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INTRODUCTION TO ENVIRONMENTAL SCIENCE

ECOLOGY

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Interactions: Environment and Organisms

Ecology – how organisms interact, adapt and response to one another and with the non-living environment such as weather, minerals, soil, pH, etc.

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Everything within the environment goes back to the environment which can be classified as Biotic (living) and Abiotic (non-living)

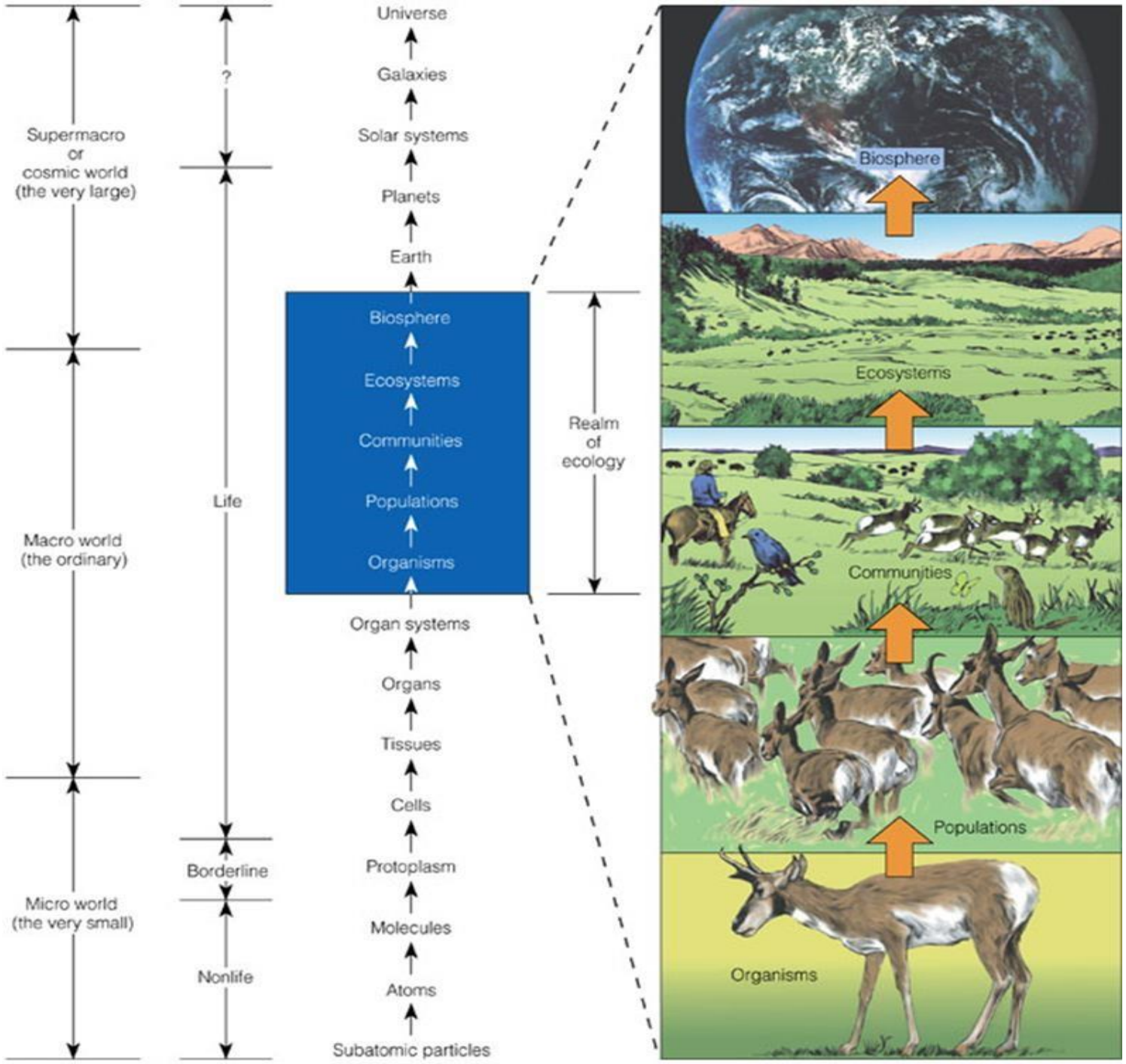
Biotic factors involve the interaction of all forms of life of the organisms

Abiotic factors are non-living things that influence an organisms.

Ecology

Ecology: Study of how organisms interact with each other and with their nonliving surroundings.

Levels of organization in nature. The shaded portion is the five levels that ecology is based upon



The Nature of Ecology

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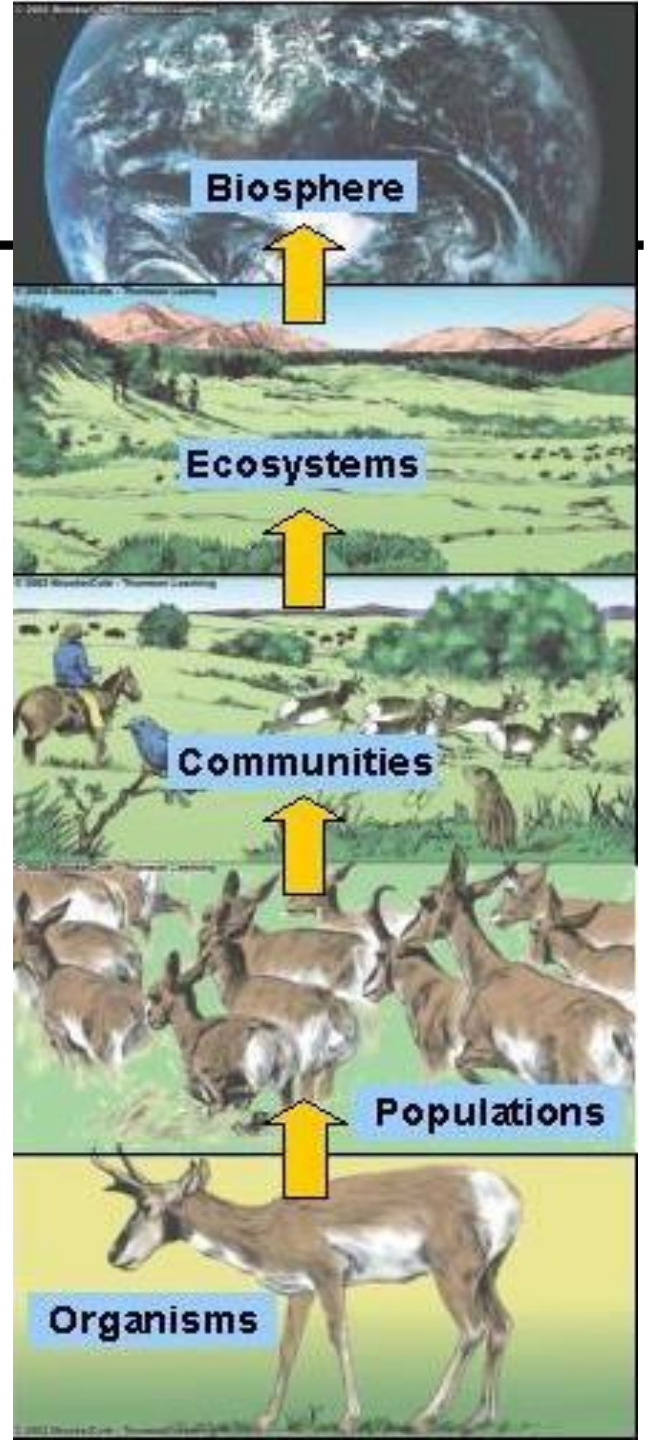
Levels of study in Ecology:

- Organisms – single animal
- Populations – same species
- Communities – population living together
- Ecosystems – community + physical environment
- Biosphere – all the earth's ecosystems



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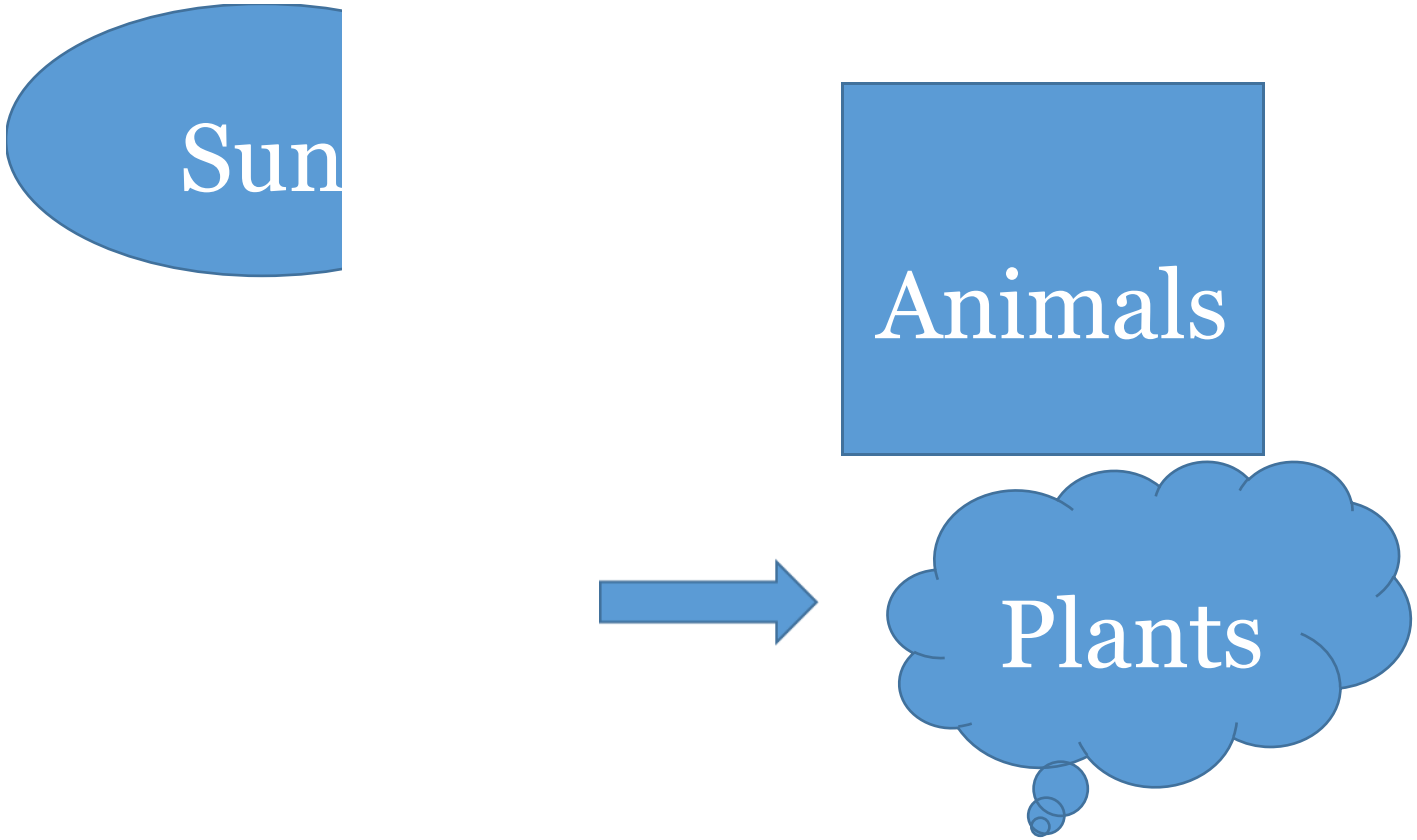
Energy flow in the Ecosystem



The sun is the major source of energy for all living things. Plants depends on the sun for food production and animals including humans also depend on the plants.

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Ecological process therefore involves the interaction of energy, matter and organisms resulting in photosynthesis in plant, plant decay by bacteria and fungi, disease caused by bacteria, viruses and other parasites.

All these processes require energy flow to allow all organisms to maintain themselves.

Energy Flow in Ecosystems

Food chains – sequence of organisms which is a source of food for the next organism.

Food webs – most species participate in several food chains (they don't just eat one thing!).

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Trophic levels - each step in the flow of energy through an ecosystem (feeding level)

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Food Chains and Energy Flow in Ecosystems

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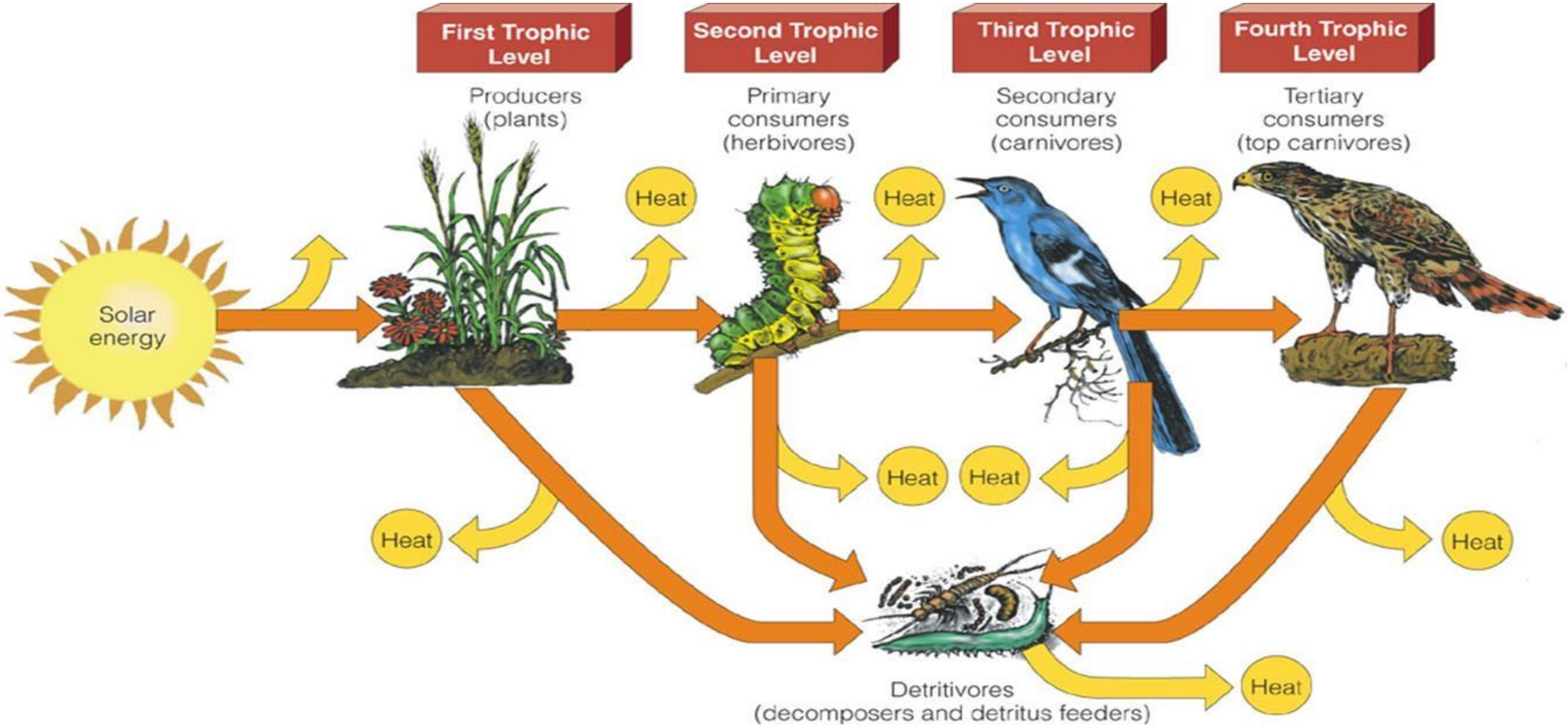

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Limiting factors

The success of organisms to interact with the environment may be limited by certain factors. The limiting factors could be abiotic or biotic and may differ from species to species.

For instance, plants can be limited by drought, sunlight, soil nutrients, etc. Animals can be limited by certain food substances, climate conditions, etc.

Fish in water can be limited by dissolve oxygen, water acidity, temperature and pollution. All species have a range of tolerance of the limiting factors.

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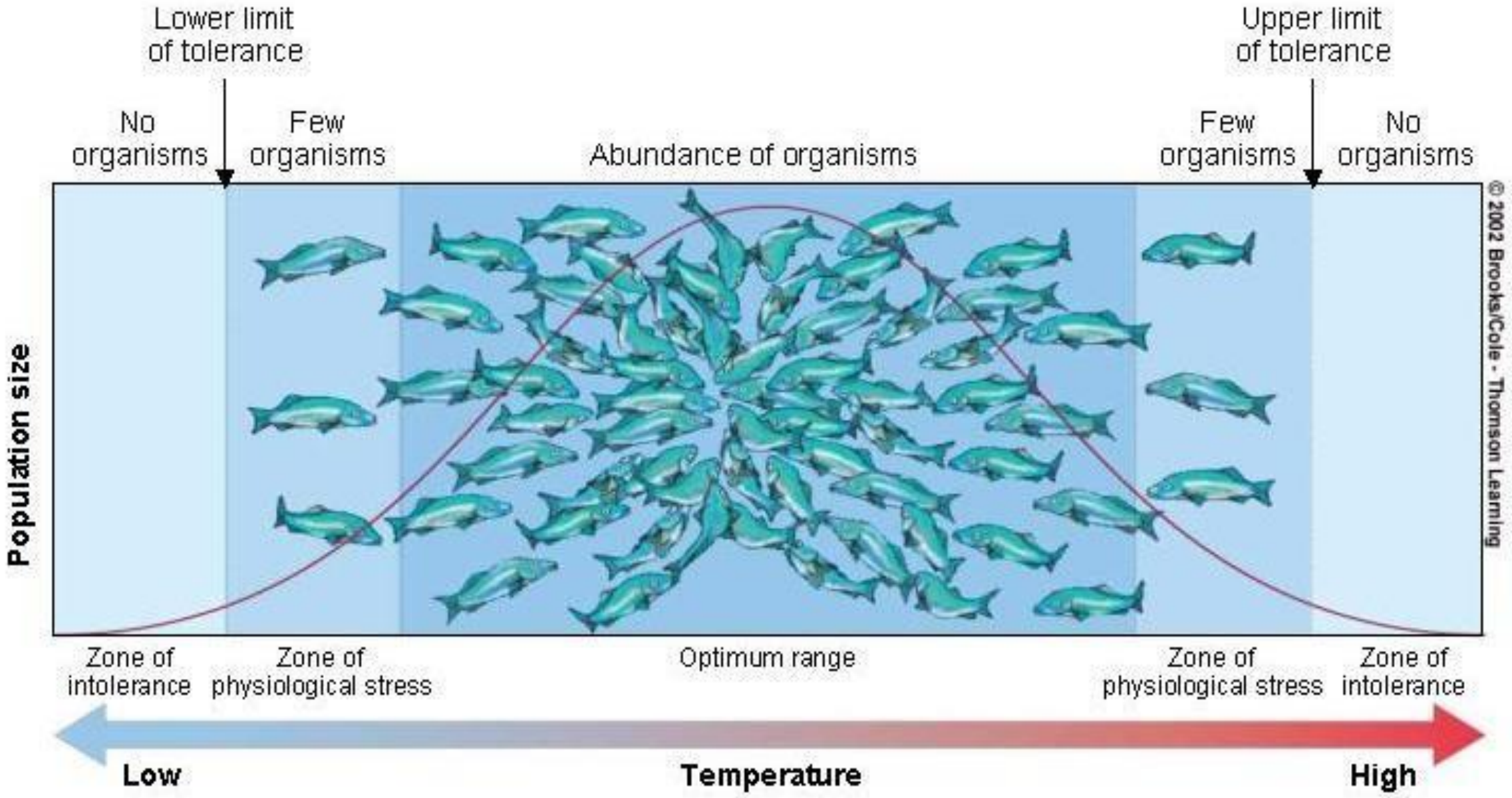
Lower limit of tolerance
Upper limit of tolerance
No organisms
Few organisms
Abundance of organisms
Few organisms
No organisms
Population size
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Zone of intolerance
Zone of physiological stress
Optimum range
Zone of physiological stress
Zone of intolerance
Low
Temperature
High

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Common limiting factors

Limiting factors – more important in regulating population growth than other factors.

Terrestrial ecosystems (on land)

- Precipitation
- Temperature
- Soil nutrients

Aquatic ecosystems

- Temperature
- Sunlight
- Nutrients
- Dissolved oxygen
- Salinity

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Habitat and Niche

The environment in which species live affect the organisms and vice versa.

Habitat is the space where the organisms live which is characterized by soil type, water availability, climate conditions, etc.

The physical and biological requirement of the organisms will determine where it is likely to live.

Niche of an organism is the functional role of the organism with its surroundings.

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It involves how the organism affects the other organisms it interacts or modifies its physical environment or how the organism is being affected by its environment.

Genes, Populations and Species

Genes are distinct pieces of DNA (Deoxyribonucleic acid) that determine the display and X'tics of an individual such as color, behavior, shape of feathers, etc.

Each individual has a particular set of genes.

Population – all the organisms of the same kind found within a specific geographical area.

A population will have different genes than the individual within the population. However, genes from individuals are passed on from one generation to the next within the population.

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A **species** is a population of all the organisms of a particular kind capable of interbreeding and producing fertile offspring. Eg certain organisms and plants.

Species of organisms are specifically adapted to a particular habitat in which is has a very specific role (niche) to play.

Natural Selection

Natural selection (a concept developed by Charles Darwin) is the process that determines which individuals within a species will reproduce and pass their genes to the next generation.

Evolution – the changes observed in the genes and the characteristic displayed by successive generations of a population of organisms over time.

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Speciation is the production of new species from previously existing species by dividing into two isolated subpopulations with some genetic differences.

Extinction

Extinction is the loss of an entire species due to species lack of genetic resources to cope with a changing environment. Extinction also occur to some local aspect of the population with specific gene combination.

However, humans have great influence of the extinction of many kinds of species in recent times.

Various activities of humans have modified the environment thus displacing many species and causing many into extinction.

Activities such as farming, hunting, road construction, urbanization, etc. have led to mass extinction at a faster rate.

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Types of organism interactions

1. **Predation:** this is when one organism (predator) kills and eat another (prey). The predator benefits while the prey is harmed. Examples are lion and zebras, Venus flytrap and insects.

As organisms interact, they develop specific characteristics that make them suited for their role (niche)

Predators have certain characteristics such as ability to run, lie in wait, use snare, etc. to catch prey while the prey also uses keen senses, camouflaged, motionless, etc, to detect and avoid predators.

Adaptation: the prey population are able to produce more offspring with the healthier ones likely to survive and better adapt to their environment. The predator population also produce less but the strong ones survive

Both are subjected to the process of natural selection.

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Competition

Here, two organisms strive to obtain the same limited resources.

Two types of competition

1. **Intraspecific competition** – competition between members of the same species

Examples are corn plants striving for water and nutrients, two dogs fighting for a bone, etc.

2. **Interspecific competition** – competition between two members of different species

Many predators may struggle for prey and some may be successful than others.

In each case, organisms are harmed but the one less harmed becomes the winner and the other more harmed become the loser.

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Competition and Natural Selection

Competition among species of the same kind can affect the evolution of species.

For intraspecific competition - Competition among the same species of similar needs will be very intense.

For a limited resources, the less adapted individual is to die or denied mating privileges and the stronger will tend to dominate the environment.

For the Interspecific competition, the species with the larger number of successful individuals emerge from the interaction better adapted to its environment than the less successful ones.

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The principle Competitive Exclusion

It is the concept that, no two species can occupy the same ecological niche in the same place at the same time.

The more similar two species are, the more intense will the competition between them be. The less adapted will either migrate or become extinct.

For two similar species with different niche (role), the difference in their niche requirement will reduce the intensity of the competition between them.

Symbiotic Relationship

It is close, long-lasting, physical relationship between two different species of which one of them obtain some benefit from the contact.

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Three types of symbiotic relationship

1. Parasitism
2. Commensalism
3. Mutualism

Parasitism

It is a relationship between a parasite and a
host where the parasite lives in or on the host and derives nourishment.

The host is mainly affected by the parasite but at different levels. However, some parasites could be more destructive than others.

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The parasite is not intended to kill the host

Parasitism – one benefits

but if the parasite are more, the host may from the other with harm die. The host, however, develop defensive ability to reduce the harm or tolerate it.

Parasitism

Parasite which lives in the host is called endoparasite.
Eg. Tapeworm, bacteria,

Parasite which lives outside the host is called ectoparasite. Eg. Fleas, lice, etc.

Plants also have parasites such as the **Mistletoe** which is a flowering plant that parasite a tree.

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The flower establishes itself on the surface of a tree and grows down into the water conducting tissues of the tree and uses the water and minerals it obtains for it growth.

Commensalism

It is a relationship between organisms in which one organism benefits while the other is not affected.

Since the host always develops strategies to combat the negative effects of the parasite, they are likely to evolve to a point where the host is not harmed at all.

Examples are:

1. Orchids use trees as a surface upon which it grows
2. Mosses, ferns and many vines uses tree surfaces for growth
3. Remora (small fish) attaches itself to sharks to obtain small bits of food from the sharks while eating.

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Commensalism – one Benefits from the other without harm

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Mutualism

It is a symbiotic relationship and is actually beneficial to both species involved.

Such a relationship is supposed to be mandatory since it brings mutual success to both species.

For instance: certain species of ants feed and live on trees and also protect the tree from being eaten or affected.

Bacteria that live in the root of the legumes gain nutrients from the plant and also provide nitrogen Mutualism – both benefit containing molecules that the plant use for growth.

These are mutually beneficial relationships where both organisms benefits.

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Ecosystem Interactions

An ecosystem is a space / area in which interactions take place between population of different species with all its complex interrelationship and the physical environment.

The physical environment can put limitation on the kinds of organisms that can live in an area while the organisms can also influence the physical environment.

The ecosystem has parts that must be organized in a specific ways in order to function perfectly

NB: physical environment – soil, air and water

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Biological Components of Ecosystems

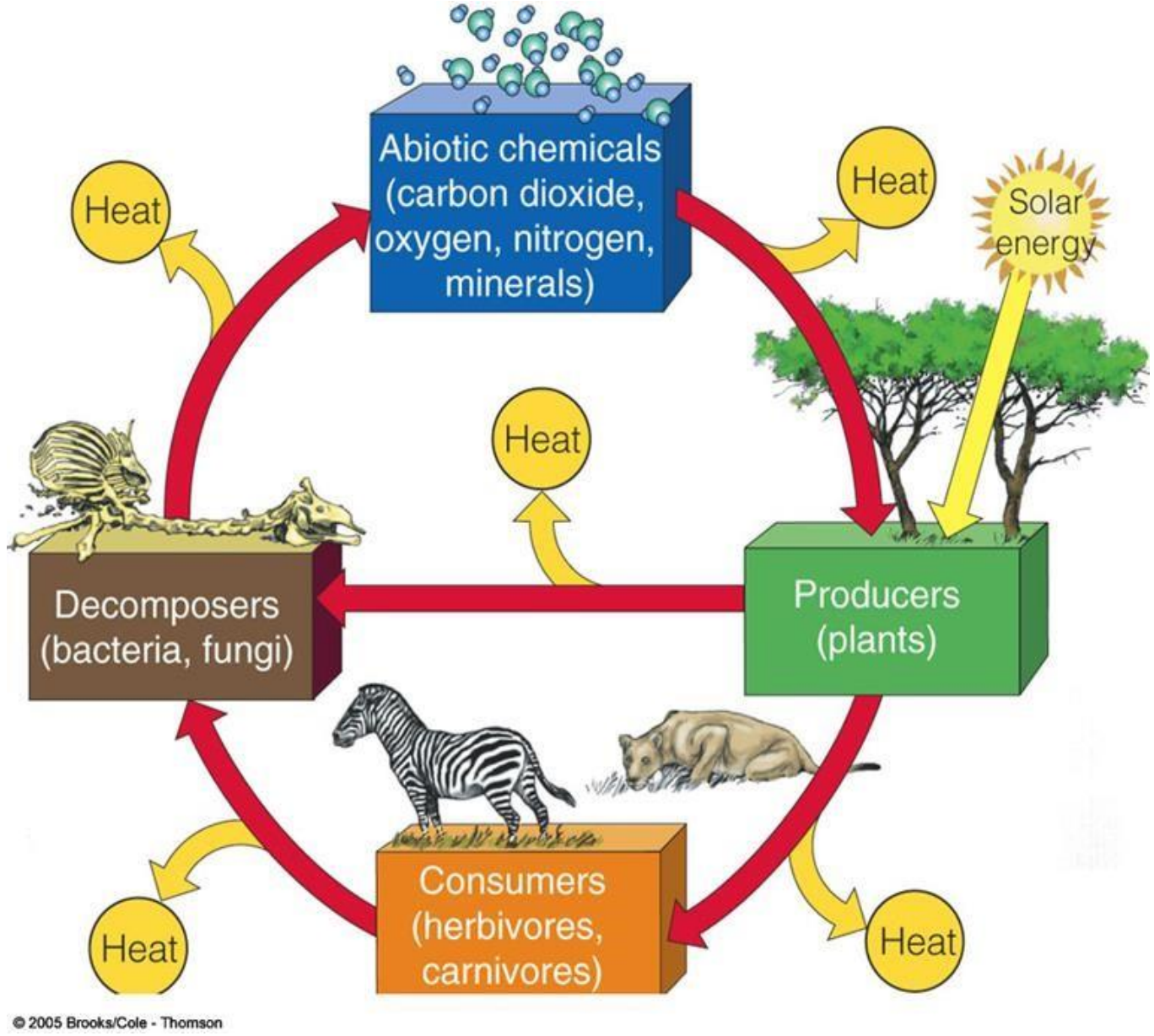
Producers (autotrophs)

Consumers (heterotrophs)

Herbivores, carnivores, omnivores

Decomposers and detritivores

detritus = dead organic material



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Major roles played by organis

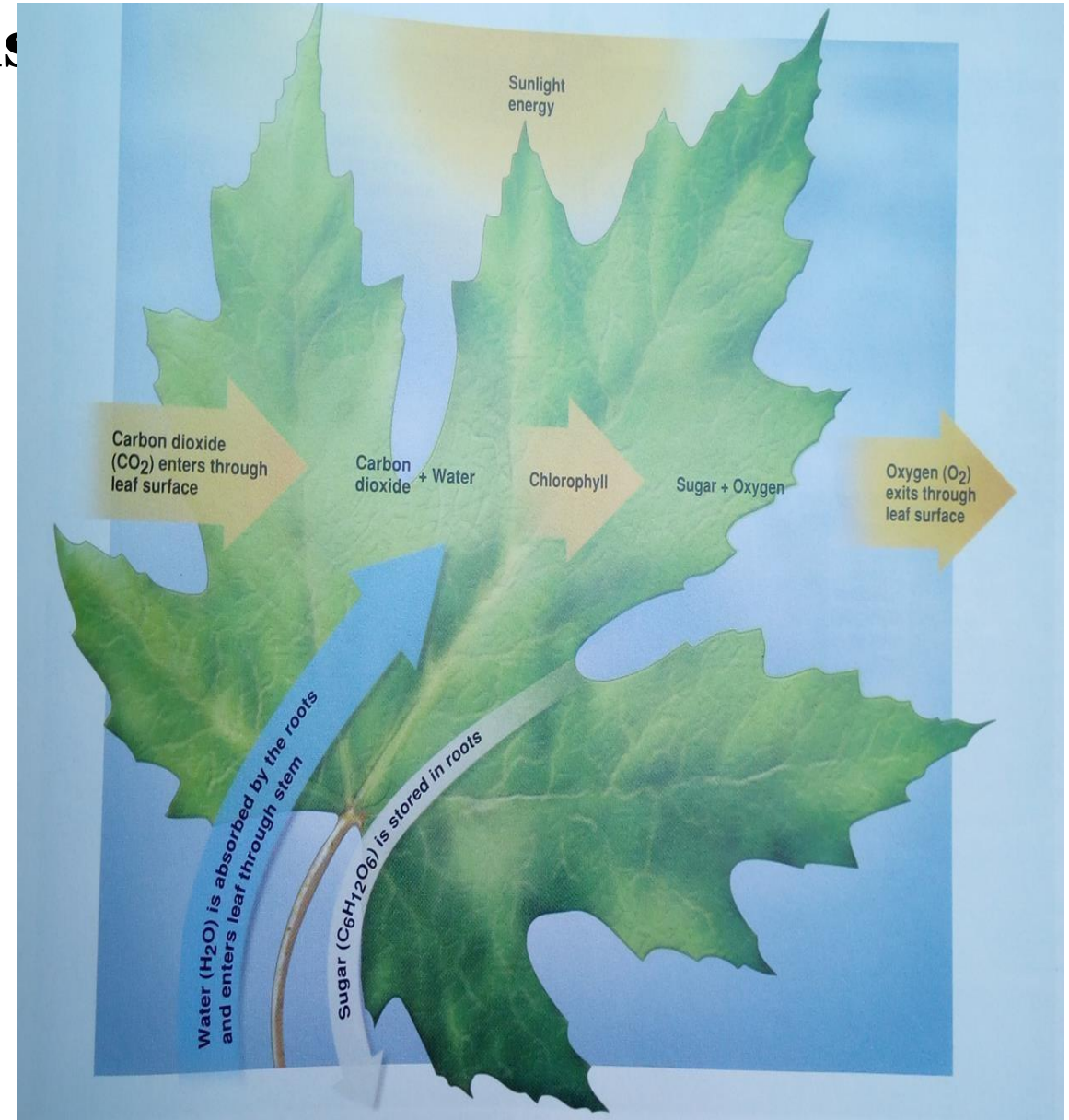

FIGURE 4.9 **Photosynthesis** This reaction is an example of one that requires an input of energy (sunlight) to combine low-energy molecules (CO_2

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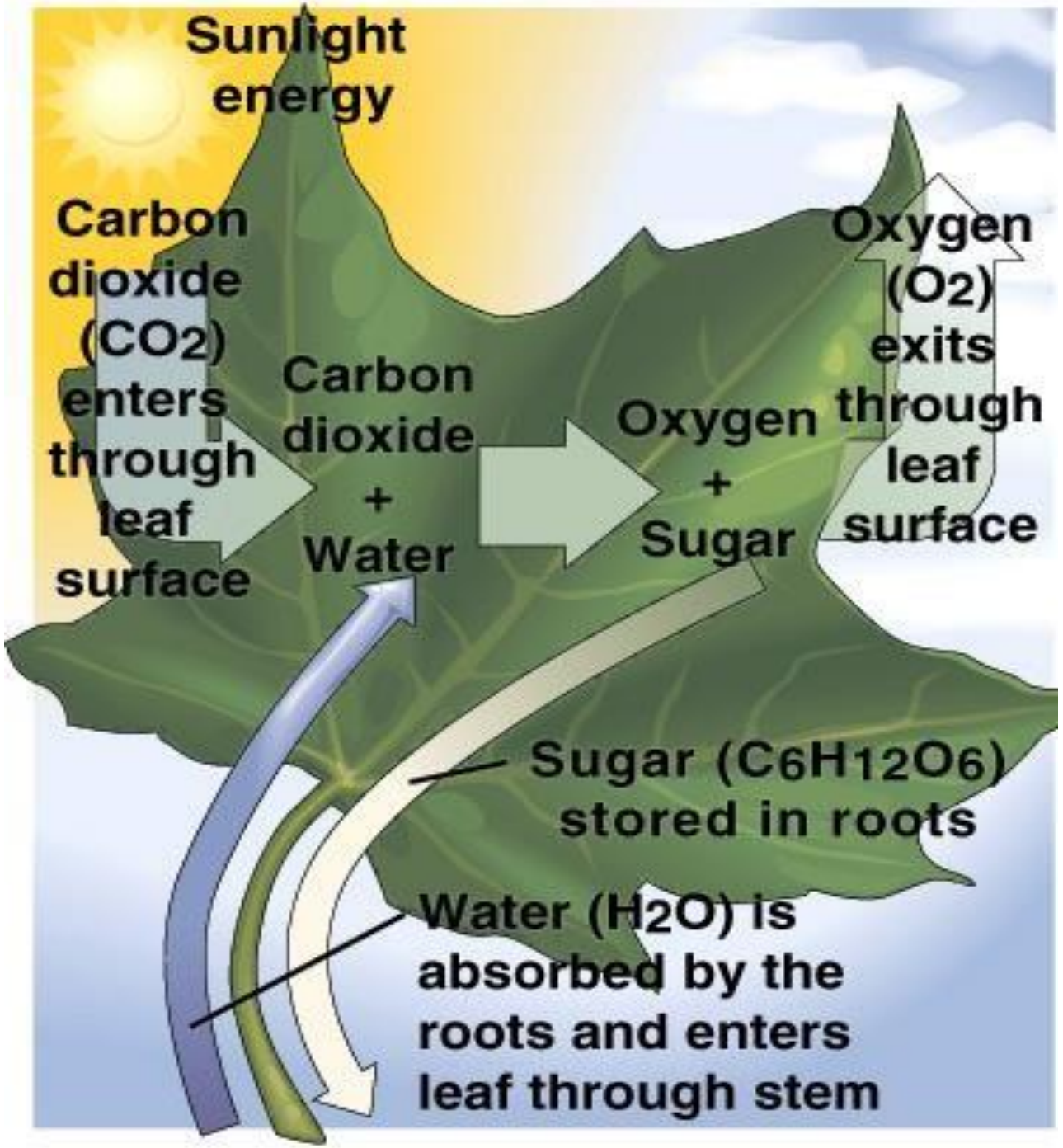
1. Producers (Autotrophs)–

They are plants that use the sun's energy to photosynthesize complex organic molecules from inorganic materials.

Almost all organisms depend directly or indirectly on producers for their survival.

Examples are: plants, algae, phytoplankton
(tiny aquatic organisms)



- Photosynthesis is the process of converting solar energy into chemical energy stored in food

- $CO_2 + H_2O$ ---> $C_6H_{12}O_6 + O_2$

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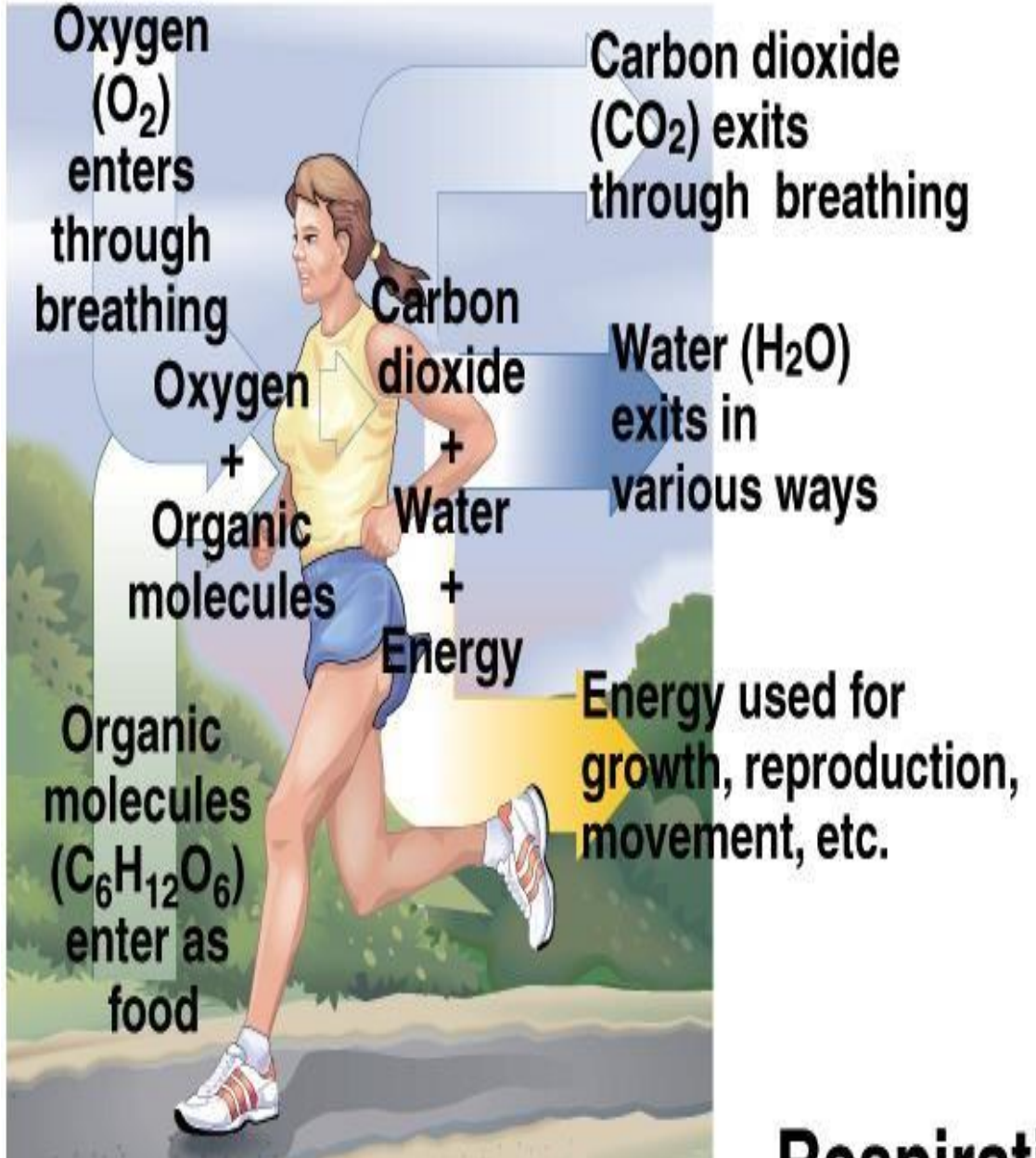
hemical energy stored in food to be used



by living things.

- $C_6H_{12}O_6 + O_2 \text{ ---> } CO_2 + H_2O + \text{Energy}$

2. Consumers (heterotrophs)

Organisms that use organic matter as a source of food for energy (food produced by autotrophs).

They are classified as:

1. Primary consumers (herbivores) – animals that eat producers as a source of food for energy. They are numerous in the ecosystem.

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2. Secondary consumers (carnivores) – animals that eat other animals they capture and kill.

3. Omnivores include both plants and animals in their diet.

3. Decomposers (heterotrophs)

Decomposers are organisms that use non-living organic matter as a source of energy and raw materials to build their bodies.

Decomposers recycle matter by converting organic matter or inorganic material. Many small animals, fungi and material fill this niche (role).

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