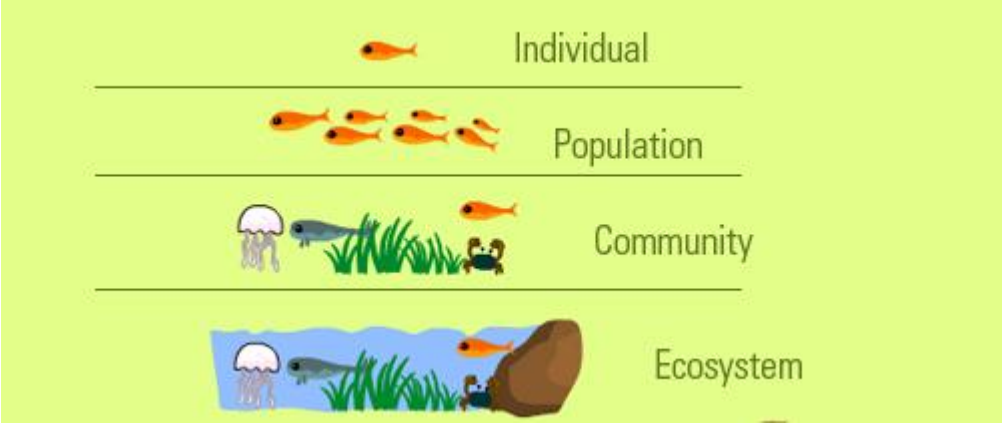
# Ecology

Ecology is the scientific study of how living organisms interact with each other and their environment. It involves understanding the relationships between organisms, their habitats, and the natural processes that shape the world around us.

**What is a Habitat?**

It is the natural environment in which an organism lives, including the **biotic** (living) and **abiotic** (non-living) factors.

## Populations, Communities and Ecosystems



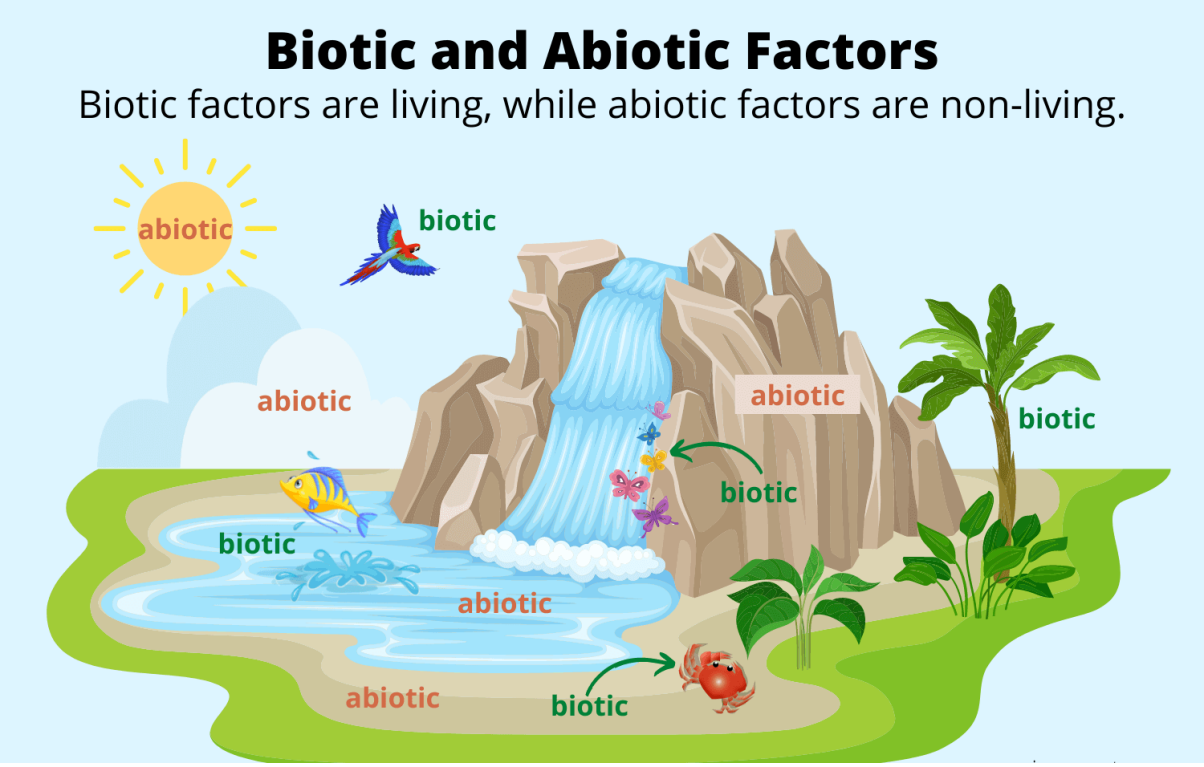

- A *population* is a group of organisms of **the same species living in a particular area**.
- A *community* is made up of all the populations of **different species living in a particular area**.
- An *ecosystem* is a **community of organisms** that interact with each other (biotic) and with their non-living environment (abiotic).

Local examples of ecosystems:

| Ecosystem | Location | Description |
|---|---|---|
| Woodland | Buskett | A dense forest consisting of native trees such as Carob trees, and provides a habitat for various bird species. |
| Maquis | Dingli cliffs | A dense shrubland dominated by small trees such as Olive and is home to various small mammals and reptiles. |
| Garigue | Pembroke | A low-growing, Mediterranean scrubland consisting of drought-resistant plants and is a habitat for various bird and insect species. |
| Freshwater | Chadwick Lakes | A still or slow-moving body of water containing a range of aquatic plant and animal life, including fish, amphibians, and insects. |

| Ecosystem | Location | Description |
|---|---|---|
| Sand Dunes | Is-Simar, Marsalforn | An ecosystem consisting of sand and vegetation adapted to the harsh, dry conditions and is home to various reptile and bird species. |
| Rocky Shores | Sliema coast | An ecosystem consisting of rocks, boulders, and crevices, and provides a habitat for various intertidal organisms such as limpets and crabs |

## Biotic and Abiotic Interactions




**Biotic interactions** are interactions between living things in an ecosystem (eg: Interaction between bees and flowers)

**Abiotic interactions** are interactions between living things and non-living things in an ecosystem (eg: interaction between plants and sunlight)

Both biotic and abiotic factors can limit the size and distribution of populations in an ecosystem. Uncontrolled growth of any species can have negative effects on the environment and the survival of the same and other species, such as:

- depletion of food resources
- spread of disease.

Biotic and abiotic components interact through **competition and predation.**

- Competition is **a race** for biotic and abiotic resources.
- Predation is the most common relationship in nature that helps to keep both predator and prey in check.

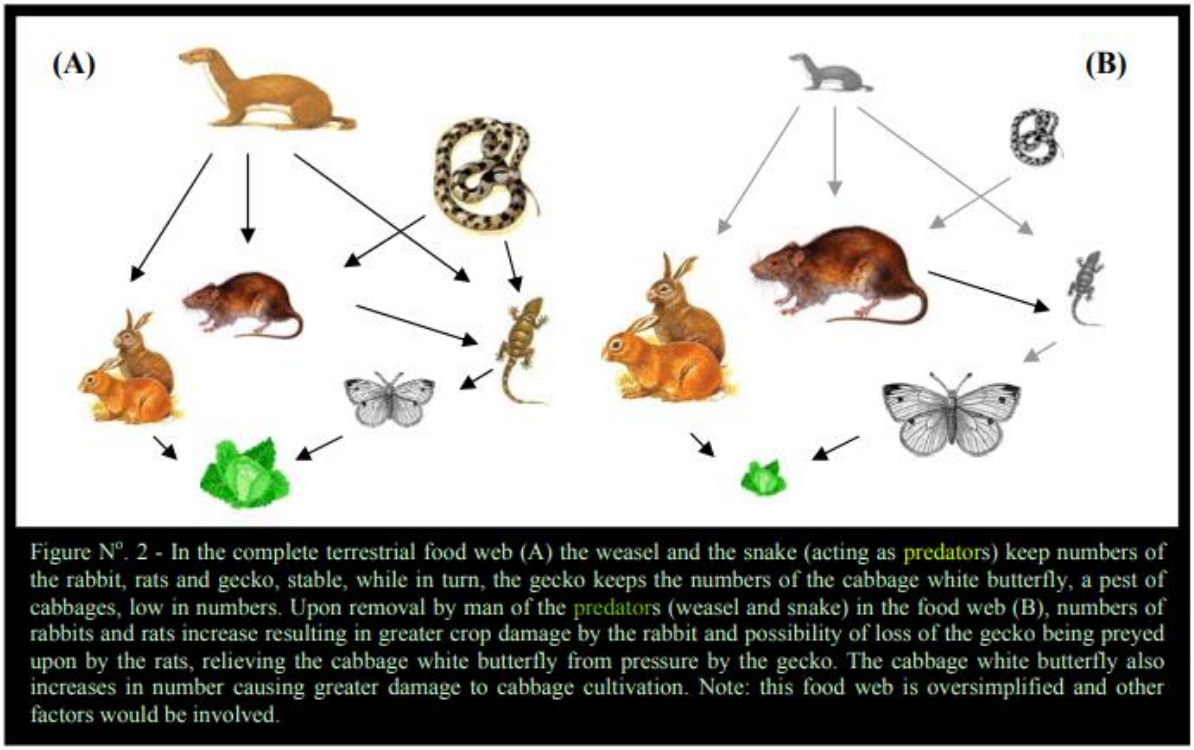



Figure Nº. 2 - In the complete terrestrial food web (A) the weasel and the snake (acting as predators) keep numbers of the rabbit, rats and gecko, stable, while in turn, the gecko keeps the numbers of the cabbage white butterfly, a pest of cabbages, low in numbers. Upon removal by man of the predators (weasel and snake) in the food web (B), numbers of rabbits and rats increase resulting in greater crop damage by the rabbit and possibility of loss of the gecko being preyed upon by the rats, relieving the cabbage white butterfly from pressure by the gecko. The cabbage white butterfly also increases in number causing greater damage to cabbage cultivation. Note: this food web is oversimplified and other factors would be involved.

## Interspecific and Intraspecific Competition

- **Interspecific competition** occurs between individuals of different species
- **Intraspecific competition** occurs between individuals of the same species. The competition is over:
    - Space: Trees competing for sunlight
    - Food: Rabbits competing for grass
    - Mate: Dears competing for the same females

## Ecological Niche

- The **ecological niche** of a species refers to the role that species has in the ecosystem. It is determined by:
    (1) the interaction of that species with other members of its community
    (2) the physical features of its surroundings.

*One example of an ecological niche is that of the European Rabbit.*

(1) The rabbit's niche **involves interactions with other members of its community**, such as predators (e.g. birds of prey, foxes, and feral cats), as well as competitors for resources such as food and habitat (e.g. other herbivorous mammals).
(2) The rabbit's niche is also shaped by **the physical features of its surroundings**, such as the availability of vegetation for food and cover, the presence of burrow-making soil, and the frequency and intensity of wildfires.

➔ The rabbit has adapted to this niche by being a herbivore, being able to dig burrows for protection and shelter, and by reproducing rapidly to keep up with the pressure from predators and competitors

## Native, Alien and Endemic Species

**Native (indigenous)** species refers to organisms that occur naturally in an ecosystem (eg: *Carob tree*).

**Alien ( introduced)** species refers to organisms that have been introduced into the ecosystem by humans (eg: *Geranium Bronze butterfly*).

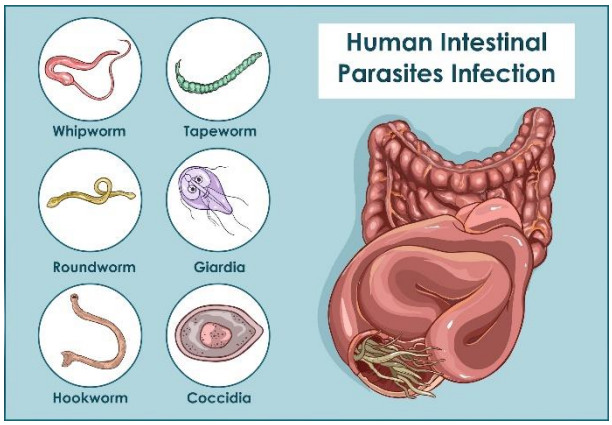
**Endemic** species are unique to a particular location and are found nowhere else (eg: Maltese Wall Lizard).

➔ Indigenous (native) species have evolved and are an integral part of the natural system. Introduced species can cause **disruptions** in the ecosystem and may result in displacement of other organisms.

# Parasitism and Mutualism

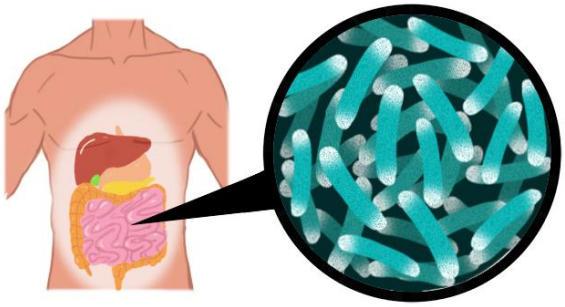
- **Parasitism** is a relationship where one organism (parasite) benefits at the expense of another organism (host).

  *Example*: **Tapeworm** in humans is found in our intestines. It attaches using hooks and absorbs some of the digested nutrients through its skin. It does not benefit the humans in any way but harms them.




- **Mutualism** is a relationship where both organisms benefit.

  *Example:* **Gut flora** in our stomach helps us to digest material that we are incapable of digesting. In return these bacteria take a small percentage of the nutrients themselves. They are also provided shelter by living in our stomach.



- An **endoparasite** lives inside the body of the host, while an **ectoparasite** lives outside the body of the host.

  An example of an endoparasite is the tapeworm.

  An example of an ectoparasite is the **leech** which absorbs blood by piercing the skin of mammals.

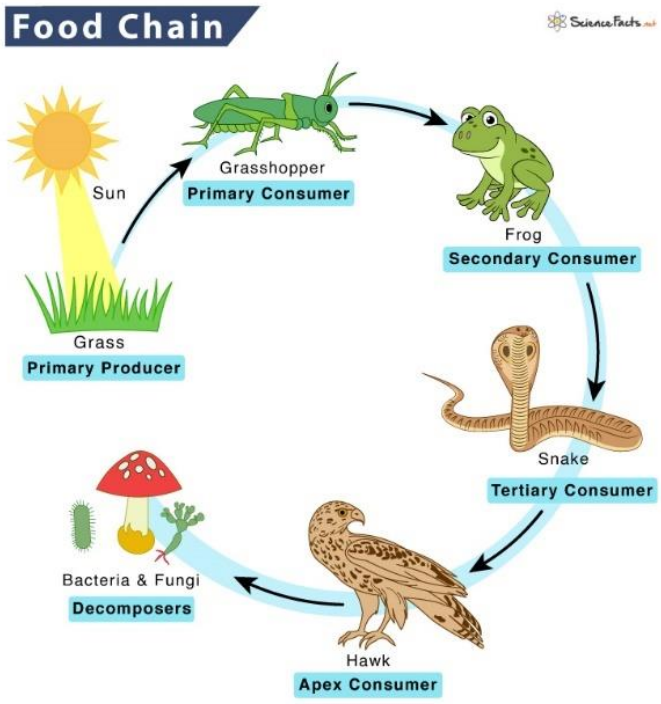
# Food webs and food chains

All organisms in an ecosystem are related to one another via feeding relationships called food chains and food webs.

- **Producers** are organisms that produce their own food through photosynthesis, such as plants.
- **Consumers** are organisms that eat other organisms for energy. They can be classified as carnivores (eat other animals), herbivores (eat plants), or decomposers

## Food chains

- A **food chain** is a linear sequence of organisms starting with a producer and ending with a top predator.
- A food chain can be interpreted as a **pathway through which energy flows**, from the producer to the top predator.
- Only about 10% of the energy is passed on from one level to the other.

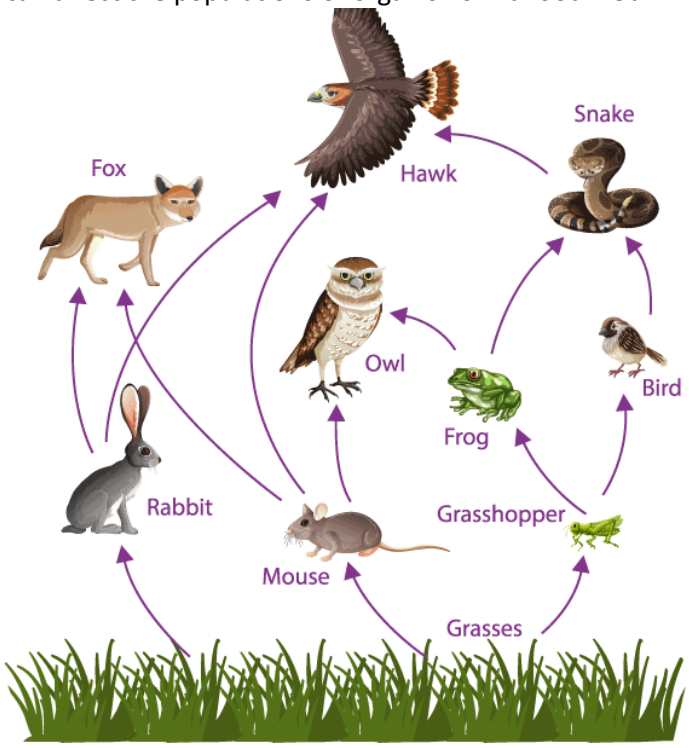



## Food webs

- A **food web** is a more complex representation of the feeding relationships between organisms in an ecosystem, as it includes multiple interconnected food chains. A food web can be constructed by drawing interconnected food chains, showing the feeding relationships between multiple organisms in an ecosystem.
- A food web can be interpreted as **a pathway through which energy flows**, from the producer to the top predator. The direction of the arrows in the food web is indicative of the flow of energy. Food webs are considered **true representations** of biotic interactions in an ecosystem as they show the multiple feeding relationships and interactions between organisms, which is more representative of the complexity of real ecosystems compared to a food chain.

Changes in biotic and abiotic factors can affect the populations of organisms in a food web.

*For example*, **a decrease** in the population **of a primary consumer** (mouse) due to disease can lead to **an increase** in the population of **the producer** (grass), as there are fewer herbivores feeding on them. This could also cause **a decrease** in the **secondary consumer** (owl) as it would find less food.



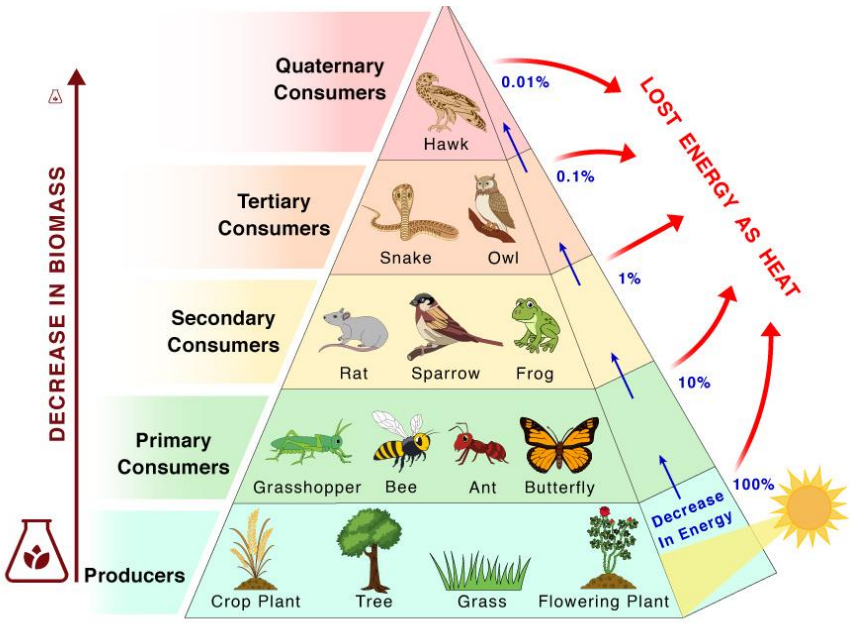

→ **Producers** are organisms that can produce their food through **photosynthesis or chemosynthesis**. They are usually plants or algae.

→ **Consumers** are organisms that cannot produce their food and depend on producers and other consumers for their energy. There are 3 types of consumers:

- **Herbivores**: These are primary consumers that eat only plants.
- **Carnivores:** These are secondary or tertiary consumers that eat other animals.
- **Decomposers**: These are organisms that break down dead organic matter into simpler forms that can be used by other organisms.

*Eg: A local ecosystem like the garigue includes producers such as aromatic, **succulent plants**, and shrubs. The primary consumers are herbivores like **insects** that feed on the plants. The secondary consumers are carnivores like **lizards** and birds that prey on the herbivores.*

# Trophic Levels




**Trophic levels** refer to the different levels in a food chain or food web.

- ➔ The first trophic level is made up of producers (eg. plants), followed by primary consumers (eg. Herbivores), secondary consumers (carnivores) and so on. In general, as we move up the trophic levels, the amount of available energy decreases.

- ➔ Energy is lost as it is transferred from one trophic level to another due to processes like **respiration and digestion**. This loss of energy means that there is less energy available to organisms at higher trophic levels. Only about 10% of the energy is passed from one tropic level to the other. As a result, the number of organisms at each trophic level decreases.

# Producers and Consumers as Pyramids

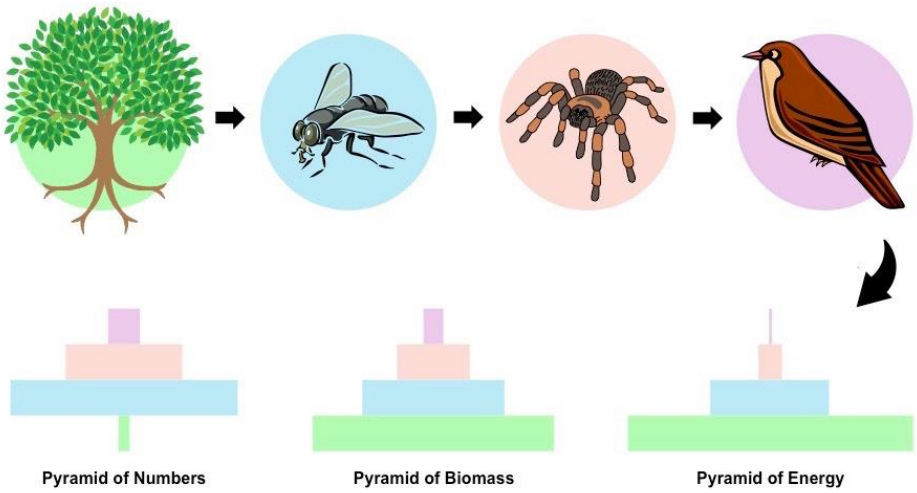
Pyramids of numbers, biomass, and energy are used to represent the relationship between producers and consumers.

- ➔ In a **pyramid of numbers**, the number of organisms at each trophic level is represented.
- ➔ In a **pyramid of biomass,** the amount of living matter at each trophic level is represented.
- ➔ In a **pyramid of energy**, the amount of energy available at each trophic level is represented.

*For example: In the example below in a **pyramid of numbers**, the number of trees (green) is the lowest number as one tree is capable of feeding hundreds of organisms. Primary*

*consumers (flies) would have the highest number, then secondary consumers (spiders) and then tertiary consumers (birds).*

*Using the same example, both in a **pyramid of biomass and a pyramid of energy** the component of trees would have the highest value both in terms of mass and energy.*




## The Earth as a Closed System

Earth is considered a closed system because **matter is not created or destroyed**, but it changes form. This means that the amount of matter on Earth remains approximately constant. However, **energy can enter and exit the system** in various forms.

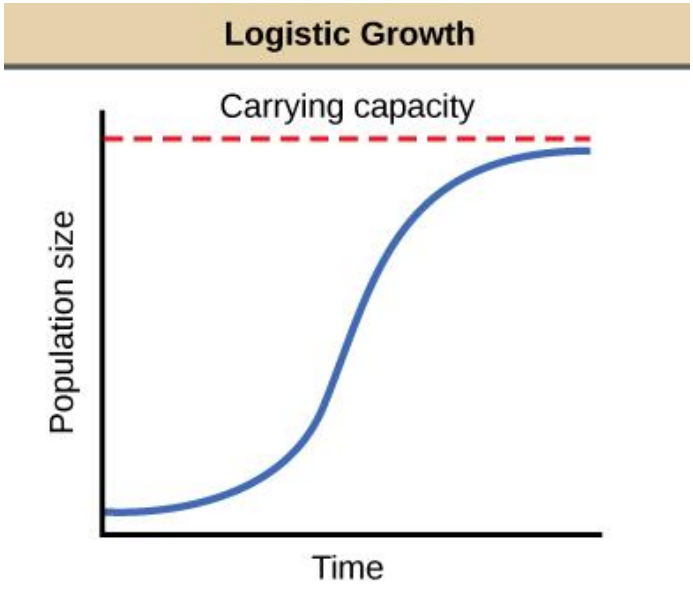
Although Earth is considered a closed system, there is still an exchange of energy and matter. *For example*, **energy from the sun** enters the Earth's system and is used by producers to produce food through photosynthesis. In addition, **matter like meteorites** and human space debris can enter the Earth's system and affect the ecosystem.

It is important to understand that the survival of a species is directly related to the **availability of resources** such as food and water, as well as **suitable living conditions** in the environment. This is influenced by both abiotic (non-living) and biotic (living) factors, which impact the resources available to a species.

- **Carrying capacity** is the maximum number of individuals of a species that can be supported by the resources available in a given environment. This is influenced by both abiotic and biotic factors, and is an important concept to understand in ecology.

- Unlimited growth of a population cannot be sustained by a planet with finite resources. This is because the carrying capacity of a given environment is limited by the resources available. It is important to recognize that the resources on our planet are limited and that sustainability is key to the continued survival of all species.

## S- growth




S-curved growth, also known as logistic growth, describes a pattern in which a population initially grows exponentially, but eventually levels off and stabilizes at the carrying capacity of its environment.

This stabilization occurs due to

- **limited resources availability** (eg: food and oxygen)
- **increased competition** among individuals for those resources
- **waste accumulation**

There is a potential decline in population size if the carrying capacity is exceeded.