2. FOOD CHAIN

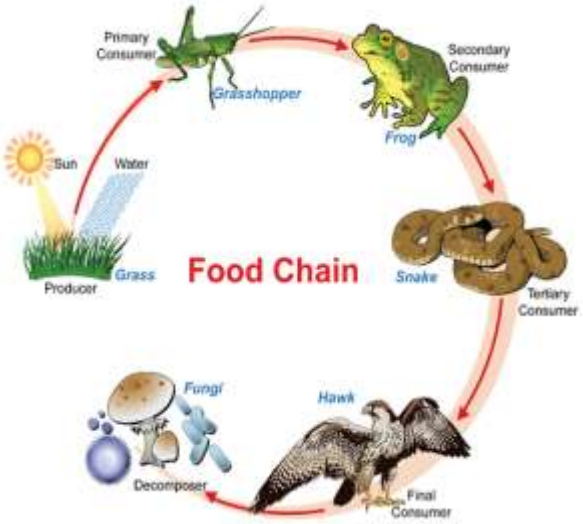
Energy Flow

- The pathway along which the energy flows through the organisms can be studied in the following ways:
  - a) Food chain
    1. Grazing
    2. Detritus
    3. Parasitic
  - b) Food Web
  - c) Ecological pyramids
    1. Pyramid of Numbers
    2. Pyramid of biomasses
    3. Pyramid of energy

- Except for the **deep sea hydro-thermal ecosystem**, sun is the only source of energy for all ecosystems on Earth. Of the incident solar radiation, less than 50 per cent of it is **Photosynthetically Active Radiation** (PAR).
- Plants capture only 2-10 per cent of the PAR and this small amount of energy sustains the entire living world. So, it is very important to know how the solar energy captured by plants flows through different organisms of an ecosystem. All organisms are dependent for their food on **producers**, either directly or indirectly.
- Hence, there is a **unidirectional** flow of energy from the sun to producers and then to consumers.

A. Food Chain

- A **food chain** is a linear network of links in a food web starting from producer organisms (such as grass or trees which uses sunlight to make their food) and ending at apex predator species (Tiger or whales), detrivores (like art or woodlice), or decomposer species (such as fungi or bacteria).



- **Grazing Food Chain** and **Detritus food chain** are the two important types of food chains in an ecosystem.

a) Grazing Food Chain

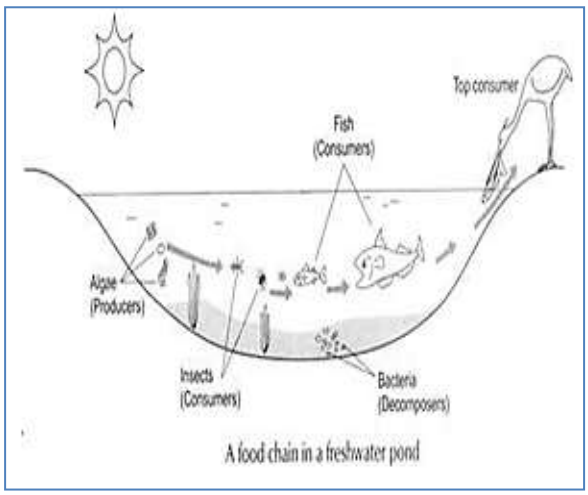
- In a terrestrial ecosystem, major producers are herbaceous and woody plants.
- Likewise, primary producers in an aquatic ecosystem are various species like phytoplankton, algae and higher plants.
- Starting from the plants (or producers) food chains and food webs are formed, such that an animal feeds on a plant or on another animal and in turn is food for another. This type of food chain, that begins with the primary producers are known as **Grazing Food Chain**.

Simple examples for grazing food chain (GFC):

Grass → Goat → Man

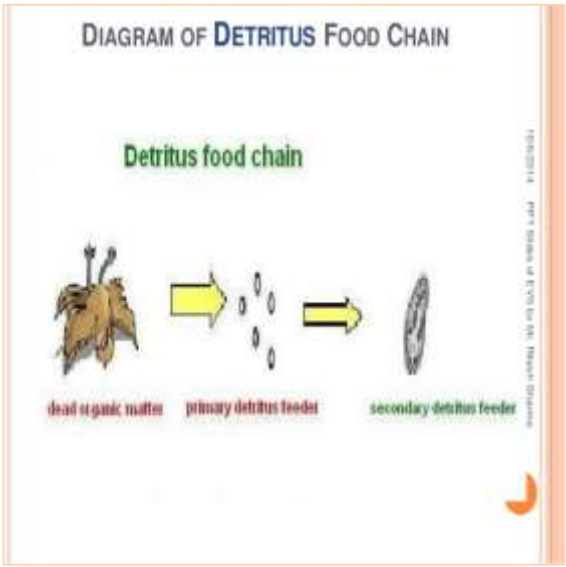
Diatoms → Crustaceans → Herrings

(Producer) → (Primary Consumer) → (Secondary consumer)



A food chain in a freshwater pond

b) Detritus Food Chain



- The **Detritus Food Chain** (DFC) begins with dead organic matter. It is made up of **decomposers** which are heterotrophic organisms, mainly **fungi** and **bacteria**.
- They meet their energy and nutrient requirements by degrading dead organic matter or detritus.
- These are also known as **saprotrophs** (sapro: to decompose).
- Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them.

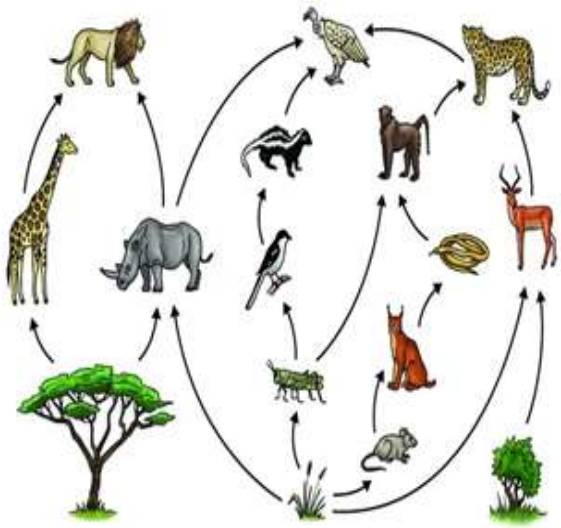
In an **aquatic ecosystem**, a large fraction of energy flow through the **GFC**.

In a **terrestrial ecosystem**, a much **larger fraction of energy flow** through the **DFC** than through the **GFC**.

c) Parasitic Food Chain

- This food chain starts from herbivore but food energy passes from larger to smaller organism without outright killing as in case of predator. Hence, the larger animals are considered to be the hosts and the smaller animals which fulfill their nutritional requirements from the hosts are considered as parasites.

FOOD WEB

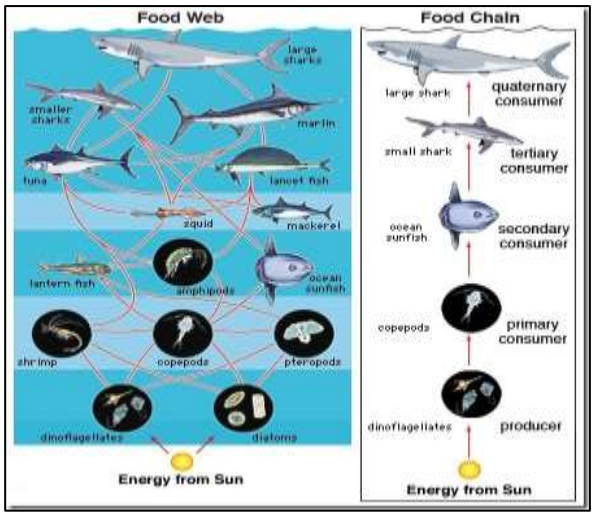

Food Chain vs Food Web

- The length and complexity of food chains vary greatly.
- Each organism is generally eaten by two or more, other kinds of organisms, which in turn are eaten by several other organisms.
- So instead of a straight line food chain, the relationship can be shown as a **series of branching lines** called a **Food Web**.

- Detritus food chain may be connected with the grazing food chain at some levels: some of the organisms of DFC are prey to the GFC animals, and in a natural ecosystem, some animals like cockroaches, crows, etc., are omnivores. These natural interconnections of food chains make it a **food web**.

Food chain

1. It is the single straight pathway through which food energy travels in the ecosystem
2. Usually members of higher trophic level* feed upon a single type of organisms of lower trophic level
3. Isolated or separate food chains increases the instability of the ecosystem
   - It does not have any effect on improving the adaptability and competitiveness of the organisms.

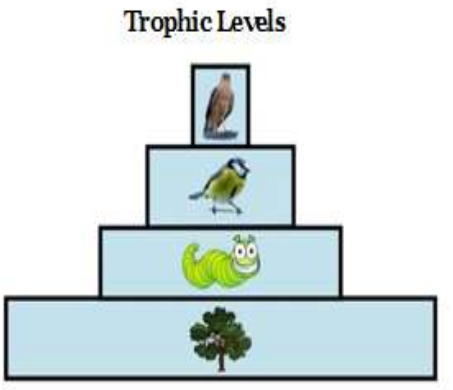


Food Web

1. It consists of number of interconnected food chains through which food energy travels in an ecosystem
2. Usually members of higher trophic level feed upon many organisms of lower trophic level
3. Presence of complex food webs increases the stability of the ecosystem
4. More complex food webs improves the adaptability and competitiveness of the organisms

Trophic Level

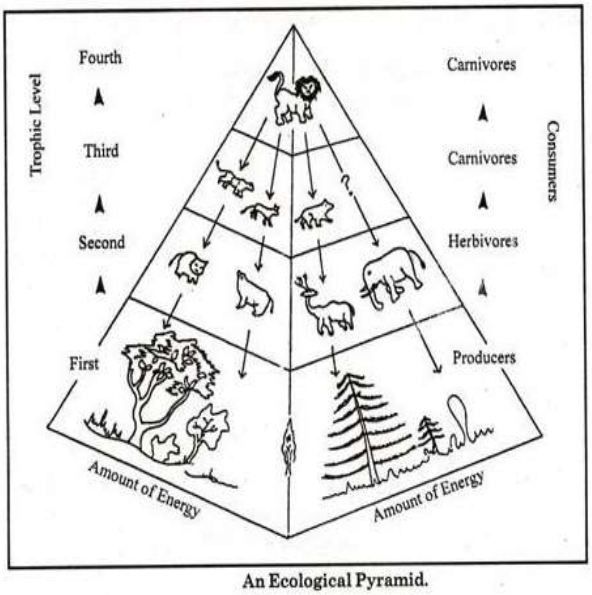
1. Based on the source of their nutrition or food, organisms occupy a specific place in the food chain that is known as their **trophic level**.
2. Producers belong to the first trophic level, herbivores (primary consumer) to the second trophic level and carnivores (secondary consumer) to the third trophic level.
3. The important point to note is that the **amount of energy decreases** at **successive trophic levels.**
4. Organisms at each trophic level **depend** on those at the **lower trophic level** for their **energy demands**.
5. Each trophic level has a certain mass of living material **(biomass)** at a particular time called as the **standing crop** and it is measured by biomass or the number in a unit area.



ECOLOGICAL PYRAMIDS

- Ecological pyramids are the graphic representations of trophic levels in an ecosystem.
- The base of each pyramid represents the producers or the first trophic level while the apex represents tertiary or top level consumer.

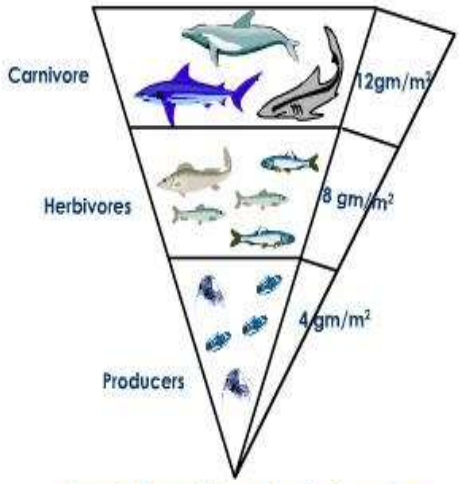
- The three ecological pyramids that are usually studied are (a) pyramid of number; (b) pyramid of biomass and (c) pyramid of energy.
- In most of the ecosystems, all the pyramids, of number, of energy and biomass are upright.



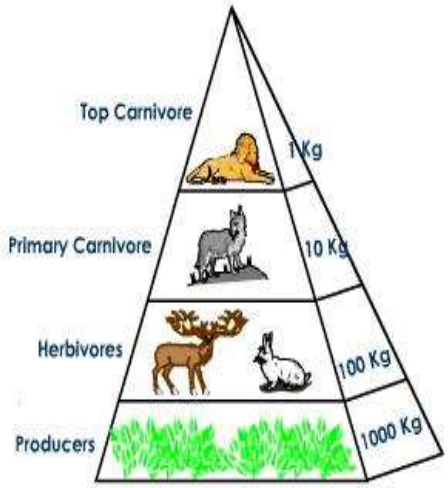
An Ecological Pyramid.

a) Pyramid of numbers is mostly upright. i.e., producers are more in number than herbivores and herbivores are more in number than carnivores. Exceptional cases are there. (e.g.) many number of birds and insects in a single tree.

b) Pyramid of biomass is mostly upright. Biomass of producers is more than biomass of herbivores and biomass of herbivores is more than biomass of consumers. But**, pyramid of biomass is inverted** in **sea**, as the biomass of fishes exceeds the biomass of phytoplankton.



Inverted Pyramid in an Aquatic Ecosystem



Upright Pyramid of biomass in a Terrestrial Ecosystem

c) Pyramid of energy is **always upright**, can never be inverted, Energy at a lower trophic level is always more than energy at a higher trophic level, because when energy flows from a particular trophic level to the next trophic level, some energy is always lost as heat at each step.

Limitations of Pyramids

- It does not take into account the same species belonging to two or more trophic levels.
- It assumes a simple food chain, something that almost never exists in nature.
- It does not accommodate a food web.
- Saprophytes are not given any place in ecological pyramids even though they play a vital role in the ecosystem.