

## ***ELECTIVE COURSES***

<b>SR. NO.</b>	<b>TITLE OF COURSES</b>	<b>TYPE</b>	<b>CREDIT HRS</b>
1.	<b>HAZARDS OF HEAVY METAL POLLUTION</b>	<i><b>ELECTIVE</b></i>	<i><b>02</b></i>
2.	<b>PLANTS AND ENVIRONMENT ELECTIVE</b>	<i><b>ELECTIVE</b></i>	<i><b>02</b></i>
3.	<b>ANIMALS AND ENVIRONMENT</b>	<i><b>ELECTIVE</b></i>	<i><b>03</b></i>
4.	<b>ENVIRONMENTAL TOXICOLOGY</b>	<i><b>ELECTIVE</b></i>	<i><b>03</b></i>

**ELECTIVE: HAZARDS OF HEAVY METAL POLLUTION (02 Credit hrs.)**

**PRE-REQUISITES:** ENSC-205, ENSC-308

**LEARNING OUTCOMES**

By the end of the course, the student is expected to have:

- A clear understanding of the inorganic micropollutants, significance and associated environmental hazards
- An understanding of pharmacokinetics and environmental fate of different inorganic micropollutants
- Information about possible methods of controlling micropollutant contamination
- A critical grasp on public health and environmental burdens caused by inorganic pollutant

**CONTENTS**

The identification of inorganic micropollutants, heavy metals, cations, radioactive compounds etc. impacts on abiotic environment and biota, reversing toxicity

**Unit-1: Introduction Micropollutants**

- 1.1. Basic introduction to micropollutants
- 1.2. General mechanism of toxicity
- 1.3. Bioaccumulation, bioconcentration and biomagnification
- 1.4. Global disease burden caused by inorganic micropollutants

**Unit-2: Mercury as Environmental Pollutant**

- 2.1. Introduction to Mercury, its uses and sources
- 2.2. Historical incidents of mercury contamination
- 2.3. Metabolic pathways of mercury poisoning
- 2.4. Impacts on environment
- 2.5. Reversing mercury poisoning through chelation etc.

**Unit-3: Arsenic and its Environmental Impacts**

- 3.1. Introduction to Arsenic, its sources and sinks, applications
- 3.2. Historical arsenic contamination incidents
- 3.3. Movement of arsenic in groundwater
- 3.4. Carcinogenicity and permissible levels established by EPA-IRIS, WHO, PEQS.

**Unit-4: Lead and Environmental Significance**

- 4.1. Natural and anthropogenic sources of lead
- 4.2. Historic and industrial applications of lead
- 4.3. Health and environmental consequences, global disease burden
- 4.4. Global Alliance to eliminate lead

**Unit-5: Cadmium and Environmental Impacts**

- 5.1. Cadmium, its sources, historic and current day uses
- 5.2. Presence in various environmental media
- 5.3. Cadmium specific health effects (*Itai Itai* disease etc.)

**Unit-6: Chromium and Environmental Impacts**

- 5.1. Sources, speciation and toxic states of chromium
- 5.2. Specific diseases, bioaccumulation potential, contamination of abiotic and biotic factors
- 5.3. Reclamation of chromium contaminated soils etc.

**Unit-7: Radioactive Elements**

- 7.1. Radioactive elements, historical incidents

- 7.2. Background emissions, half-life
- 7.3. Uses and environmental impacts
- 7.4. Detection of radioactive elements, biological pathways etc.

### TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Documentaries
- Quizzes

### ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- hands-on-activities,
- short tests, quizzes etc.

### ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

### RECOMMENDED TEXTBOOKS / SUGGESTED READINGS

1. Devi, P., Singh, P., & Kansal, S. K. (Eds.). (2020). *Inorganic Pollutants in Water*. Elsevier.
2. Kumar, V., Sharma, A. and Cerda, A. (2020). *Heavy Metals in the Environment*. Elsevier.
3. Anjum, N. A., Gill, S. S., & Tuteja, N. (Eds.). (2017). *Enhancing cleanup of environmental pollutants*. Springer.
4. Zaikov, G. E., Weisfeld, L. I., Lisitsyn, E. M., & Bekuzarova, S. A. (Eds.). (2017). *Heavy metals and other pollutants in the environment: biological aspects*. CRC Press.
5. Chen, J. P., Wang, L. K., Wang, M. H. S., Hung, Y. T., & Shammass, N. K. (Eds.). (2016). *Remediation of heavy metals in the environment*. CRC Press.
6. Coleman, N., Castrejon, A., Blaine, C., & Chemmachel, T. (2017). *The toxicology of essential and nonessential metals*. Lulu. com.
7. Corn, M. (2012). *Handbook of hazardous materials*. Academic Press.

## **ELECTIVE: PLANTS AND ENVIRONMENT**

**(02 Credit Hrs)**

**PRE-REQUISITE:** ENSC-113

### **LEARNING OUTCOMES:**

The learning objectives of this lecture course are:

- To strengthen student knowledge of concepts about environment and plant distribution.
- To give the student an understanding of the impact of various environmental factors on plants and the adaptations of plants in response to these factors.
- To enhance student knowledge of systems-level concepts, including interactions of Plants within environment and ecological cycles, so that students can explain how natural systems function and how humans and global changes impact vegetation at landscape and regional scales
- To further develop oral skills through presentations and group discussions

### **CONTENTS**

#### **Unit-I: Introduction to plant and environment:**

- 1.1. Importance of plants in the biosphere.
- 1.2. Plant distribution in the biosphere,
- 1.3. Environmental factors influencing plant distribution.
- 1.4. Effect of latitudinal and altitudinal variations,

#### **Unit- II: Plants, Water and mineral nutrition:**

- 2.1. Uptake of water and mineral nutrients by plants,
- 2.2. Functions of mineral nutrients
- 2.3. Edaphic factors: Importance of Soil texture and structure
- 2.4. Classification of plants according to water availability
- 2.5. Adaptations of hydrophytes, xerophytes, succulents/cacti, halophytes, and mangroves.

#### **Unit- III: Temperature, Light and humidity:**

- 3.1. Temperature, and humidity as the regulating factors in plant distribution:
- 3.2. Factors affecting the variations in light and temperature.
- 3.3. Light and Plant Metabolism.
- 3.4. light, C3 and C4 plants and CAM
- 3.5. Ecological responses of plants to warm, chilling, and freezing temperatures.
- 3.6. Eco-physiological responses like Photoperiodism,
- 3.7. Thermo-periodism, Dormancy, Vernalization etc.

#### **Unit- IV: Fire, Winds, and other Environmental factor:**

- 4.1. Fire: Occurrence and types of fire.
- 4.2. Adaptations observed in plants in response to fire.
- 4.3. Wind as an environmental factor

#### **Unit- V: Plant adaptations and establishments**

- 5.1. Ecology of different plant growth forms,
- 5.2. Reproductive strategies of flowering plant,
- 5.3. Pollination and seed dispersal,
- 5.4. Regeneration, and establishment,

#### **Unit- VI: Interactions between plants and other organisms;**

- 6.1. Mycorrhiza, Nitrogen fixation,
- 6.2. Pathogens and endophytes,
- 6.3. Parasites, saprophytes and Carnivorous plants

#### **Unit- VII: Human uses of plants;**

- 1.1. food; construction, medicine,
- 1.2. bioremediation,
- 1.3. Tissue culture, Plant breeding,
- 1.4. Plant genetic engineering and biotechnology

### TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

### ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

### ASSESSMENT AND EXAMINATIONS:

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3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

### RECOMMENDED TEXTBOOKS / SUGGESTED READINGS

1. Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Reece, J. B. (2020). *Campbell Biology*. Pearson Education
2. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2018). *Fundamentals of Plant Physiology*. Oxford University Press.
3. Reece, J. B. U., Cain, L. A., Wasserman, M. L., & Minorsky, S. A. (2018). *Investigating Biology Laboratory Manual*. 9<sup>th</sup> Ed. Amsterdam
4. Willey, N. (2018). *Environmental plant physiology*. Garland Science.
5. Mauseth, J. D. (2014). *Botany: an introduction to plant biology*. Jones & Bartlett Publishers
6. Berg, L. R., & Berg, W. M. (2008). *Introductory Botany: Plants, People, and the Environment*. Brooks/Cole.
7. Smith, T. M., & Smith, R. L. (2014). *Elements of Ecology*. 9<sup>th</sup> Ed., Benjamin Cummins, UK.

8. Schulz, E. D., Beck, E., & Muller-Hohenstein, K. (2005). *Plant Ecology*. Springer Verlag, Germany.
9. Soni, N. K. (2010). *Fundamentals of Botany* (Vol. 2). Tata McGraw-Hill Education.
10. Subrahmanyam, N.S., & Sambamurty, A.V. S. S. (2000). *Ecology*. Narosa Publishing House, New Delhi. 616 pp.
11. Lack, A., & Evans, D. (2001). *BIOS Instant Notes in Plant Biology*. Garland Science.

**Further Reading:** As suggested by the Instructor.

## **ELECTIVE: ANIMALS AND ENVIRONMENT**

**(03 Credit Hrs)**

**PRE-REQUISITE:** ENSC-113

### **LEARNING OUTCOMES:**

Upon completion of syllabus, students will be able to understand

- the basic ecological principles with an emphasis on animal ecology and population biology.
- Population dynamics of animals and distribution of animals
- understand how critical factors influence behaviour of living organisms at population, and community scales

#### **Unit- I: Introduction to Animals and environment:**

- 1.1. Introduction and Historical Background of Animal ecology
- 1.2. Role of animals in food chain, web, and ecosystem

#### **Unit- II: Zoogeography:**

- 2.1. Factors affecting the global distribution of animals,
- 2.2. Zoogeographic regions and animal distribution

#### **Unit- III: Animal Population:**

- 3.1. Animal Population Demographics,
- 3.2. Population Size, Population Density and Distribution,
- 3.3. Age Structure, Population Size and Population dynamics

#### **Unit- IV: Population Growth Models:**

- 1.6. Exponential Growth
- 1.7. Logistic Growth
- 1.8. Density-Dependent Factors Density-Independent Factors
- 1.9. Life History Patterns
- 1.10. Human Population Growth.

#### **Unit- V: Animal communities:**

- 5.1. Competitive Interactions,
- 5.2. Resource Partitioning,
- 5.3. Predator–Prey Interactions,
- 5.4. Coevolution of Herbivores and Plants,
- 5.5. Parasites and Parasitoids, Parasitism Brood Parasites
- 5.6. Species Introduction, Loss, and Keystone Species

#### **Unit- VI: Animal Behavior:**

- 6.1. Instinct and Learning,
- 6.2. Instinctive Behavior,
- 6.3. Conditioned Responses,
- 6.4. Types of Learned Behavior

#### **Unit- VII: Behavioral Ecology:**

- 7.1. Evolution of Animal Communication,
- 7.2. Foraging and Territorial behaviour,
- 7.3. Reproductive Strategies,
- 7.4. Mating Systems, Parental Care,
- 7.5. Group Living, Benefits and Costs of Grouping

## TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

## ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

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2. Mason, K. A., Losos, J. B., Duncan, T., & Raven, P. H. (2020). *Biology*. 12th Ed. McGraw-Hill Education
3. Urry, L., Cain, M., Wasserman, S., Morgan, J., Reece, J., Minorsky, P., & Carter, M. E. (2017). *Investigating Biology Laboratory Manual*. 9<sup>th</sup> Ed. Pearson.
4. Narendran, T. C., & Balakrishnan, M. (2008). *Systematics and Biodiversity Conservation*. Riddhi International.
5. Wheater, C. P., Bell, J. R., & Cook, P. A. (2011). *Practical Field Ecology: A Project Guide*. Wiley-Blackwell
6. Gotelli, N. J. (2008). *A primer of ecology* (No. 577.88 G6). Sunderland, Massachusetts, USA: Sinauer Associates.
7. Pearl, M. C. (2000). *Research Techniques in Animal Ecology*. Publisher: Columbia University Press,

**Further Reading:** As suggested by the Instructor.



**ELECTIVE: ENVIRONMENTAL TOXICOLOGY (03 Credit hrs)**

**PRE-REQUISITE:** B.S/M.Sc. Environmental Sciences or related disciplines

**LEARNING OUTCOMES**

After this course, students will be able to

- Interpret a vast knowledge on the recent advances in techniques for studying environmental toxicology and assessing environmental impact and risk.
- Learn fundamental knowledge on major classes of chemicals of environmental concern
- Have some understanding of how toxic chemicals can be detected and quantified in the environment
- Understand the toxicological effects of environmental pollutants.

**CONTENTS**

This course is designed to develop the understanding of students about the basic concepts in environmental toxicology viz; Classification and properties of toxic substances, biological properties of important classes of chemical compounds in relation to ecosystems, Fate of xenobiotics in the environment and Environmental risk assessment

**THEORY**

**Unit-1 Introduction to environmental Toxicology**

- 1.1 Introduction and Brief history of toxicology
- 1.2 General Principles and Concepts in environmental toxicology
- 1.3 Patterns in Environmental toxicology
- 1.4 Occurrence and sources of toxicants, and their classification
- 1.5 Application of toxicology in Environmental Sciences

**Unit-2 Action of Toxicants**

- 2.1 Movement of toxicants in the environment,
- 2.2 Root of entry of toxic substances in living organisms,
- 2.3 Biotransformation – metabolism of xenobiotic compounds
- 2.4 Factors Affecting Xenobiotic Action
- 2.5 Allergic reactions

**Unit-3 Environmental Disrupters**

- 3.1 Brief Review of Disruption of Endocrinal Function
- 3.2 Impacts of xenobiotics on the individuals and Environmental integrity
- 3.3 Teratogens and Mechanisms of Actions
- 3.4 Plastic and its associated xenobiotics
- 3.5 Mutagenesis and Carcinogenesis.

**Unit-4 Toxicants in Atmosphere**

- 1.1 Sources and health effects of Air Pollutants
- 1.2 Gaseous Pollutants
- 1.3 Particulate matter and Asbestos
- 1.4 Automobile and Industrial Exhaust

**Unit-5 Inorganic Toxicants**

- 5.1 Environmental toxicology of trace elements
- 5.2 Toxicity of non-metallic inorganic substances viz; Cyanides, Phosphate, Nitrates

## Unit-6 Organic Toxicants

- 6.1 Classification and types of organic pollutants
- 6.2 Persistent Organic Pollutants
- 6.3 Food additives and contaminants

## Unit-7 Agricultural Chemicals

- 7.1 Pesticides and their chemical origin
- 7.2 Organochlorines, Organophosphorus, Pyrethroids, Carbamate
- 7.3 Neonicotinoids, and other types
- 7.4 Fertilizers and soil additives

## Unit-8 Environmental toxicants and human health

- 8.1 Pharmaceuticals and personal care products
- 8.2 Therapeutic and Drugs, Drugs of abuse.
- 8.3 Toxicological Evaluation, Risk Assessment
- 8.4 Toxicity test and Ecological risk assessment

## ASSESSMENT STRATEGIES

1. Lecture based examination
2. Presentations/seminars
3. Class discussion
4. Quizzes

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## RECOMMENDED BOOKS / SUGGESTED READINGS

1. D'Mello, J. F. (2019). *A Handbook of Environmental Toxicology: Human Disorders and Ecotoxicology*. CABI.
2. Robinson, L. (2018). *A practical guide to toxicology and human health risk assessment*. John Wiley & Sons.
3. Chadwick, J. and Shaw, I., (2016). *Principles of Environmental Toxicology*. CRC Press.
4. Philp, R. B. (2016). *Ecosystems and human health: Toxicology and environmental hazards*. CRC Press,
5. Gruiz, K., Meggyes, T., & Fenyvesi, É. (2015). *Engineering tools for environmental risk Management: 2. Environmental toxicology*. CRC Press.

**Further Reading:** As suggested by the Instructor.