BHARATHIDASAN UNIVERSITY

Tiruchirappalli- 620024,
Tamil Nadu, India

Programme

M.Sc., Environmental Science & Sustainable Management

Course Title:

Environmental Pollution & Toxicology(Core Choice)

Course Code: 25PGCC03

Unit4

Contaminants and their fate in the environment

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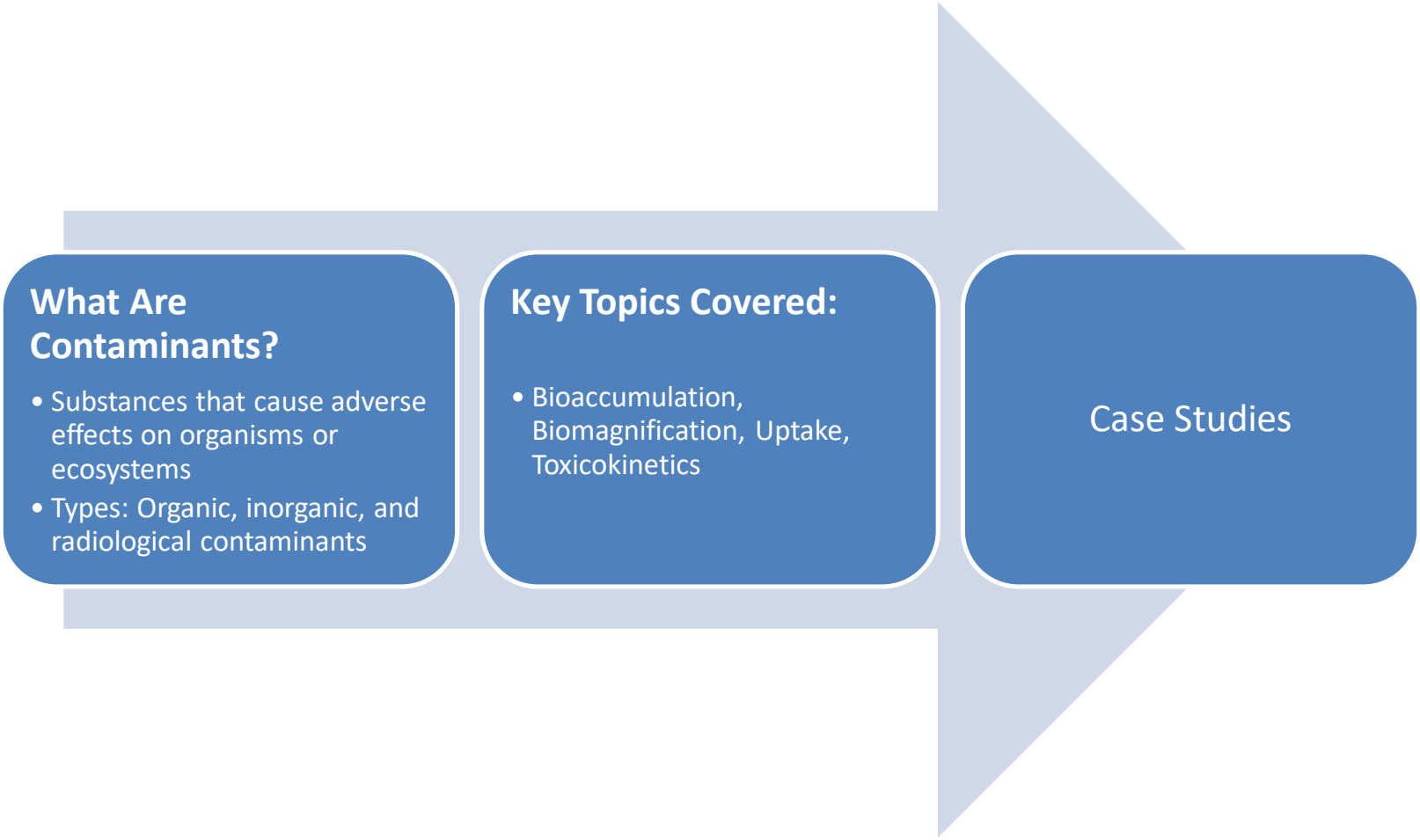
Introduction



BIOACCUMULATION AND BIOMAGNIFICATION

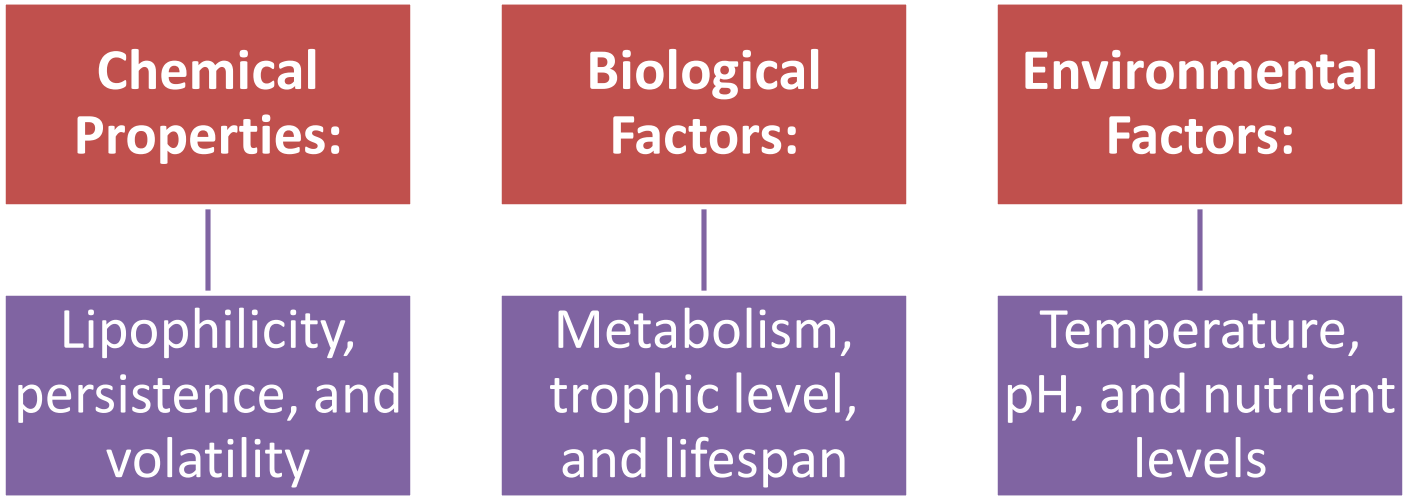
Bioaccumulation:

- Process by which **contaminants build** up in an organism **over time.**
- **Example:**Mercury in fish

Biomagnification:

- Increase in contaminant concentration at higher trophic levels of the food chain.
- **Example:**DDT in birds

FACTORS INFLUENCING BIOACCUMULATION AND BIOMAGNIFICATION

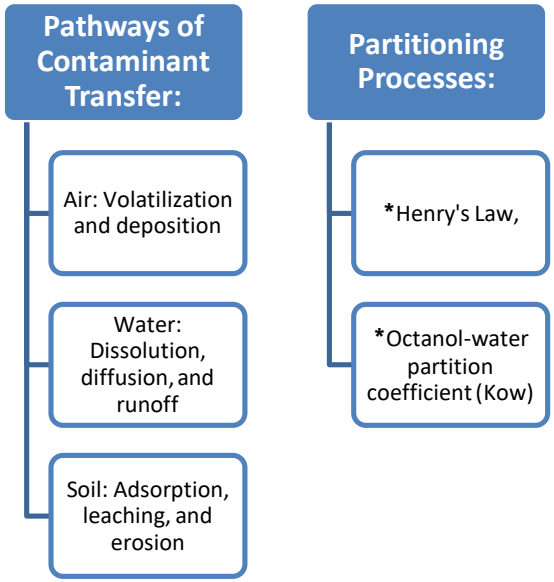


Interactive Question

Interactive Question 1

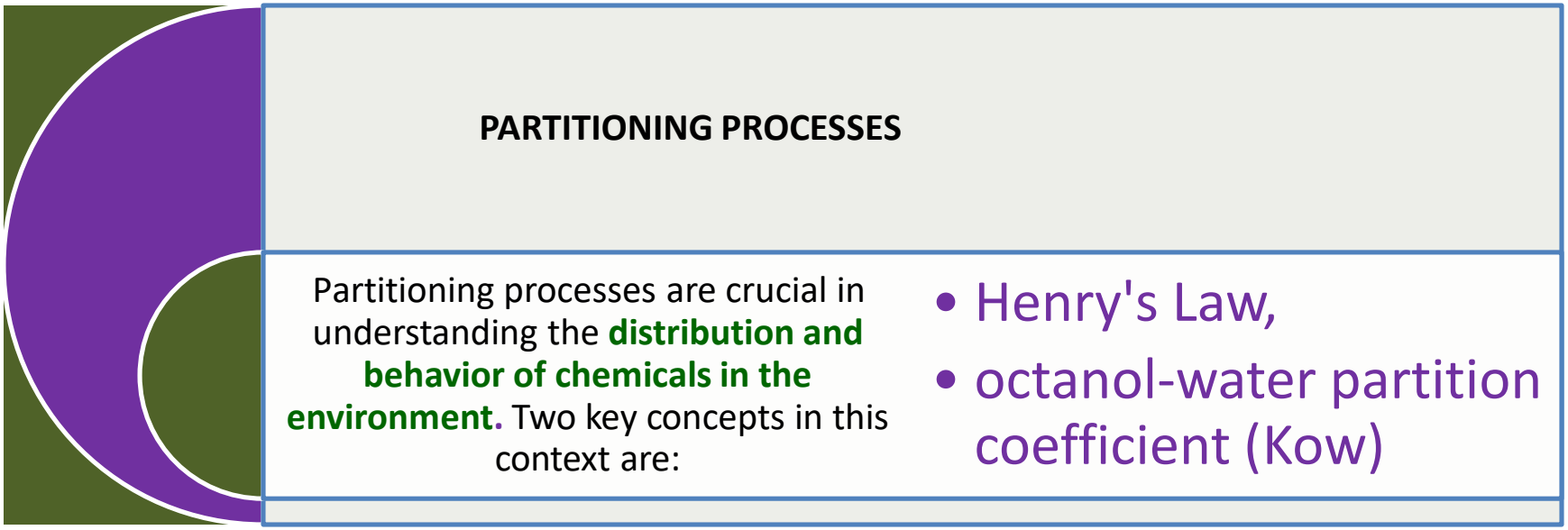
Q: Why do lipophilic contaminants like DDT and PCBs tend to biomagnify in aquatic ecosystems?

METHODS OF TRANSFER BETWEEN ENVIRONMENTAL PHASES



❖They help scientists and regulators understand how chemicals will behave in the environment, their potential for exposure, and their likely environmental impacts.

METHODS OF TRANSFER BETWEEN ENVIRONMENTAL PHASES



METHODS OF TRANSFER BETWEEN ENVIRONMENTAL PHASES

Partitioning Processes:

Henry's Law: Henry's Law describes the partitioning of a volatile compound between its gas phase and dissolved phase in a liquid, typically water. It states that at equilibrium, the concentration of a dissolved gas in a liquid is directly proportional to the partial pressure of that gas above the liquid.

The Henry's Law constant (KH) quantifies this relationship:

KH = Cg / Cw Where: Cg = concentration in the gas phase Cw = concentration in the water phase

Henry's Law is particularly important for understanding the fate of volatile organic compounds (VOCs) in the environment, especially their tendency to volatilize from water bodies or partition between air and water in the atmosphere.

METHODS OF TRANSFER BETWEEN ENVIRONMENTAL PHASES

OCTANOL-WATER PARTITION COEFFICIENT (KOW):

The octanol-water partition coefficient is a measure of how a chemical partitions between octanol (a non-polar solvent) and water (a polar solvent). It is expressed as the ratio of a chemical's concentration in the octanol phase to its concentration in the water phase at equilibrium: Kow = Co / Cw Where: Co = concentration in octanol Cw = concentration in water Kow is often expressed as log Kow. This coefficient is crucial for predicting:

1. Bioaccumulation potential: Chemicals with high Kow values tend to accumulate in fatty tissues of organisms.
2. Soil adsorption: Higher Kow values generally indicate stronger adsorption to soil organic matter.
3. Environmental fate: Kow helps predict a compound's distribution between environmental compartments (e.g., water, soil, biota).

BIOAVAILABILITY OF CONTAMINANTS

Definition:

- Fraction of a contaminant available for uptake by organisms

Influencing Factors:

- Chemical form, environmental matrix, organism's physiology

UPTAKE OF CONTAMINANTS

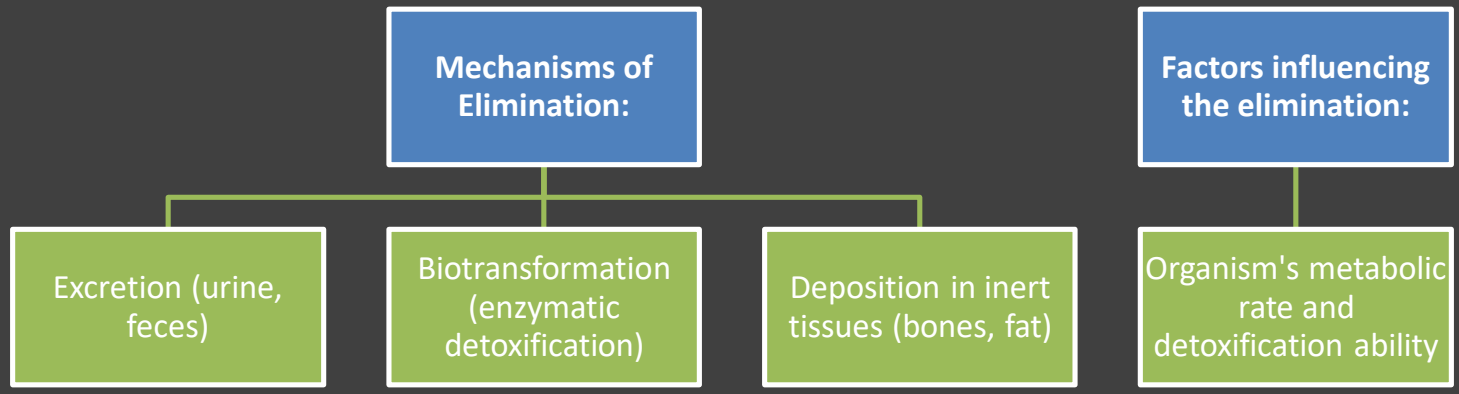
Different Routes:

- **Inhalation:** Airborne contaminants
- **Ingestion:** Contaminated water and food
- **Dermal Absorption:** Direct contact with contaminated surfaces

Key Determinants:

- Contaminant properties (solubility, size)

ELIMINATION OF CONTAMINANTS



Interactive Question

Interactive Question 2

Q: How do contaminants stored in fat tissues pose long-term risks to predators higher in the food chain?

TOXICOKINETICS

Definition:

- STUDY OF MOVEMENT OF CHEMICALS THROUGH AN ORGANISM

Phases:ADME

- **Absorption → Distribution → Metabolism → Excretion (ADME)**
- **Examples of Models:**
  - One-compartment and multi-compartment models

PROPERTIES OF TOXIC COMPOUNDS

Physical and Chemical Properties:

- water solubility , volatility, Lipophilicity.

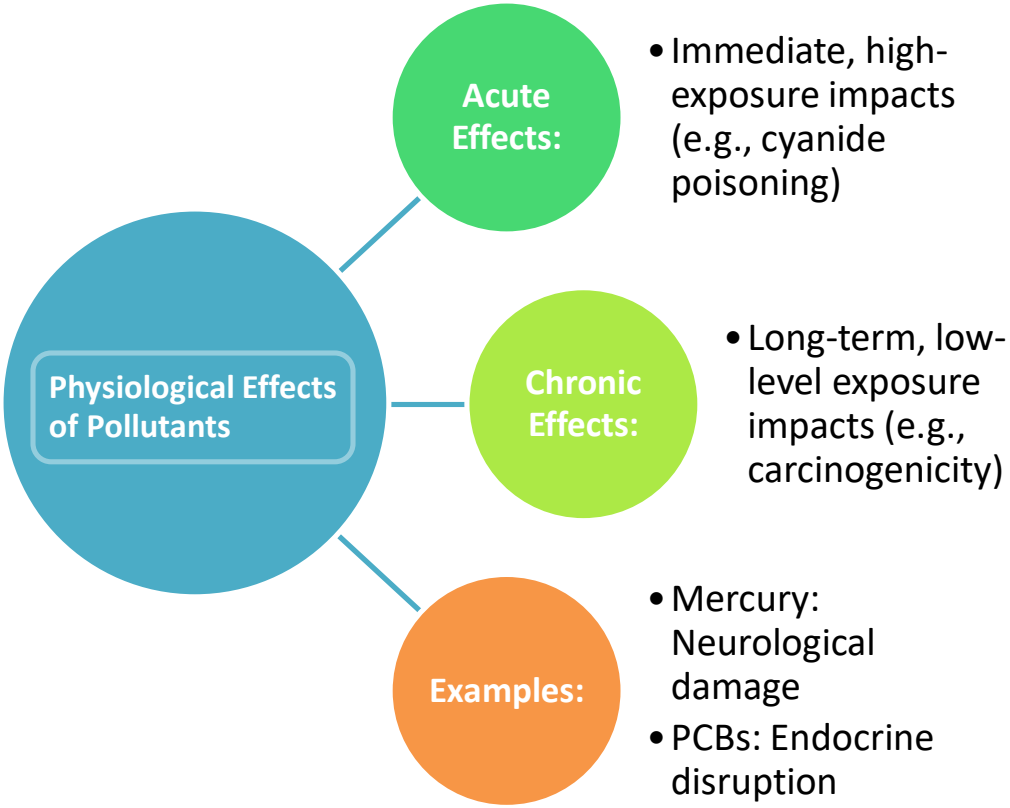
Toxicity Indicators:

- LC50, NOAEL, bioaccumulation factors

Examples:

- Arsenic: High water solubility, neurotoxic
- Dioxins: Persistent, carcinogenic

PHYSIOLOGICAL EFFECTS OF POLLUTANTS



Interactive Question

Interactive Question 3

Q: What are the major challenges in predicting the chronic effects of persistent organic pollutants (POPs)?

CASE STUDY – MINAMATA DISEASE

Overview:

- Caused by **mercury contamination** in Minamata Bay, Japan

Sources:

- Industrial wastewater discharge

Impacts:

- **Severe neurological symptoms** in affected populations

Lessons Learned:

- **Need for stringent regulation of industrial emissions**

CASE STUDY – ARSENIC IN GROUNDWATER (INDIA)

Overview:

- Groundwater contamination in **West Bengal**

Sources:

- Naturally occurring arsenic in **aquifers**

Impacts:

- **Skin lesions, cancer**, cardiovascular diseases

Mitigation Efforts:

- **Arsenic filters**, improved water management

CASE STUDY – PCB CONTAMINATION (USA)

- **Overview:**
  - PCB contamination in the Hudson River
- **Sources:**
  - Industrial waste discharge from General Electric
- **Impacts:**
  - Bioaccumulation in fish, fishing bans
- **Cleanup Efforts:**
  - Dredging and sediment removal

TESTING AND MONITORING TECHNIQUES

Key Methods:

- Gas Chromatography-Mass Spectrometry (GC-MS)
- **Inductively Coupled Plasma Mass Spectrometry** (ICP-MS)

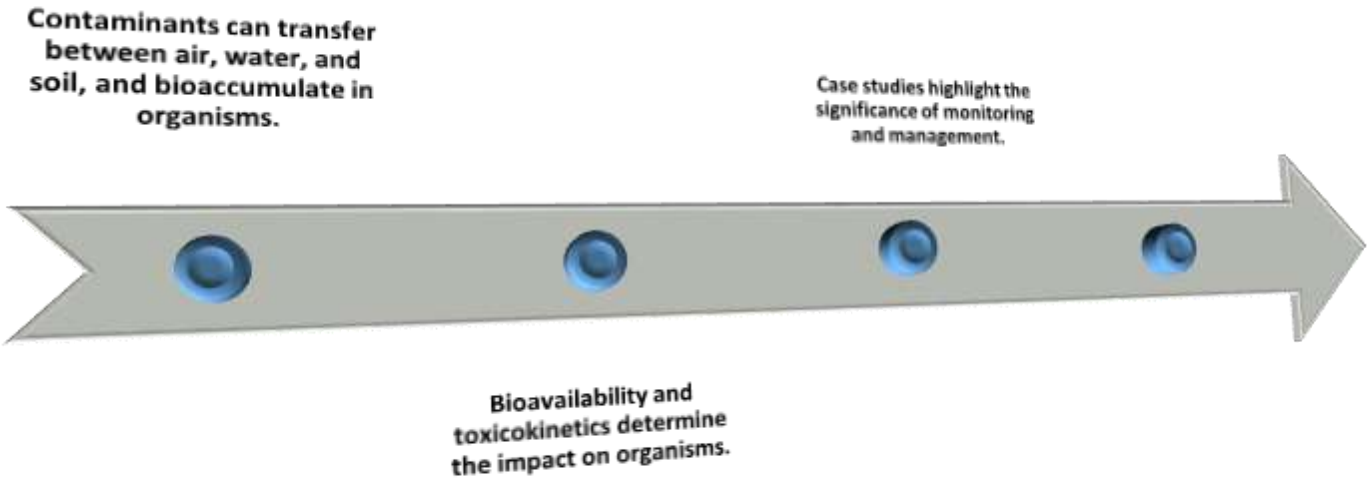
Importance:

- **Early detection of toxic contaminants**

Challenges:

- Sampling accuracy, cost constraints

Summary & Key Takeaways



References

- **Books and Articles:“**
  - Environmental Toxicology” by Wright and Welbourn
  - “Principles of Ecotoxicology” by Walker et al.
- **Reports and Guidelines:**
  - WHO Guidelines for Drinking Water Quality
  - IPCC Reports on Pollution Management
- **Websites:**
  - CPCB Environmental Guidelines (India)
  - US EPA Toxic Substances

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