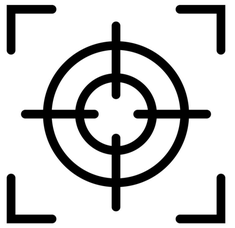
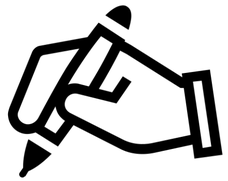
Topic 19:
Organisms and their Environment

Chapter Analysis



FOCUS

- Straightforward chapter
- content heavy, memorisation intensive



EXAM

- Tested every year
- tested thrice in section B in the past 5 years

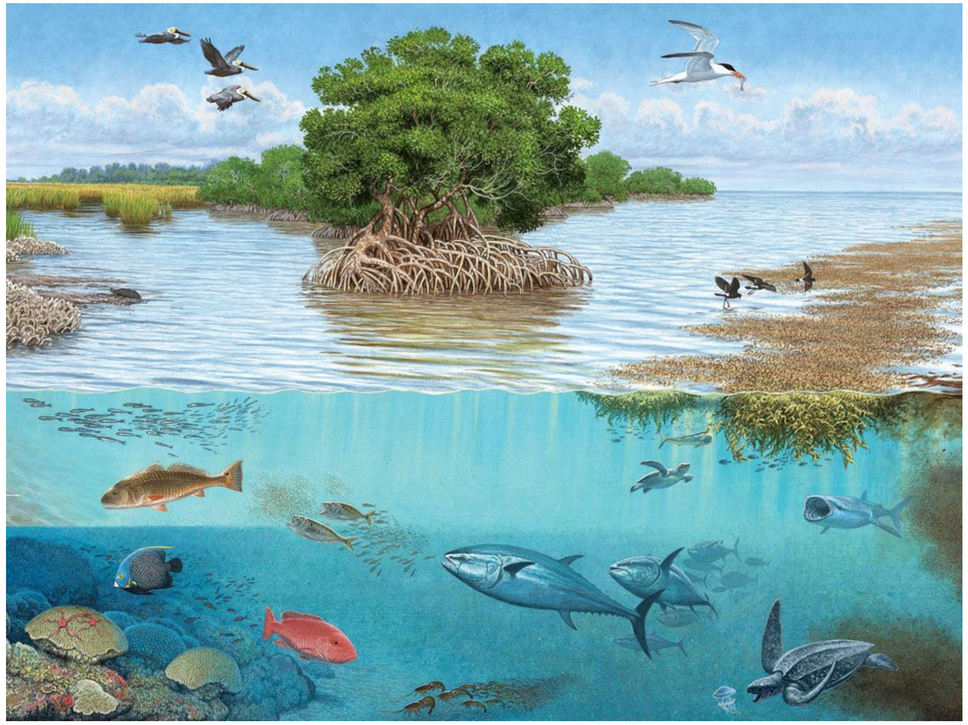
WEIGHTAGE

- Highest weightage
- Constitute to around 17% in Paper 2 in the past 5 years

Key Concept

food chain
carbon cycle

ecosystem



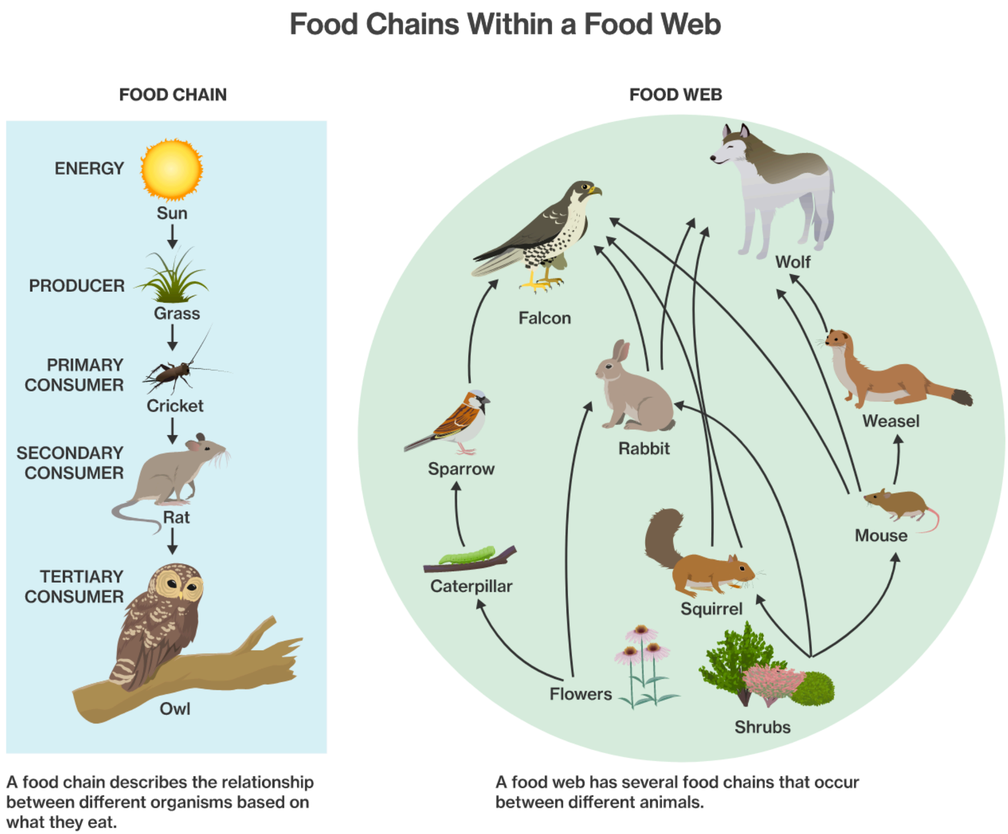
Ecology is the study of interactions between organisms and the interactions between these organisms and their environment

Ecosystem consists of a community and the abiotic environment / physical environment.

- **Community** is all the organisms that live in a particular habitat, thus these populations of organisms interact with one another.
- **Abiotic environment** is the physical factors in the environment that the community interacts with such as

pH of water and soil	affect enzyme activity
Temperature	affect enzyme activity and metabolism of organisms
Light Intensity	affect rate of photosynthesis
Water availability	water is important for the survival of all living things
Oxygen content	necessary for aerobic respiration
Salinity of water and soil	affect water potential of environment thus water uptake or removal for plants

food chain



A food chain describes the relationship between different organisms based on what they eat.

A food web has several food chains that occur between different animals.

Food chain

- A food chain is a **sequence of energy transferred** in the form of **food**, between **organisms** in an ecosystem.
- Each level of the food chain is known as **trophic level**
- Interconnected food chains form a **food web**

Producer:

- organisms that contain **chlorophyll** thus are able to **convert light energy from the sun to chemical energy** thus making their own food via photosynthesis
- provides food for other organisms in the community thus occupies first trophic level in food chain

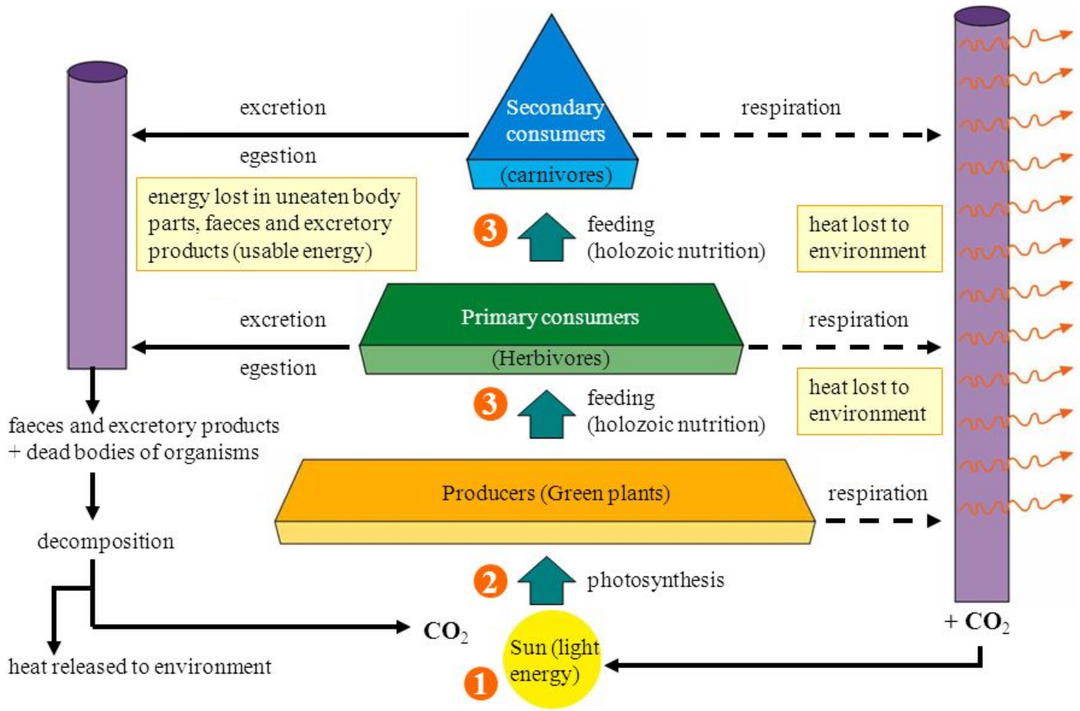
Consumer

- Organisms that are not able to make their own food and **obtain energy by feeding on other organisms**
- Primary consumers feed on primary producers directly. They are herbivores.
- Secondary consumers feed on primary consumers. They are carnivores.
- Tertiary consumers feed on secondary consumers. They are carnivores.

Food Web

- Food web consists of **two or more food chains** linked together.

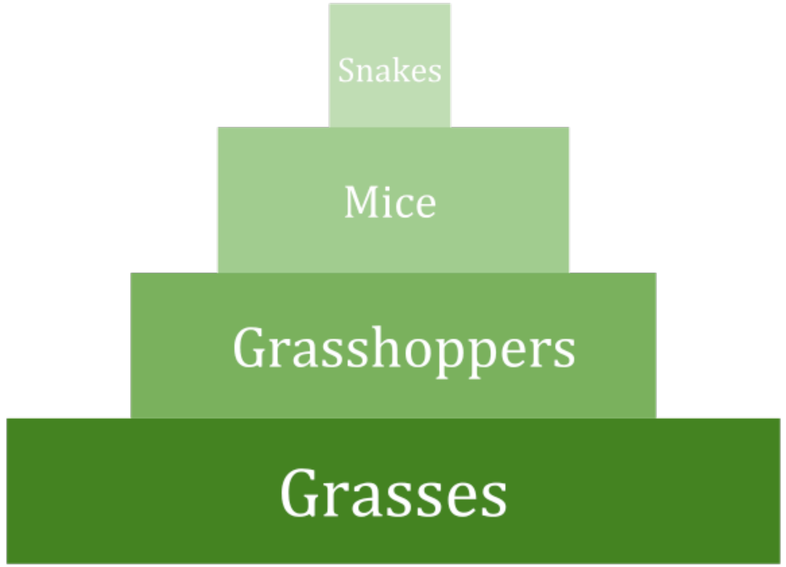
Non-cyclic energy flow



1) In any ecosystem, the **ultimate source of energy is the Sun**. **Light energy** from the sun is absorbed by **chlorophyll** in producers and converted into **chemical energy** during **photosynthesis**
2) Plants make its **own food** via photosynthesis and **contain carbon** in the form glucose, sucrose, starch.
3) Energy is passed from **one trophic level to another** when primary consumer feed on the producers and so on.
4) Organisms at each trophic level **pass on about 10% energy** to the next trophic level compared to what they receive.
5) This is because **energy is lost** at every trophic level as **heat in respiration, uneaten organism parts and through excreted and egested waste material**. These energy lost cannot be recycled.
6) Faeces, excretory products and dead organisms **contain trapped chemical energy.** This energy is released through the activity of **decomposers**. Decomposers use some of this trapped chemical energy for their needs, releasing CO2. The rest of the energy is lost as heat.

pyramid of food chain

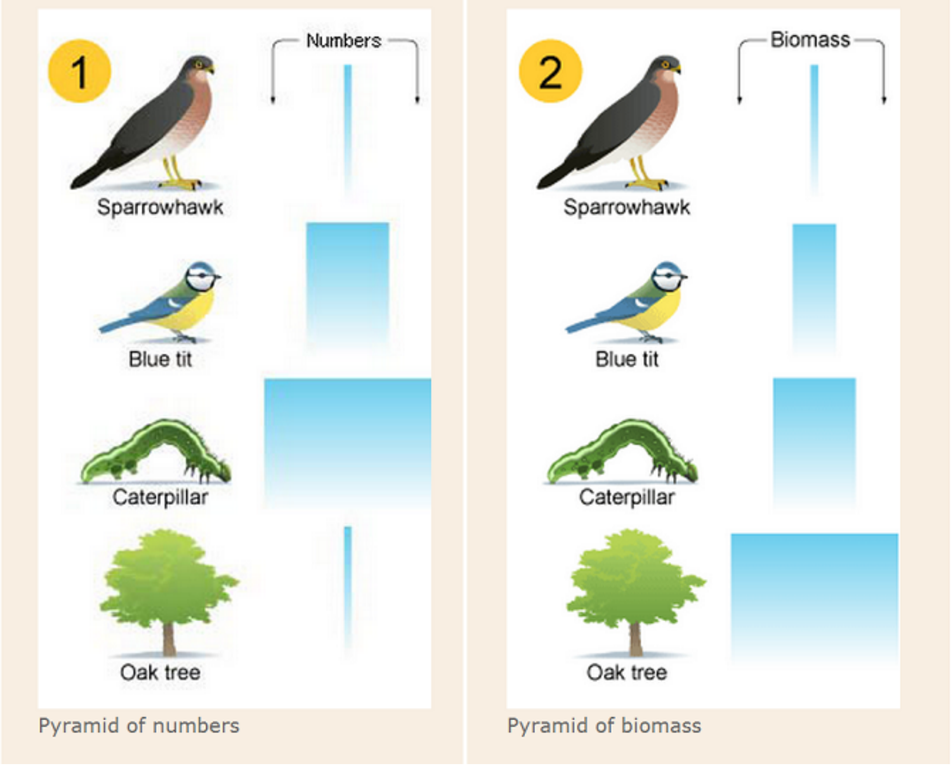
pyramid of number



- A **pyramid of numbers** shows the relative population of each trophic level in a food chain at a particular time
- Pattern: Usually, the number of producer at the base is highest number, as it is needed to **feed the next level.** The number of consumers gradually decreases towards the top
- Disadvantage: It is **not an accurate estimate** of the amount of energy at each trophic level because the **population number** does not always correspond to the **amount of energy** it can transfer to the next trophic level, e.g. a single tree can support a large population of caterpillars

pyramid of food chain

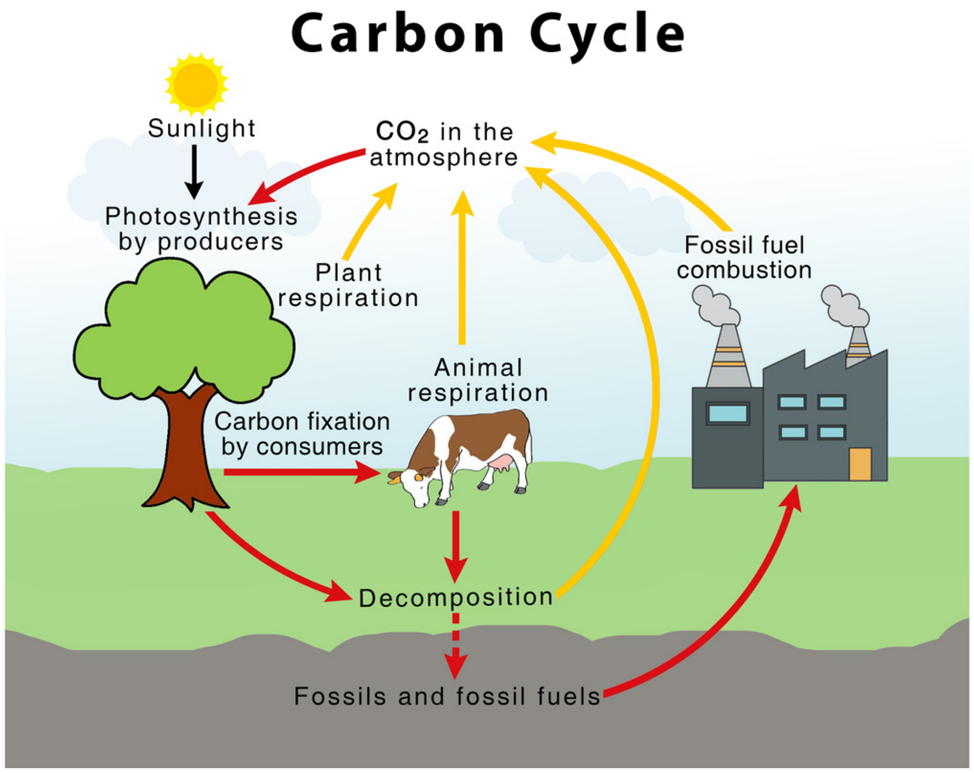
pyramid of biomass



- A **pyramid of biomass** shows the dry mass of organisms at each trophic level in a food chain.
- Pattern: The **biomass of the producer is the largest** as it **supplies all the energy** for the resumers. Biomass is lost along the food chain due to loss of energy thus **biomass decreases along the food chain.**
- Disadvantages:
  - Dry mass **cannot be easily obtained** from every animal e.g. human being, large animals like tiger
  - It is also **destructive** as it involves drying the organism at 100 °C, which will affect the food chain/ food web

One single tree has larger biomass than a large number of caterpillar.

carbon cycle



Removal of carbon dioxide

1. Plants convert atmospheric carbon dioxide into glucose during **photosynthesis**. Glucose can be converted to other carbohydrates, proteins and fats within the plants

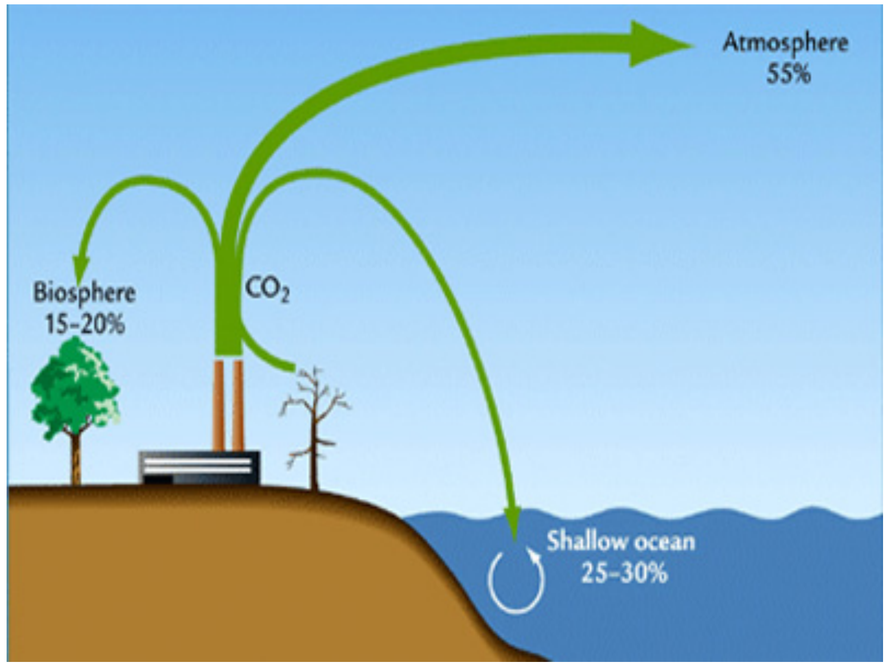
Return of carbon dioxide

2. Carbon dioxide is returned to the atmosphere when **cellular respiration** takes place in living organisms.
3. When the plants and animals die, **decomposers** such as bacteria and fungi **break down the organic matter** into carbon dioxide, which is released back to the atmosphere
4. Fossil fuels are formed from the **fossilised remains of dead plants and animals**. Carbon compounds from these dead organisms are stored as **fossil fuels.**
5. When **fossil fuels and wood are burnt**, carbon dioxide is produced.

Importance of carbon cycle

- Ensures that there is a continuous supply of carbon dioxide for plants to carry out photosynthesis.
- Allows photosynthesis to convert light energy from the Sun into chemical energy in food, which non-photosynthetic organisms can feed on to stay alive.
- Enables energy to flow through the ecosystem. Carbon compounds carry the stored energy from organism to organism in the food chains of an ecosystem.
- Maintains the correct concentration of carbon dioxide in the atmosphere.

carbon sinks



An area that that absorbs more carbon than it releases as carbon dioxide

Oceans

- Atmospheric carbon dioxide is absorbed by the ocean as carbon dioxide dissolves in the ocean's water
- Dissolved CO2 is used by phytoplankton and algae in photosynthesis.
- Iron compounds increases the photosynthetic activity of phytoplankton.
- The organisms in the oceans store carbon compound. When they die, they may sink and be buried deep in the seabed and may form fossil fuels.

Forests

- The plants in forests absorb atmospheric carbon dioxide for photosynthesis
- A large amount of carbon compound is stored in trees. When trees die, they are buried deep in the ground and form coal, a kind of fossil fuels.

Key Concept

water pollution
sewage treatment

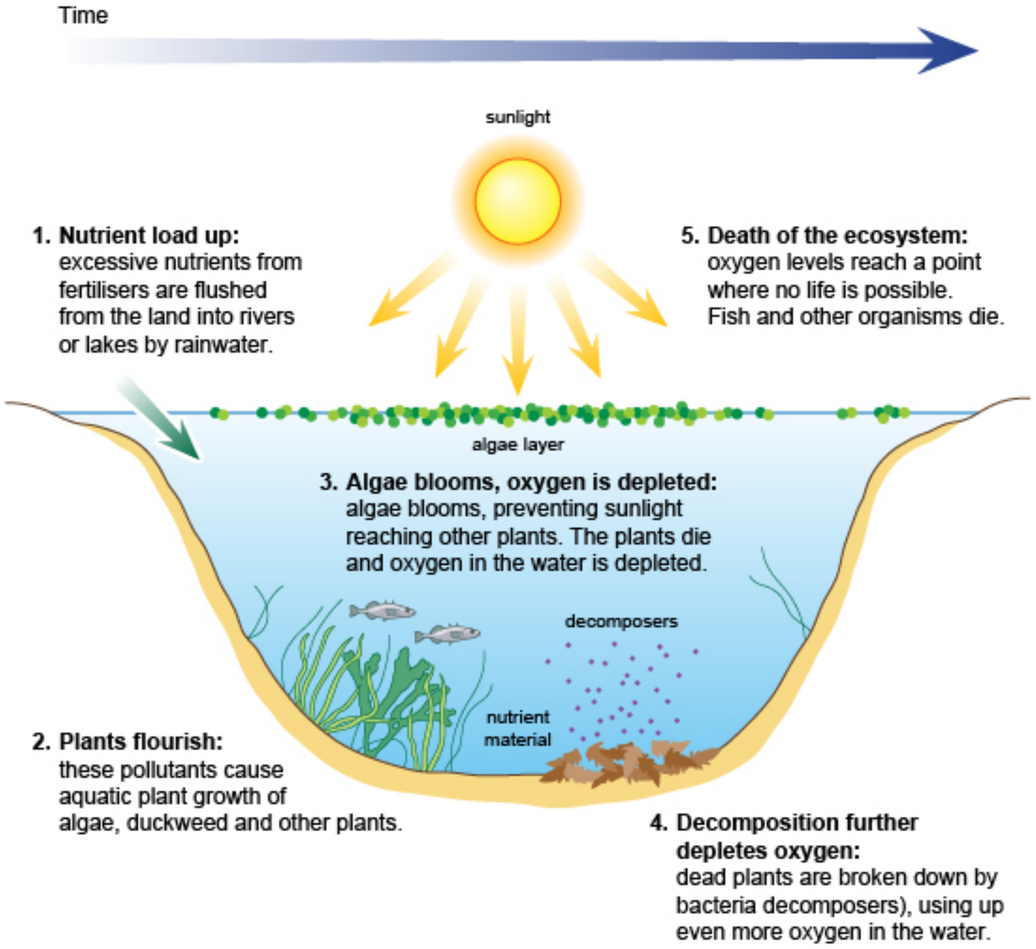
water pollution

Pollution is the contamination of the environment due to addition of substances called pollutants, causing harm and damage to the ecosystem.

- Water pollution can be caused by **sewage** and **inorganic waste**
  - Sewage consists mainly of organic wastes such as detergents, oils and fats, insecticides and herbicides, and debris
  - Inorganic waste consists of leached nutrients and fertilisers (nitrates and phosphates) from farmland, ammonia, sulfur dioxide from power plants, and heavy metals.
  - They are **discharged directly into water** without undergoing treatment
    1. Some of these pollutants can be **directly toxic** to the living organisms in the water, causing them to die.
    2. Contaminated water usually **encourages growth of microorganisms** such as bacteria, parasites and viruses. These could lead to **diseases** such as gastroenteritis, cholera, typhoid and parasitic infection.
    3. **Eutrophication**, which is the **excessive growth of algae and water plants** due to excessive nutrients of **phosphates and nitrates**

water pollution

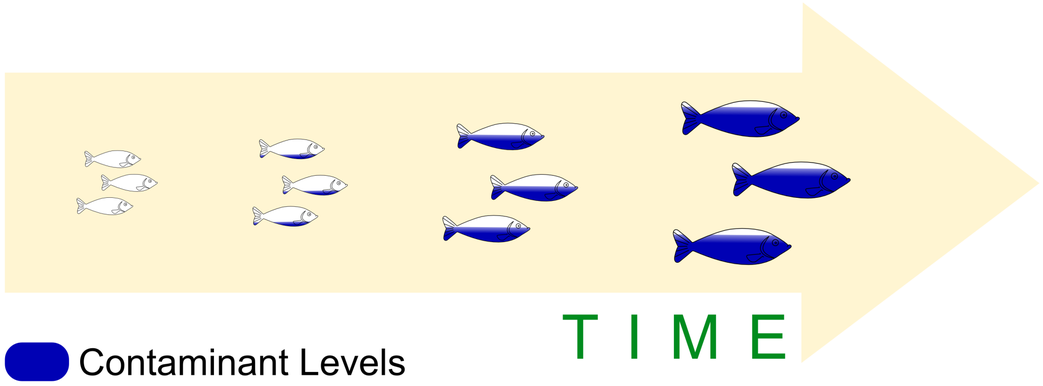
eutrophication



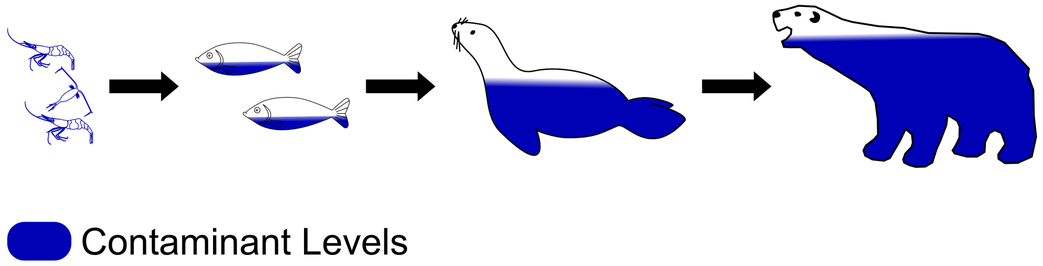
1. **Untreated sewage or excess fertilisers** runoff is discharged into waterbodies
2. It is **rich in phosphates and nitrates** causing surface **algae, phytoplankton and water plants multiply rapidly**
3. Overgrowth of these plants **prevents sunlight from reaching the submerged plants**, causing the **submerged plants to die** due lack of sunlight for **photosynthesis**
4. These dead plants cause **bacteria decomposers** to multiply rapidly. They **break down dead plants**, **using up oxygen** in water.
5. Fish and other organisms die due to **lack of oxygen** for **respiration**.
6. Anaerobic bacteria break down organic water, releasing foul-smelling gases such as hydrogen sulphide and ammonia

water pollution

When pollutants such as mercury, arsenic and DDT (dichlorodiphenyltrichloroethane) are released into the environment, they are non-biodegradable, which means it cannot be broken down by the environment so it persists in the environment. they also enter the bodies of organism.



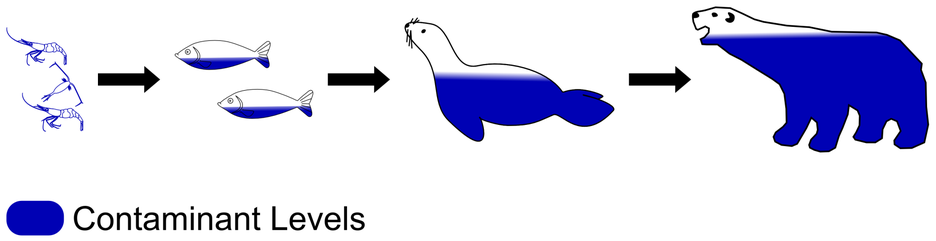
- **Bioaccumulation** refers to certain **substances that cannot be broken down** (detoxified) and excreted by organisms, thus they **accumulate** in the **fatty tissues** of organism. It occurs within an organism.
- However, the concentration may not be high enough to cause the organism to die



- **Bioamplification** is the **increase in concentration of a substances up a food chain**.
- The organism at the **higher trophic level** contain **higher concentration of substances**. It occurs in a food chain across trophic levels.
- Thus, the **tertiary consumers** are most **susceptible** to problems arising from such pollutants as the concentration of toxic substances may **reach a fatal level**

DDT

an example of non-biodegradable insecticides



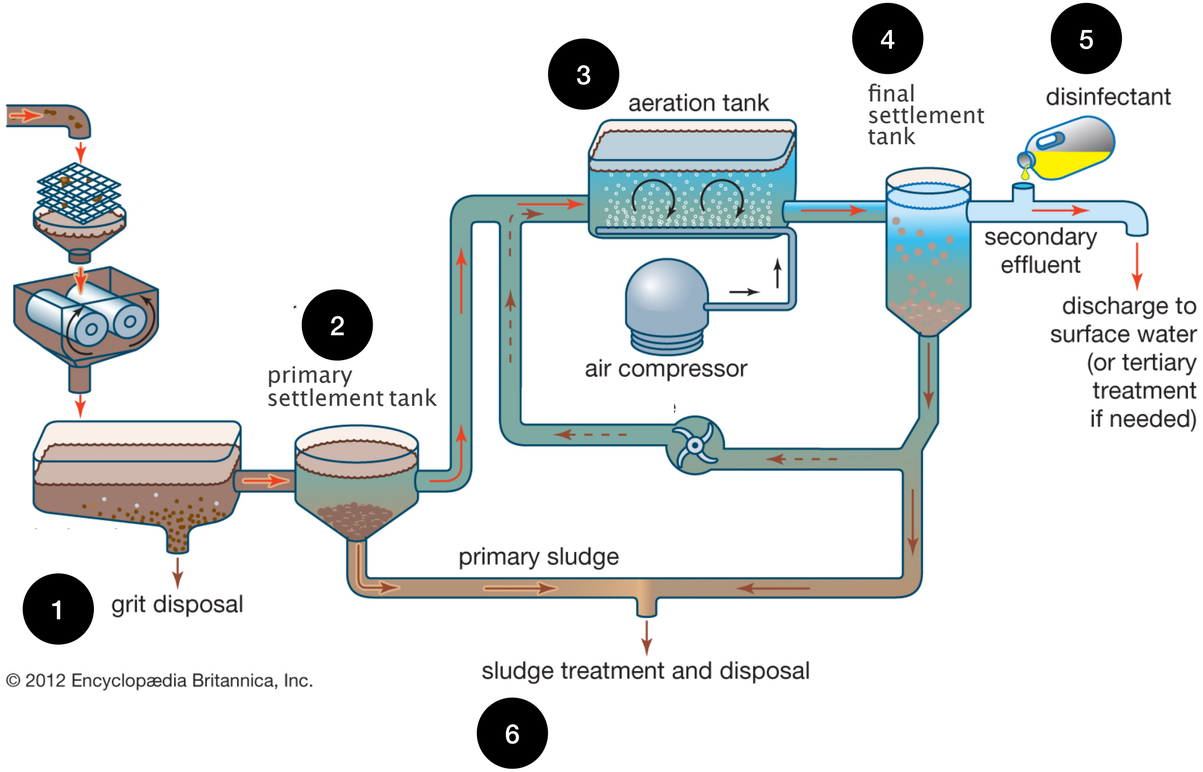
DDT (dichlorodiphenyltrichloroethane)

DDT is a synthetic pesticide used to control mosquitoes. They are extremely toxic, especially at high concentrations

(a) DDT is non-biodegradable and is transported by water to far-reaching areas.
(b) DDT is absorbed by the small prawns and accumulates in the fatty tissues of the consumers
(c) The concentration of DDT increases along the food chain. At the higher trophic levels, consumers consume a larger biomass than it possesses due to energy loss at every level
(d) Concentration of DDT increases and reaches the maximum at the top consumer (bears) and the high level of DDT may be toxic enough to kill them

Sewage treatment

environmental biotechnology



1. In sewage treatment plants, sewage is added to the **settling tanks** for screening, where **large solids are removed**.
2. The sewage liquid is then sent to the **primary settlement tank**, where **smaller solid suspensions** to settle to the bottom of the tank as **primary sludge** and removed.
3. The liquid then flows into an **aeration tank**, where pure **oxygen** is bubbled in and **aerobic bacteria** are added. The bacteria **decompose the organic waste into harmless substances**
4. The treated water is channeled into the **final settlement tank**. A portion of the sludge is returned to the aeration tank for reuse.
5. The sewage water leaving final settlement tank is **disinfected** to **reduce the number of microorganisms in the water** before it is discharged back into the environment.
6. The excess **sludge is sent to an anaerobic digester** where there is no oxygen. Anaerobic bacteria **decompose the organic matter in sludge,** producing **biogas**, mainly **methane**. Methane is used as a **fuel to generate electricity.** The remaining solid material is removed from the tank. It may be used as fertiliser or burnt in an incinerator.

Key Concept

conservation

Conservation

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This EnviroAtlas eco-wheel was created by Jessica Jahre, EPA contractor

Conservation is the protection and perseveration of species, their habitats and entire ecosystems from extinction.

Conservation is important

1. **Maintenance of biodiversity**
- Maintaining a large gene pool is important as many wild plants and animals possess favourable genes.
- By cross-breeding the different varieties of wild plants and animals, we can improve agricultural produce such as improving yield and quality of organisms

2. **Scientific research**
- Many tropical plants are of great importance as they are sources of medicinal drugs.

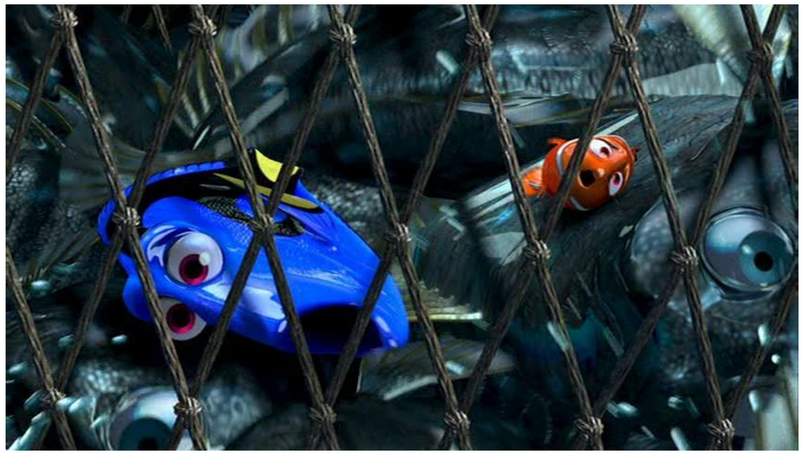
3. Conservation preserves the **existence of rich variety of species** for us and future generations to appreciate and enjoy

4. **Economical value**
- Tropical rainforests provide raw materials such as timber, cotton and rubber for industries
- Ecotourism is a source of income for several countries such as Costa Rica, Madagascar, and Kenya.
- Marine life, tropical rainforests provide food sources such as seafood and maize

5. **Stable and balances ecosystem**
- This prevents disruption of natural cycles such as carbon cycles
- Prevents global warming

Conservation

ocean



As the human population increases, **demand for fish increases**. to respond to this increase in demand, there is **overfishing** leads to some species **populations to have decreased significantly**.

Uncontrolled fishing practices:

1. **Drift nets** are nets that are **left to drift freely** in the seas. These nets trap almost everything in their path.
2. Shrimp or prawn **trawlers drag large fishing nets along the bottom of the sea**, trapping marine life indiscriminately.
3. Scallop **dredges scrape the seabed**, destroying coral reefs and organisms that live on the seabed.

Impact

- Marine life are caught **indiscriminately**, young fish that are caught will not have a chance to grow and reproduce while marine organisms that are unintentionally caught often do not survive.
- **Populations of organisms will decrease** and eventually some species may become **endangered and even extinct**

Management of fisheries

1. **Banning the use of drift nets, trawlers and dredgers** which indiscriminately trap all forms of marine life.
2. Using nets with a **certain mesh size** so that young or immature fish are not caught
3. Regulating the entry of ships into fishing grounds
4. Limiting the period of fishing
5. Breeding of endangered fish in captivity then released into the wild to prevent fish population from depleting

Conservation

forest

Negative impact of deforestation

1. **Global warming:** The 'slash and burn' practice used to clear forests for agriculture releases a large amount of carbon dioxide which contributes to global warming.
2. **Soil erosion**: When trees are removed, the soil is directly exposed to the force of the rain. There are also no roots to bind the soil. The topsoil is eroded during heavy rains. Soil erosion can lead to flooding. The eroded soil may be deposited in rivers and streams, blocking the flow of water. The water levels in rivers rise rapidly, causing floods.
3. **Desertification**: When forests are cleared, sunlight falls directly onto the soil. Water evaporates rapidly from the soil, causing it to harden. The land becomes barren and plants cannot grow in the soil.
4. **Climate change:** Rainwater that is retained and absorbed by the roots of trees is lost as water vapour during transpiration. The water vapour eventually condenses and falls as rain. When trees are cleared, there are fewer clouds, less transpiration and less rainfall. The area becomes dry and warm, and annual rainfall decreases.
5. **Loss of habitat** for many organisms: Forests are habitat for many organism, loss of habitat can lead to species to become endangered or even extinct. This leads to loss of biodiversity

Management of timber production

- Regulating the rate of logging
- Selective logging where young trees are not cut down
- Designating land as forest reserves
- reforestation, which is the act of restocking forests which have been depleted. New seedlings are planted to replace trees that have been felled.

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