggested Readings**


1. Rafferty JP (ed) (2011). *Climate and Climate Change (The living Earth)*, Britannica Educational Publishing, New York
2. Eggleton T (2013). *A Short Introduction to Climate Change*. Cambridge University Press, New York
3. Wredford et al (2010). *Climate Change and Agriculture: Impacts, Adaptation and Mitigation,* OECD Publications
4. Lobell D and Burke M (eds) (2010). *Climate Change and Food Security: Adapting Agriculture to a Warmer World*. Springer
5. Ringler et al (eds) (2010). *Global Change: Impacts on Water and Food Security*. Springer
6. Jeffries MA (2006). *Biodiversity and Conservation (2nd Edition)*. Routledge (Taylor and Francis Group), London and New York
7. Sumi et al (eds) (2010). *Adaptation and Mitigation Strategies for Climate Change*. Springer


**Paper: EWS705L (Lab)**

## FIELD WORK, ENVIRONMENTAL CHEMISTRY AND POLLUTION

CREDITS: 4 (0+0+4)

**Unit 1: Fieldwork 1 - Orientation to Field Biology and Natural History**

Observations and collection of study material, wildlife signs and evidences; use of basic field

equipment: compass, binoculars, GPS, range finder, spherical densiometer, camera trap, altimeter.

**Unit 2: Field work 2 - Technique Tour**

Distance sampling methods for population estimation; behavioural sampling; seed dispersal study; vegetation sampling**,** measuring species diversity, mark-recapture methods for population size estimation

**Unit 3: Hands-on Practicals at Computer Lab**

1. Life table analysis
2. Application of Lotka-Volterra equation to experimental data and determine population growth rates and carrying capacities
3. Examine the effects of interspecific competition on population growth rates
4. Calculate and compare co-efficients of determination to decide how well the data fit island biogeographic models
5. Niche measures and resource preferences
6. The estimation of productivity and the construction of energy budgets

**Unit 4: Practicals on Environmental Chemistry and Pollution**

1. Estimation of pH and conductivity water
2. Estimation of total dissolved solids in water samples
3. Analysis of turbidity in water samples
4. Estimation of alkalinity, hardness and chloride in water samples
5. Estimation of sulphate and fluoride in water samples
6. Estimation of biological oxygen demand and chemical oxygen demand in water samples
7. Analysis of soil pH and conductivity
8. Analysis of soil organic carbon and macronutrients
9. Gaseous and particulate matter sampling and analysis

**Suggested Readings**


1. Bruaude S and Low BS (eds) (2010). *An Introduction to Methods and Models in Ecology, Evolution and Conservation Biology*. Princeton University Press
2. Handerson PA (2003). *Practical Methods in Ecology*. Blackwell Publishing
3. Southwood TRE and Henderson PA (2000). *Ecological Methods (3rd Edition)*. Blackwell Science
4. Krebs CJ (1999). *Ecological Methodology (2nd Edition)*. Addison-Wesley Educational Publishers, Inc.
5. Manahan SE (2001). *Fundamentals of Environmental Chemistry (2nd Edition)*. CRC Press, Inc., USA

6. Sawyer CN, McCarty PL and Parkin GF (2003). *Chemistry for Environmental Science and Engineering*. Tata-McGraw-Hill Edition
**7.** Clesceri LS (1998). *American Public Health Association (APHA). Standard Methods for the Examination of Water and Wastewater Analysis (20th Edition).* American Public Health Association, Washington, DC