

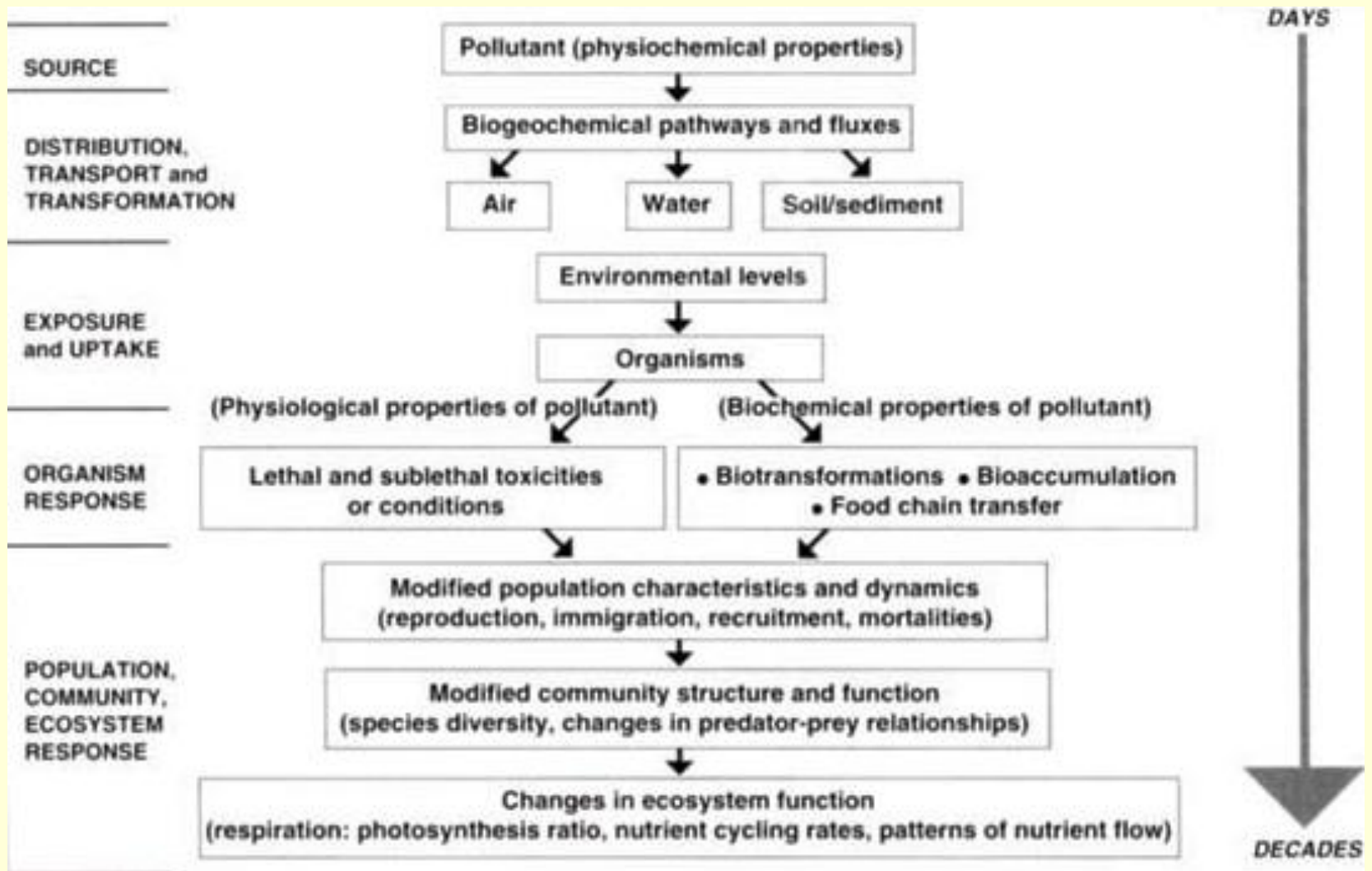
Ecotoxicology

seminar from Toxicology

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Ecotoxicology

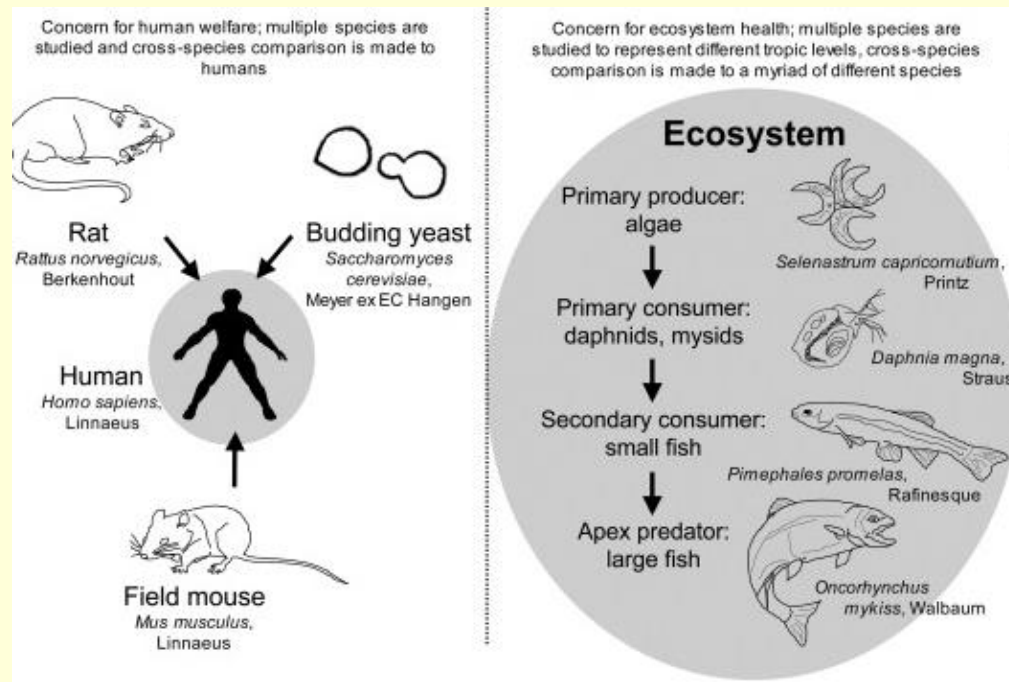


Ecotoxicology

- basis for determining the effects of contaminants on ecosystem is at **organism level**
- at organism level, response can be:
 - **acute toxicity** causing mortality
 - **chronically accumulating damage** ultimately causing death
 - **sublethal impairment** of various aspects of physiology and morphology
 - sublethal **behavioral effects**
 - measurable **biochemical changes**

Toxicology vs. Ecotoxicology

- Absorption
- Distribution
- Metabolisation
- Elimination
- Release into the environment
- Fate and disposition
- Metabolism
- No counterpart



Toxicology vs. Ecotoxicology

- host defence mechanisms
- individual susceptibility
- single effects
- cumulative exposure
- bioaccumulation
- bioconcentration (in water)
- biomagnification
- never single effects
- movement between media (water, air...)

Risks

Embryonic period

- peak period of risk is **first trimester**, first ten weeks, during **organogenesis**
- severe damage is likely to result in **spontaneous abortion**

Fetal development

- some late developing organs
- **neurological development and behaviour**
- **cancer risk**

Risks

After birth

- lactation and exposure through breast milk
- environmental exposure

Toddlers and young children

- accidental exposures
- inquisitive behaviour
- compulsive ingestion

- higher minute ventilation
- more active, behaviourally and metabolically
- growing
- incomplete defenses and physiological barriers

Assessment of Structural Changes

Changes in species / population structure

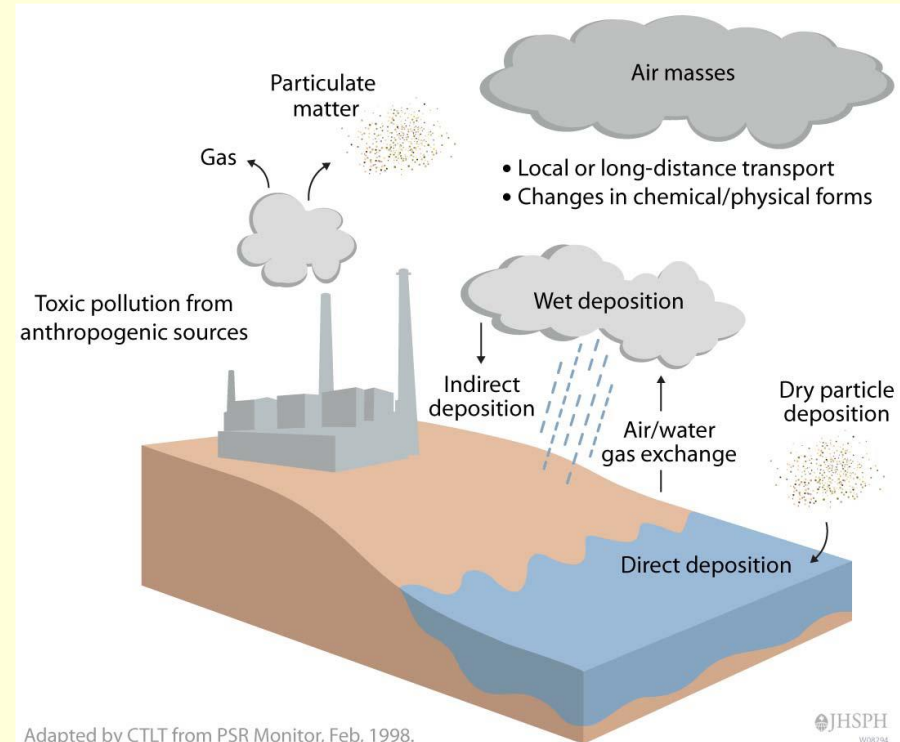
- appearance/disappearance of an **indicator species**
- **number** of individuals of a species
- **biomass** of a species
- **presence or absence** of a species

Changes in community/ecosystem structure

- biomass
- abundance
- **biotic indices** (e.g. trophic types)
- **species richness / diversity**
- **dominance**
- **food chain length/complexity**

Chemicals of Interest

- DDT (DDE), aldrin, hexachlorobenzene, PCBs, dioxines
 - remain in the environment for a long time, very stable
 - resist chemical and biological degradation
 - it leads to their **persistence** and ubiquitous nature in the environment
-
- almost all chemicals of ecotoxicological interest are bioavailable and in most **bioaccumulation** and **biomagnification** (food chain)



Chemical Behaviour

BIOAVAILABILITY

- fraction of a chemical in the available form to organisms
e.g. fish: food, absorption from water

BIOCONCENTRATION

- chemical concentration in an organism exceeds the concentration in the surrounding media (water) as a result of exposure through the respiratory surfaces (gills/dermal surfaces) - not food!
- referring to **uptake and accumulation** of a substance **from water** alone

Chemical Behaviour

BIOACCUMULATION

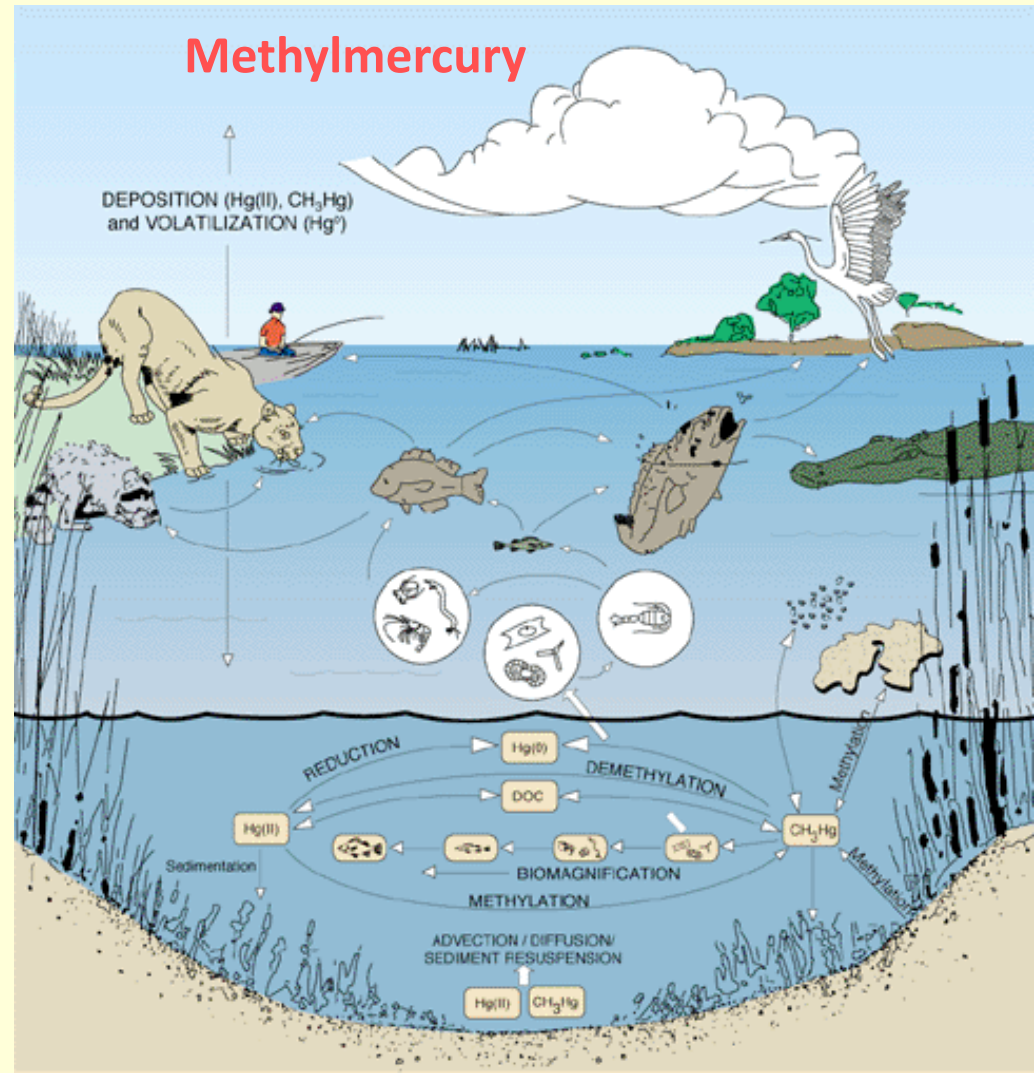
- accumulation of chemicals in the tissue of organisms through any route, including respiration, ingestion, or direct contact with contaminated water, sediment, and pore water in the sediment
- **bioaccumulation factor**: c in organism/ c in food (or ingested water)

BIOMAGNIFICATION

- increased concentration of substances (DDT) in the organisms at higher trophic levels or food chains
- **biomagnification factor**: c in predator/ c in prey

Biomagnification and Bioaccumulation

- environmental persistence
- lipophilicity
- biotransformation
- plankton
- small fish
- predatory fish
- animals and humans



Terrestrial Ecosystems

CONTAMINATED SOILS

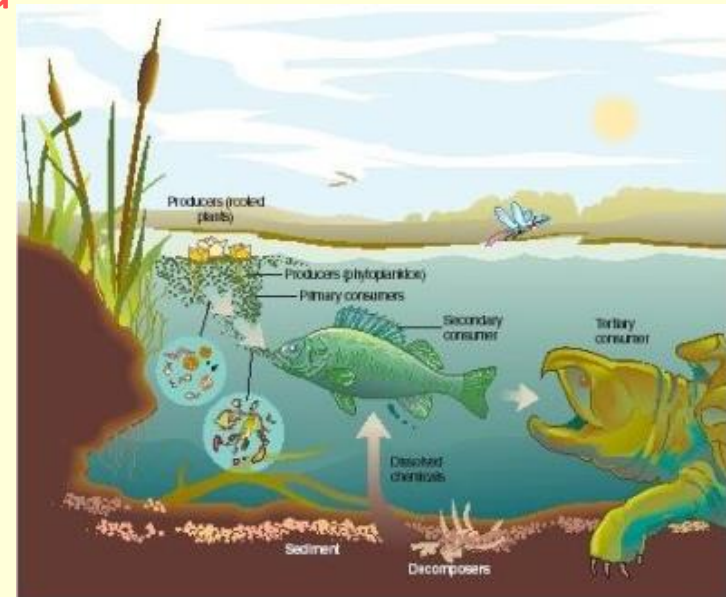
- by **metals** and **radioactive isotopes** resulting from
 - industrial, mining or deposition from agricultural practices such as application of metal-containing pesticides or metal-contaminated sewage sludge
 - wet or dry deposition from smelting activity
 - lead-containing car exhaust
 - atmospheric nuclear weapon testing or accidents such as Chernobyl

Metals

- non-biodegradable
- formation and degradation of organometallic compounds like methylmercury (MeHg)
- bio-accumulation of cadmium (Cd) is higher than most metals as it is assimilated rapidly and excreted slowly
- aluminium (Al) – insoluble at normal to slightly acidic pH but below pH 4.5 solubility increases dramatically and becomes responsible for fish kills in acidified lakes

Aquatic Ecosystems

- the ultimate “sink” for metals is the **ocean** but difficult to estimate the effect on living organisms due to the massive dilution
- effect of metals on biota is much felt in **estuaries** especially those receiving water from contaminated sites
- in estuaries the flow rate diminishes, **suspended sediments** settled and dissolved **metals precipitated**
- **contaminated water** affects organisms



Bioindicators

- species used to monitor the health of an environment or ecosystem

Plant indicators

- mosses, lichens, fungi, algae

Animal indicators

- organisms are monitored for changes (biochemical, physiological, behavioral) that may indicate a problem within the ecosystem
 - content of certain elements or compounds
 - their morphological or cellular structure
 - metabolic-biochemical processes
 - behaviour
 - population structure

Air Pollution

- sulphur (SO_x) and nitrogen oxides (NO_x)
- carbon monoxide (CO)
- carbon dioxide (CO_2)
- fine particles
- volatile organic compounds
- ground-level ozone (O_3)

HEALTH RISKS

- heart diseases (stroke)
- pulmonary diseases (COPD, bronchial asthma, cystic fibrosis)
- lung cancer

Water Pollution

- contamination of groundwater, lakes, rivers, oceans, aquifers

Chemicals

- detergents
- disinfectants
- herbicides
- insecticides

Pathogens

- coliform bacteria



Common Environmental Toxicants

PCBs (polychlorinated biphenyls)

- cooling and hydraulic fluids

Pesticides

- destroying, or repelling any organism which may be considered harmful (fungi, insects, weeds)

Phthalates

- plastic bottles and wraps

Dioxins

- result of combustion processes – waste incineration and burning fuels (wood, coal, and oil)

Heavy metals (arsenic, mercury, lead, cadmium)

- fish

Asbestos

- insulation of ceilings, heating ducts

Ecosystem Relations

