

## Chapter 03: Introduction to Ecology (Principal concepts):

### 1-Organization of living beings:

Levels of organization in ecology help scientists generally study the anthropogenic impact, energy flow and changes in population dynamics. Natural organisms can be studied at small or large levels, which are:

- **Organism:** The specimen or the first unit of living beings. We focus at this level on the relationship of an individual organism with its abiotic environment (temperature, moisture, light, soil etc....).
- **Population:** A group of organisms of the same species in a specific area. Ecologists are interested in the biotic and abiotic factors that affect a population's size and distribution.
- **Community:** It's about populations of different species in an area, with a focus on community structure, composition and the biotic interactions between these groups, such as predation and competition.
- **Ecosystem:** A community together with its function, which is the pools and fluxes of energy and matter within and between biotic and abiotic factors.
- **Ecoregion (Landscape):** Recurring patterns of ecosystems, associated with characteristic combinations of soil and landform. Ecosystems within an ecoregion are more similar to each other than to ecosystems elsewhere.
- **Biosphere:** It represents all of the Earth's organisms interacting with each other and the global environment.

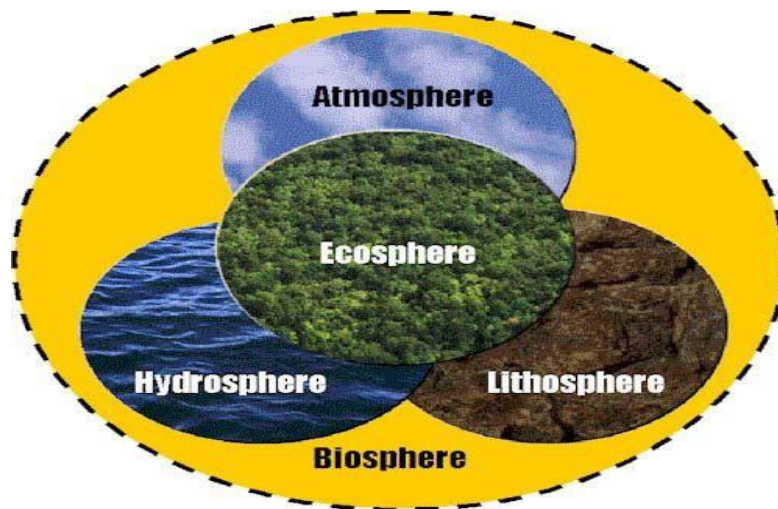


Figure 01. Organization levels of living beings

### 2-Concept of Ecology:

The word **ecology** is derived from the Greek “oikos” meaning house and “logos” meaning study (Study of the natural house of species). The word ecology is of recent origin having been first proposed by the

German biologist **Ernst Haeckel** in **1869**; as the study of organisms, populations, and communities, as they relate to one another and interact in the ecosystems they comprise.



**Figure 02. Position of the Ecosphere in the Biosphere**

### **2-1-Types of Ecology:**

According to the group of organisms to be studied, there are three types of Ecology:

- **Autecology or species ecology:**

It deals with the study of an individual species of organisms in its population. The ecologists study the behavior and adaptations of a particular species to the environmental condition at every stage of that individual's life cycle.

- **Demecology or Ecology of population:**

It includes the study of populations of different species with concern to birth rate, death rate, different factors affecting number, growth, and sizes of populations.

- **Synecology or Ecology of communities:**

It deals with the study of communities and Ecosystems, their composition, their behavior and their relation with the environment.

### **2-2- Main axes of ecology:**

The study of Ecology deals with:

- ❖ The spatial distribution and abundance of organisms.
- ❖ The temporal changes in the occurrence, abundance and activities of organisms.
- ❖ The interrelations between organisms, communities and populations.
- ❖ The structural adaptation and functional adjustments of organisms to the change in environment.
- ❖ The behavior of organisms under natural environment.
- ❖ The productivity of organisms and energy to mankind.

- ❖ The development of interactive models for predictive purposes.

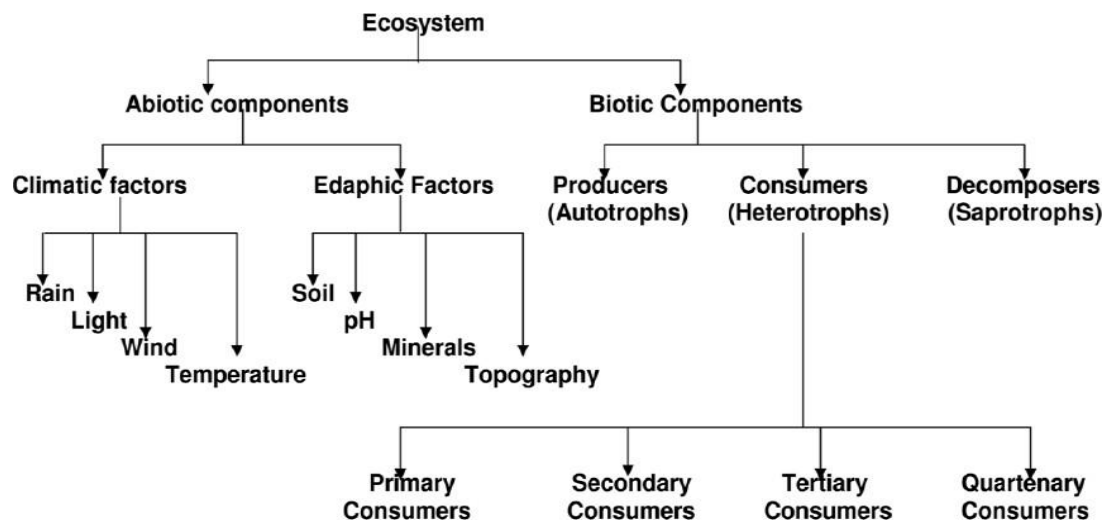
### 2-3- Concept of ecological niche:

The Niche is the set of biotic and abiotic conditions in which a species is able to persist and maintain stable population sizes. It is a complete description of how the organism relates to its physical and biological environment, as well as his principal role within a community, mainly translated by the variable behavior recorded at different seasons and different times of the same day.

### 2-4- Factors affecting an Ecosystem:

The structure of an ecosystem explains the relationship between biotic and abiotic and components:

- ✚ Biotic (living) components.
- ✚ Abiotic (non-living) components.



#### 2-4-1-Abiotic factors:

Abiotic factors are the non-living components of the ecosystem, including the chemical and physical factors, (light, radiation, temperature, water, chemicals, gases, wind and ph.....), present in the atmosphere, the hydrosphere, and the lithosphere. Without suitable abiotic factors, living organisms wouldn't be able to eat, to grow, to reproduce, and to exist.

#### 2-4-2-Biotic factors:

They include interactions between organisms, like interspecific and intraspecific interactions (predation, parasitism, and competition among species.....). In addition, living organisms themselves are biotic factors; they fall into three main categories: producers, consumers, and decomposers.

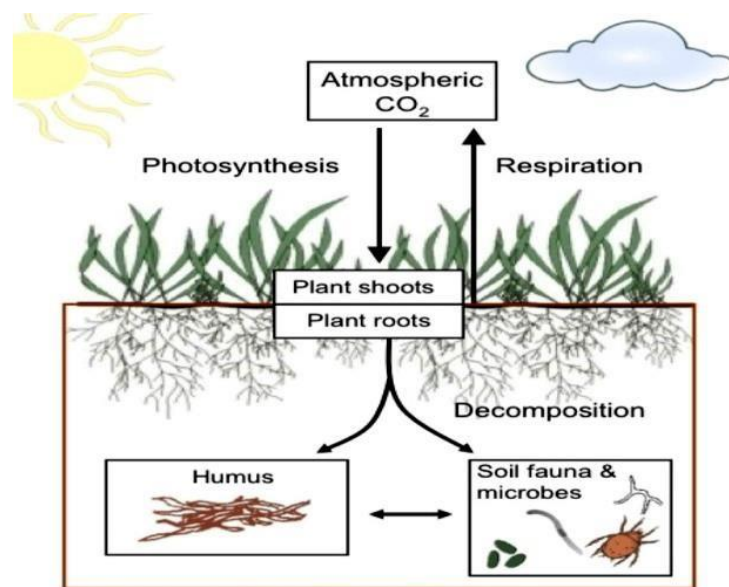
### 3-Organic matter cycle:

#### 3-1- Concept of Organic matter:

Organic matter refers to any material that contains carbon compounds, derived from living tissues including substances such as plant and animal residues, dead organisms, and other biological materials. Organic matter plays a crucial role in nutrient cycling, soil structure and fertility. It serves as a source of energy and nutrients for soil organisms and productivity.

#### 3-2- Matter cycle between photosynthesis and decomposition:

The majority of life on Earth is based on food chains, which revolves around organic matter production, as plants use sunlight, water and carbon dioxide to make food via the procedure of **photosynthesis**. While **decomposition** is the process by which dead organic substances (Plants, animals and humans) are broken down into simpler inorganic matter such as water, simple sugars and mineral elements.



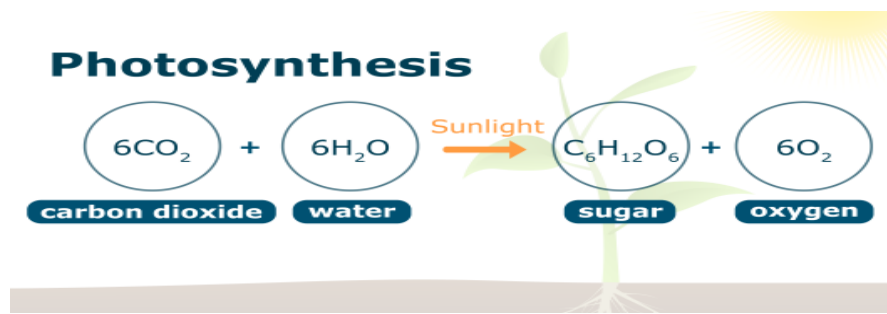
**Figure 03. Matter cycle between photosynthesis and decomposition**

#### ❖ Matter production (Photosynthesis):

Plants are the only autotroph organisms that serve as primary producers in food chains. They represent the foundation of the ecosystem pyramids by obtaining energy and nutrients from using sunlight through photosynthesis to make organic substances from inorganic ones, according to the following sources and equation:

- Carbon dioxide is obtained through tiny pores present in the leaves of the plant called stomata.
- Oxygen is also released through the stomata (respiration).
- Water is obtained by roots and then passed on to the leaves through the vascular plant tissues systems.

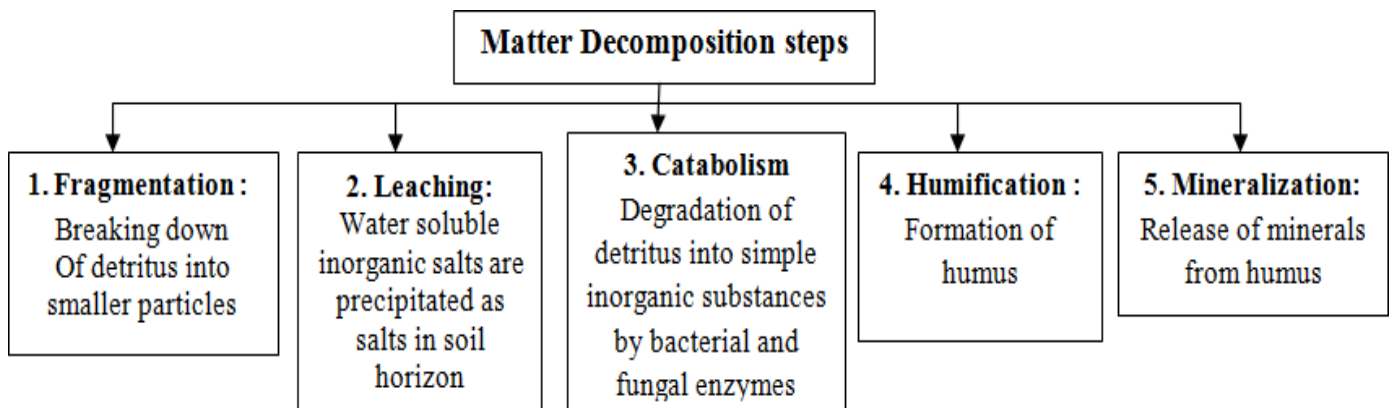
- Sunlight is absorbed by chlorophyll, a green pigment located in chloroplasts; where photosynthesis takes place.



**Figure 04. Photosynthesis equation**

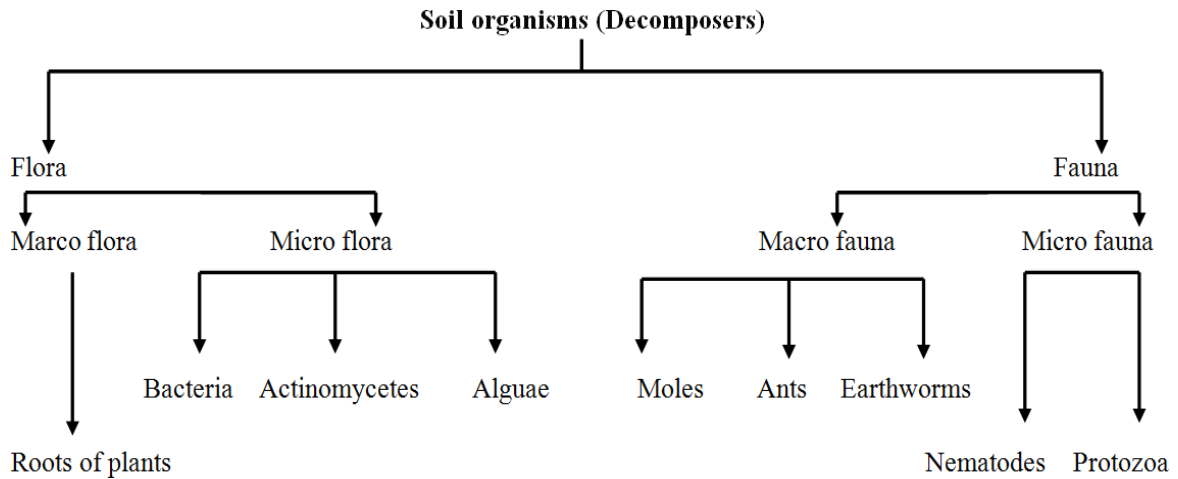
❖ **Matter degradation (Decomposition):**

It is a basic cleaning tool of nature, and a principal metabolic process, where organic residues are degraded and decomposed by oxidative processes involving rotting organisms’ species (Soil biota). It is one of the significant and essential processes of the ecosystem that corresponds to the disintegration or rupture of complex organic matter into a simpler inorganic matter in the following steps:



**3-3-Concept of Soil Biota:**

Soil biota is a term that represents all organisms that spend all or a portion of their life cycle within a soil profile and constitute the land food webs (matter decomposition). It consists of the micro-organisms (bacteria, fungi, and algae), soil animals (protozoa, nematodes, mites, springtails, spiders, insects, and earthworms).

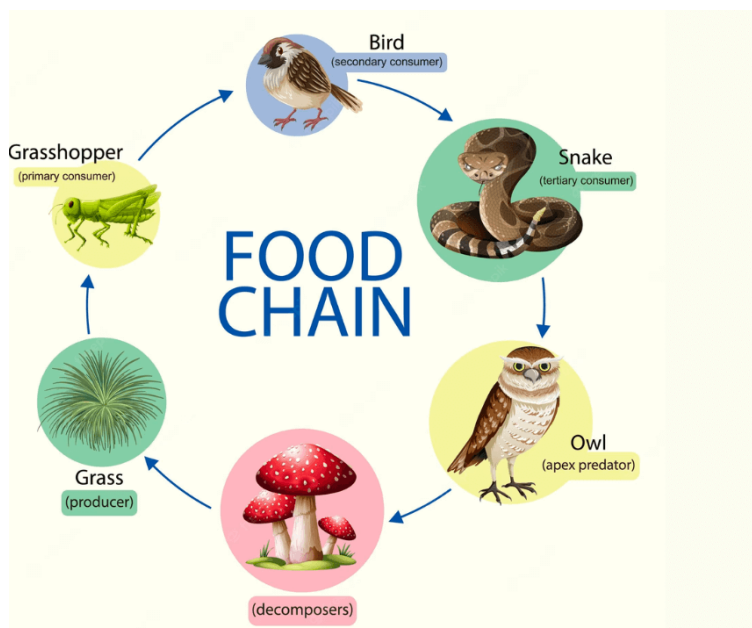


**4-Energy Flow in Ecosystems:**

Energy flows from the sun through ecosystems and from one organism to another. This energy cycles through ecosystems from producers to consumers and back into the nutrient pool through decomposers. Trophic levels describe the feeding levels of organisms.

**4-1-Concept of food chains:**

A food chain is a linear sequence of organisms where nutrients and energy are transferred from one organism to another organism. It begins with the producer, follows the chain with the consumers and ends with the decomposer organisms. After understanding the food chain, we realize how one organism is dependent upon another one for survival. Every food chain is consisted of:



**Figure 05. Example of a food chain.**

- **Producers:**

Producers are plants that produce, or create, their own food by using light energy from the sun, carbon dioxide from the air, and water from the soil. The process that makes them Autotrophs is called photosynthesis.

- **Consumers:**

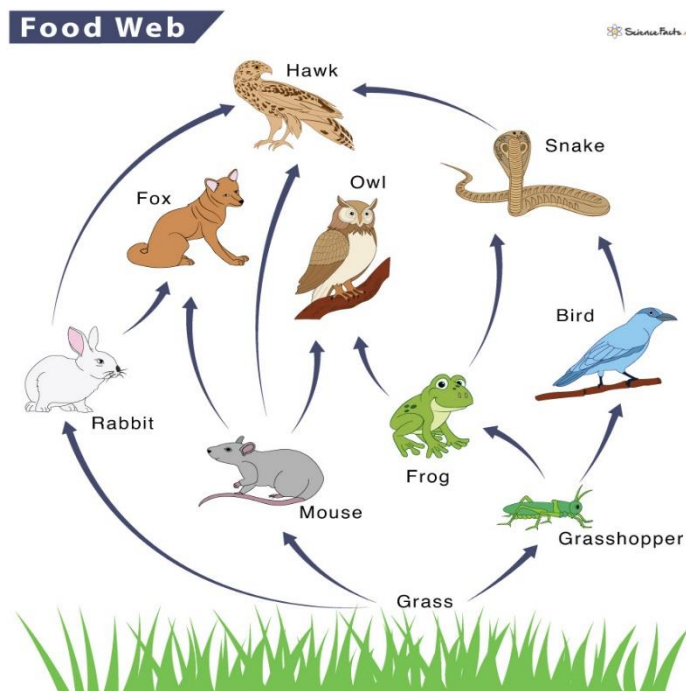
Animals are consumers. They cannot produce their own food, so they get their nutrients and their energy by consuming (eating) other plants and animals. There are 3 groups of consumers: carnivores, herbivores, and omnivores.

- **Decomposers:**

Bacteria and fungi are decomposers. They eat dead plants and animals, break them down and decompose or dispose of them. When that happens, they release nutrients and minerals back into the soil, which are then used by plants during photosynthesis.

#### 4-2-Concept of Food Webs:

A food web is made up of interconnected food chains. Most communities include various populations of producer organisms which are eaten by any number of consumer populations. The green crab, for example, is a consumer as well as a decomposer.



**Figure 06. Example of a food web**

### 4-3-Concept of Productivity in a food chain:

In ecology, productivity is the rate at which energy is added to organisms in the form of biomass. It is simply the amount of matter that's stored in the bodies of a group of organisms. Productivity can take units of either energy or biomass. There are two types of productivity in food chains:

#### 4-3-1-Primary productivity:

Primary production in biology is different compared to primary productivity; it's the amount of organic biomass produced in a given frame of time. Primary production is the amount while primary productivity is the rate. It can be estimated by:

✚ **The gross primary productivity (GPP):** The rate at which solar energy is captured in sugar molecules during photosynthesis (per unit area per unit time). Producers such as plants use some of this energy for metabolisms as cellular respiration and some for growth (building tissues).

✚ **The net primary productivity (NPP):** which is the gross primary productivity minus the rate of energy loss to metabolisms and maintenance (**RR**: Respiratory rate). In other words, it's the rate at which energy is stored as biomass by plants or other primary producers and made available to the consumers in the ecosystem.

$$\text{NPP} = \text{GPP} - \text{RR}$$

#### 4-3-2-Secondary productivity:

It stands for the production of biomass from organic matter. The main conversion is of one form of organic molecules to some other form of organic molecules. It is performed by the “heterotrophs” production in the ecosystem; hence the productivity of human beings, and other animals.

#### 4-4-Energy pyramids:

Ecological Pyramid is a graphical depiction which is meant to illustrate the relationship between different living organisms at different level in an ecosystem. Energy pyramid consists of horizontal bars showing specific trophic levels which are arranged sequentially from primary producer level through herbivores, and carnivores. The number, biomass and energy of organisms gradually decrease with each step from the producer level to consumer level and the diagrammatic representation takes a pyramid shape according to the following cases:



#### 4-4-1-Pyramid of Numbers:

Pyramids of number allow us to compare the number of organisms present in each trophic level at a particular time. They often show a reduction in number of organisms as you move along the food chain.

#### 4-4-2- Pyramid of Biomass:

Biomass is a measure of the total amount of living material present. Pyramid of biomass allows us to compare the mass of organisms present in each trophic level at a particular time. Biomass is a better way to measure the amount of living material in each trophic level if the organisms have different sizes.

#### 4-4-3- Pyramid of Energy:

Pyramids of energy permit us to compare the amount of energy passing through each trophic level over a period of time. The energy value is calculated over the whole year, which allows for seasonal variations in all populations.

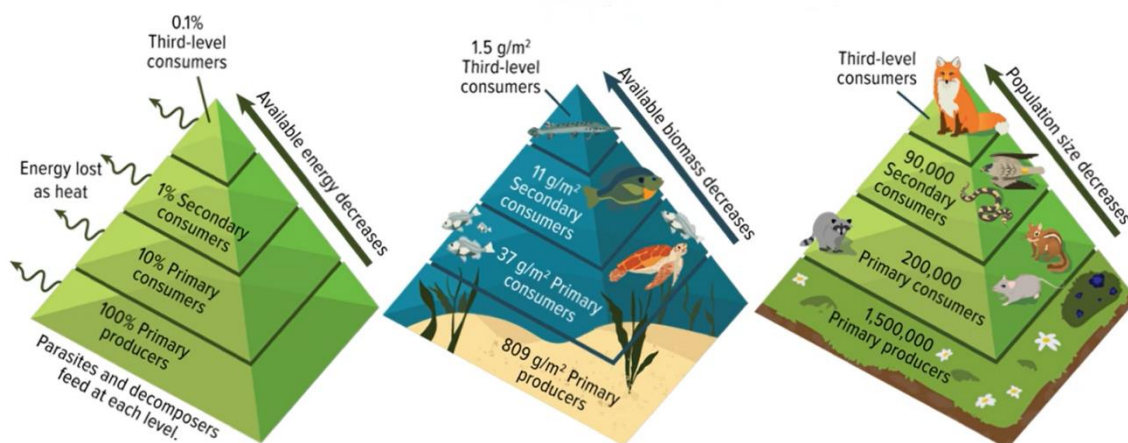


Figure 07. Ecological Pyramids

### 5-Ecological interactions between living beings:

#### 5-1-Concept of Interaction:

Living beings' interaction is the effect that a pair of organisms living together in a community have on each other. This enables the balance of life in a specific community and other organisms to benefit from efforts and activities of every element in the ecosystem. Interactions can be:

#### 5-1-1-Intraspecific interactions:

Interactions between individuals of the same species. They can be harmful, if they provoke competition for natural resources (Food, light, space) or reproduction. They can also be beneficial, if they favor

cooperation between individuals:

❖ **Intraspecific competition:**

A competition between members of the same species. Many animals have developed complex behaviors to minimize the potential impact of direct competition. For instance, the maintenance of dominance hierarchies and territories through behavioral displays reduces fighting and the risk of injury.



**Figure 08. Example of intraspecific competition**

❖ **Group effect**

Groups can better defend themselves together, modify their environment and take down larger preys and more efficiently raise offspring. This positive effect provides the benefits of co-operative behaviors often outweigh the cost of increased competition.



**Figure 09. Example of group effect**

❖ **Mass Effect**

It occurs when the environment is overpopulated and causes exacerbated competition with harmful consequences for individuals. This negative effect results in disturbances of populations, such as a drop in fertility rate, a reduction in the birth level, and an increase in mortality frequency.



**Figure 10. Example of Mass effect**

**5-1-2-Interspecific interactions:**

Interactions which are established between individuals of different species. They can be negative, neutral or positive relationships between a species A and species B as the table below:

Interaction	Species A	Species B	Description
Competition	Harmed	Harmed	Each species negatively affects the other
Predation	Benefited	Harmed	Species A feeds on species B
Parasitism	Benefited	Harmed	Species A feeds on species B
Mutualism	Benefited	Benefited	Each species is helpful to the other
Commensalism	Benefited	Unaffected	Species A benefits from species B, but species B is unaffected