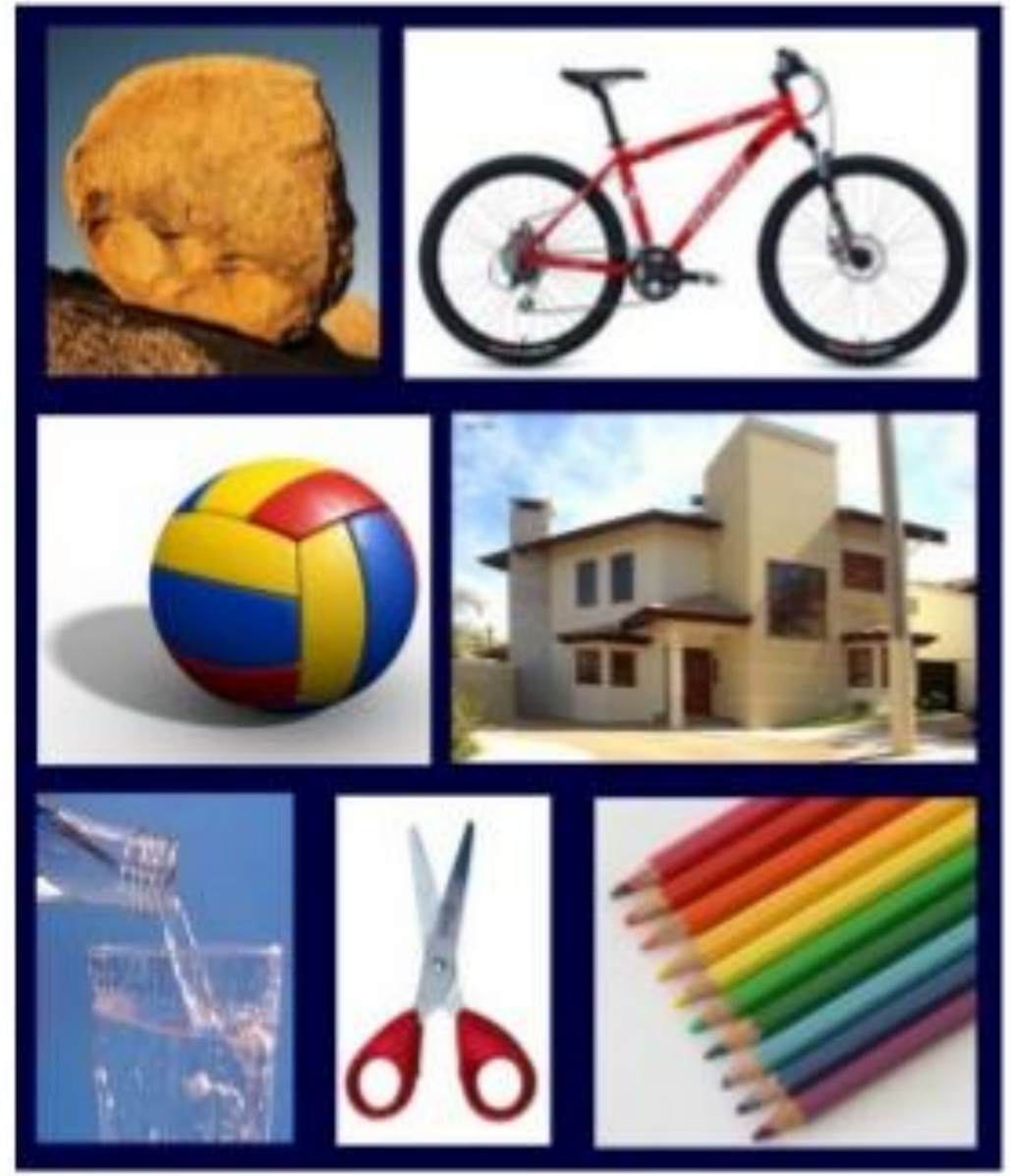
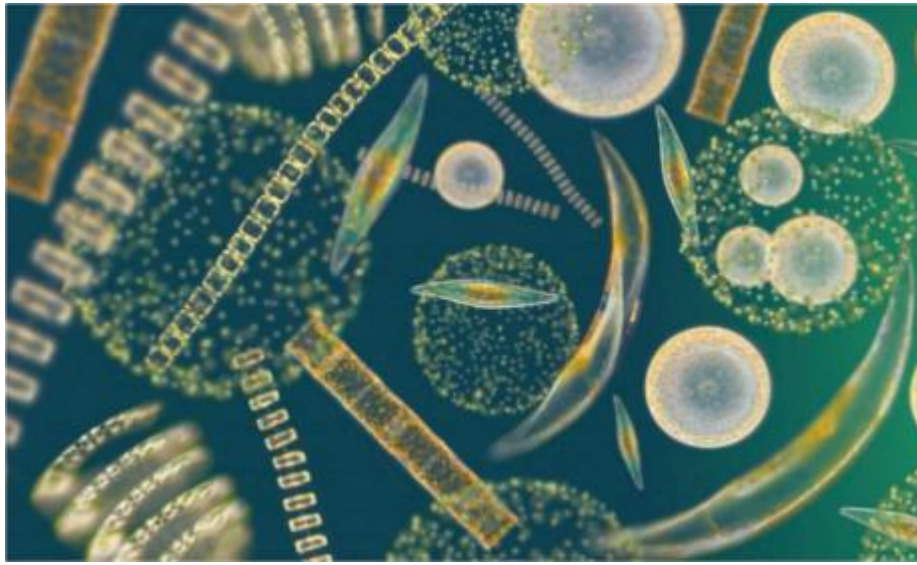




What is Life

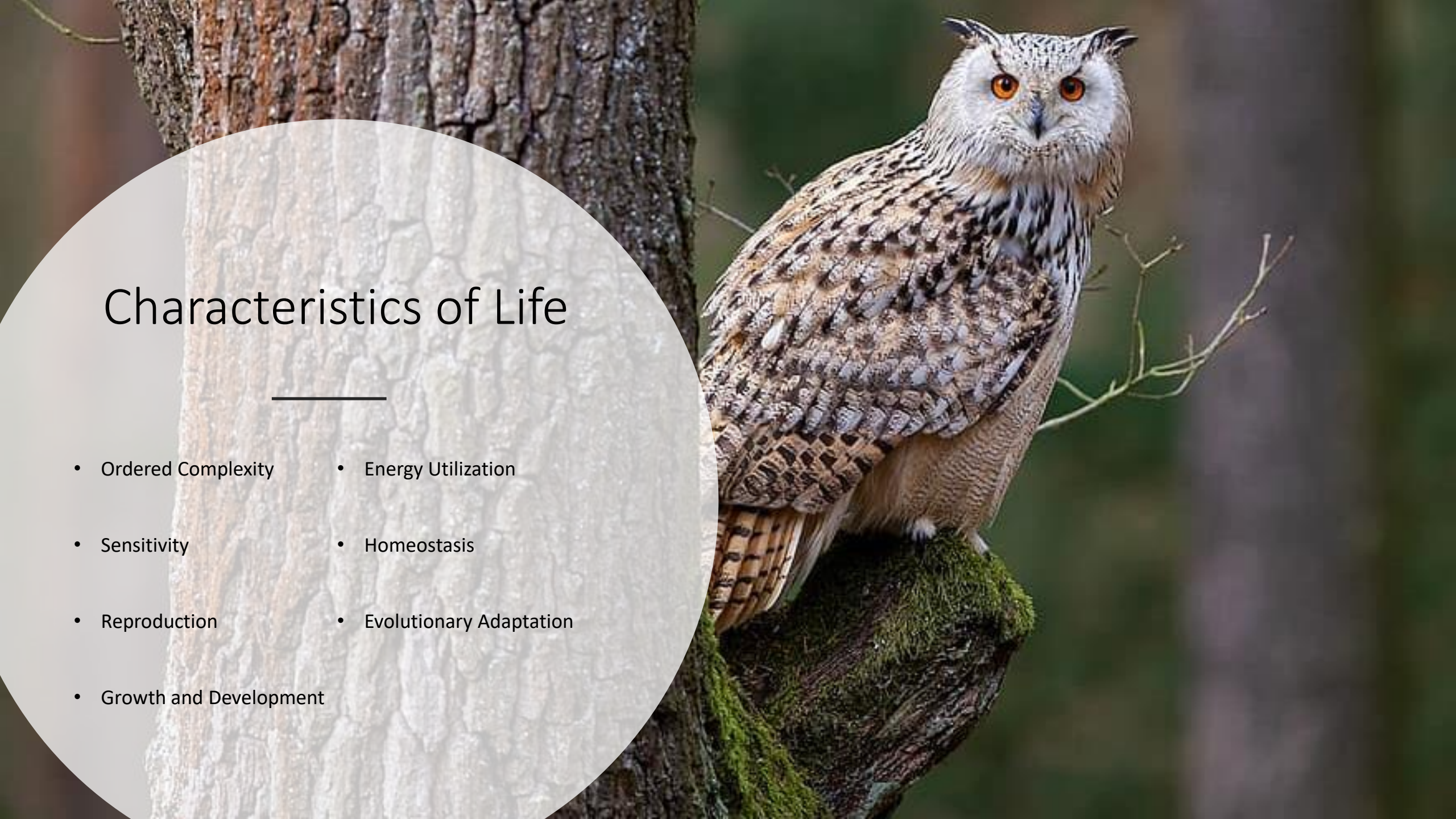
What makes something “alive”?

Life defies simple definition

- Life cannot be defined in a single sentence.
- We can only describe and observe life through its manifestations or characteristics.
- Properties of life shared by all living things.

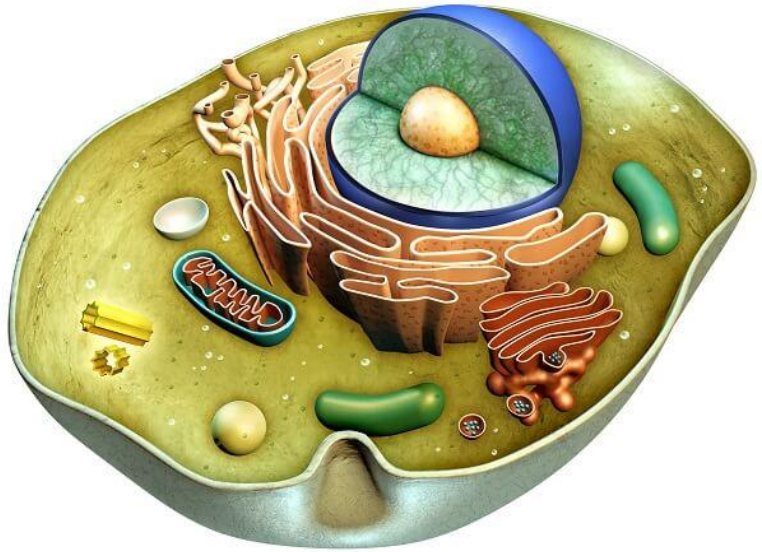
Characteristics of Life

- Ordered Complexity
- Sensitivity
- Reproduction
- Growth and Development
- Energy Utilization
- Homeostasis
- Evolutionary Adaptation



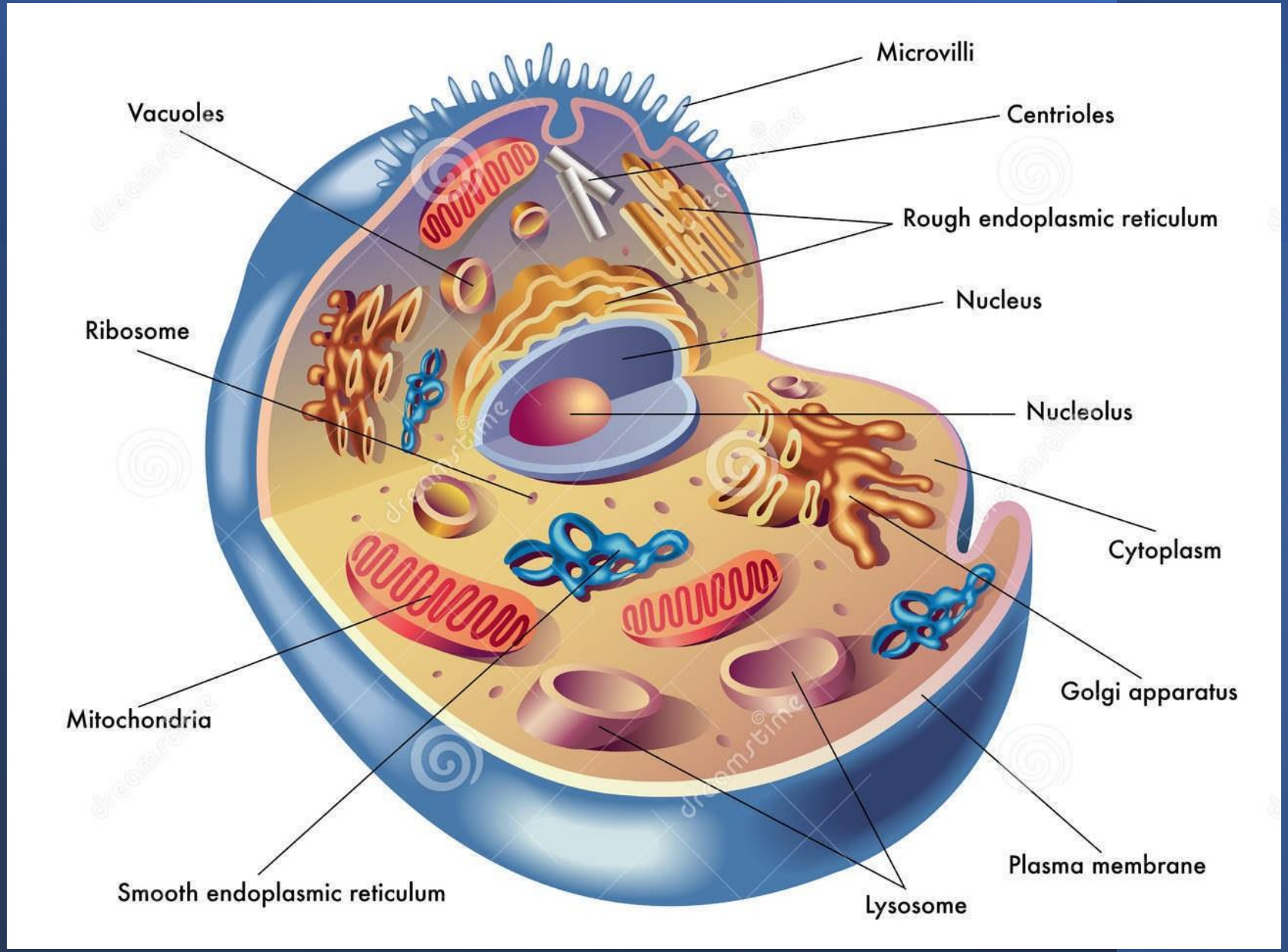
Organization

- Order
  - Structure; Form; Shape; Patter; Arrangement – specialized, specific, definite
  - Organisms are highly structured, and as a result, other characteristics of life **emerge** from this complex organization.
  - Emergent properties
    - Functions

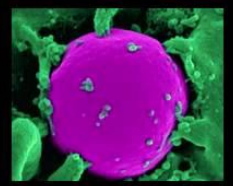


Basic organization of life/living organisms.

- All organisms consists of one or more cells.

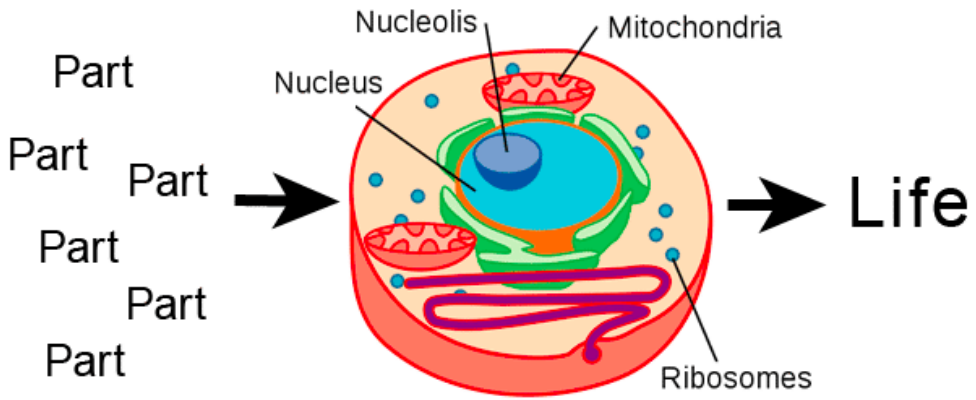

Microvilli
Vacuoles
Centrioles
Rough endoplasmic reticulum
Nucleus
Ribosome
Nucleolus
Cytoplasm
Golgi apparatus
Mitochondria
Plasma membrane
Smooth endoplasmic reticulum
Lysosome

Emergent properties are those that arise through interactions among smaller parts that alone do not exhibit such properties



- a functioning bicycle emerges only when all of the necessary parts connect in the correct way

How Life Emerges from Parts in a Eukaryote Cell



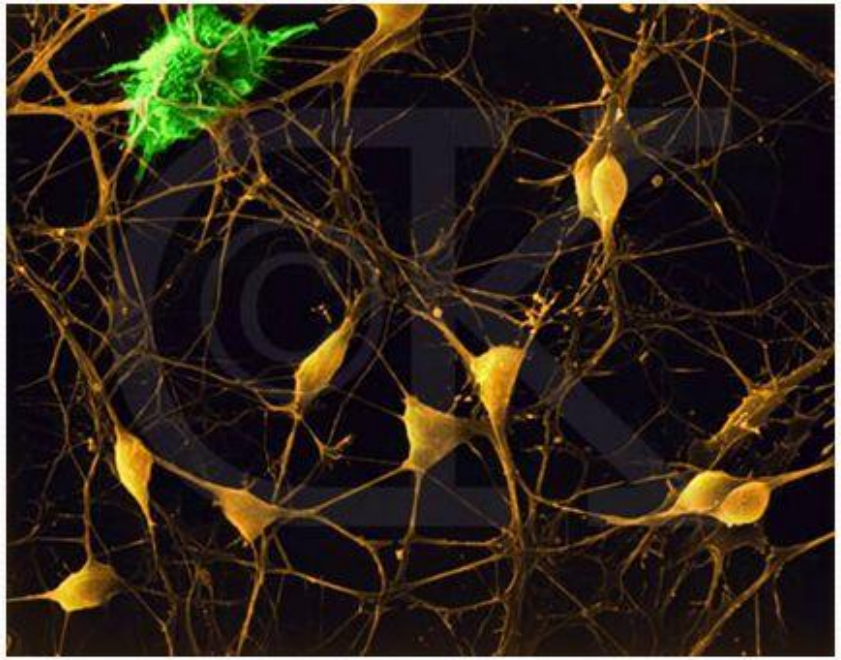
Individual parts

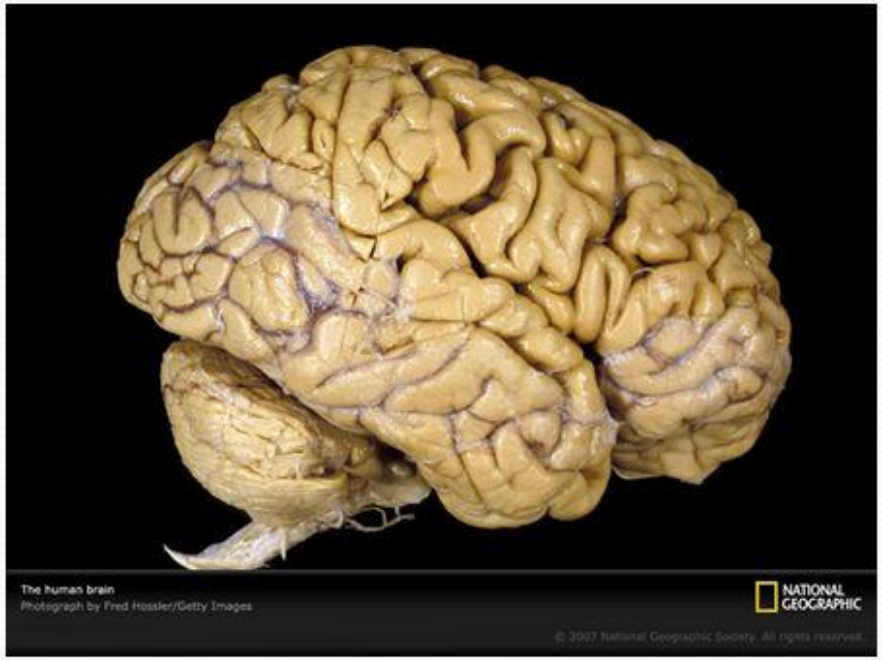
The individual parts are arranged into a structure

Emergent behavior results

Diagram by Thwink.org

- A good example of emergent properties in a multicellular organism would be the human brain. On their own, individual neurons (nerve cells) are not capable of thought but it is the interactions of all neurons that allow the brain to think.



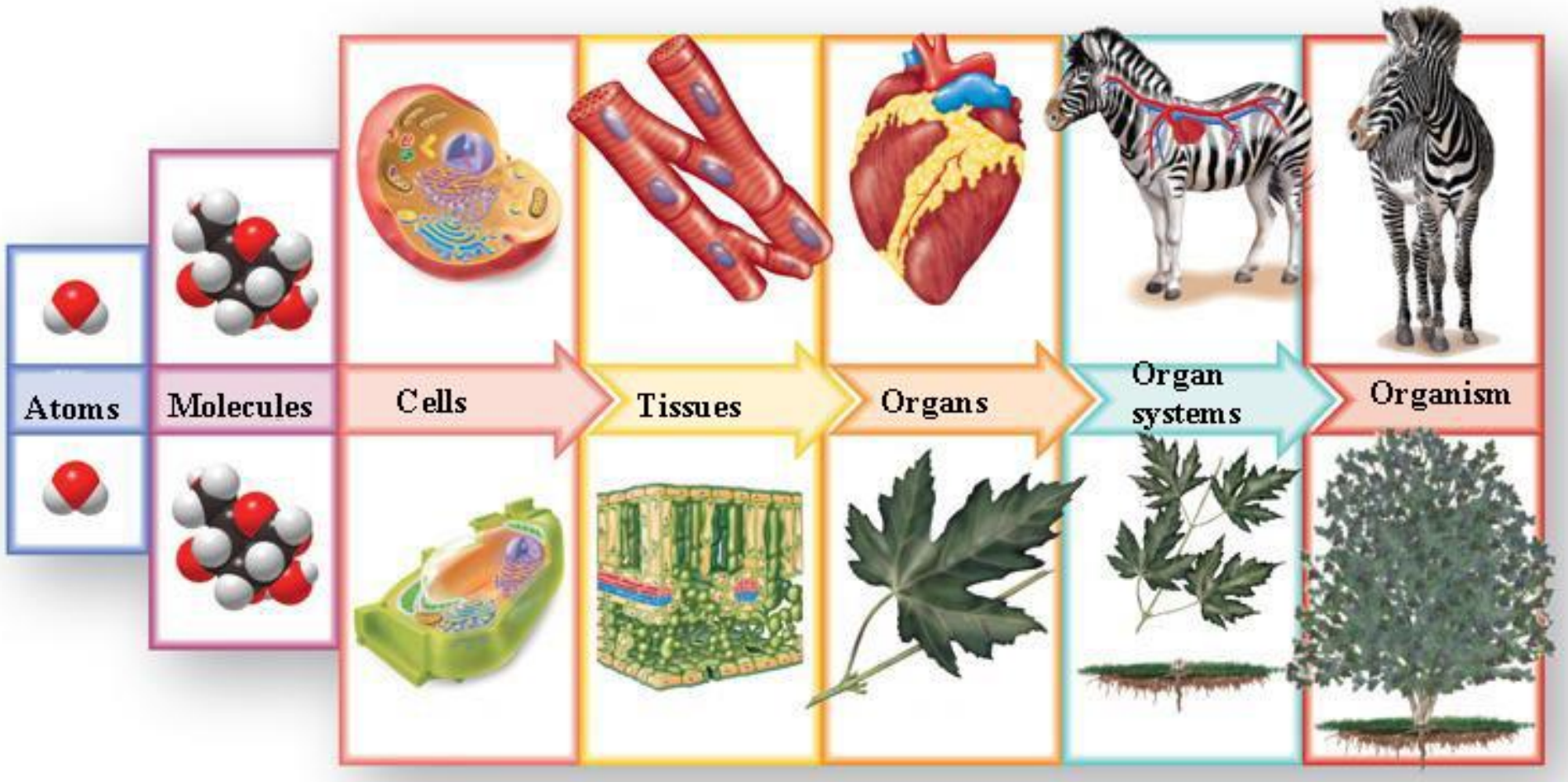


Ordered Complexity

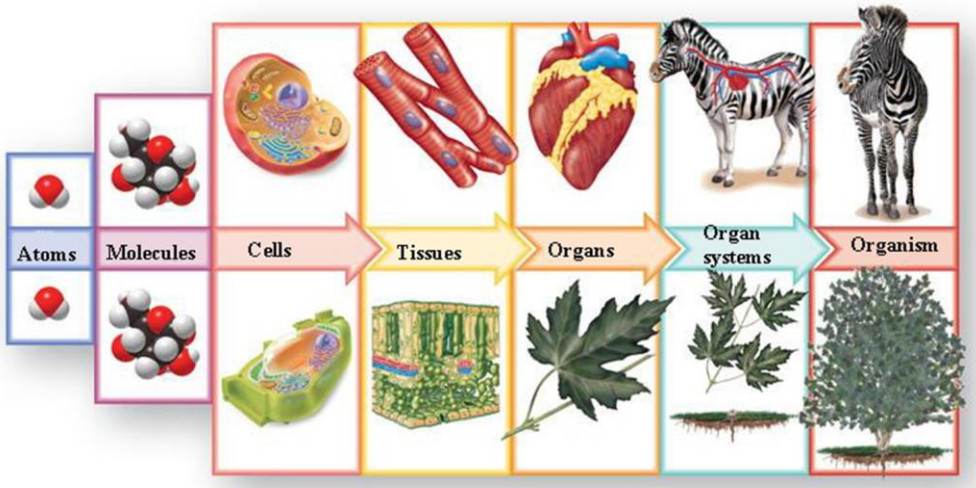
- Living things are highly organized and structured.

- The ordered complexity of life can be arranged and examined in a hierarchy on a scale from small to large (simplest to broadest).

Levels of Biological Organization

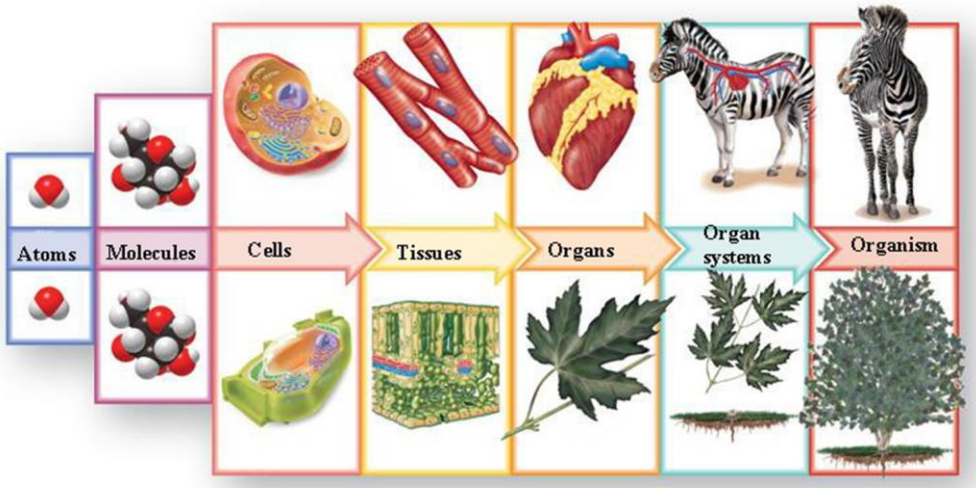


Levels of Biological Organization



Level of Organization	Explanation	Example
 Atomic Level	Atoms are defined as the smallest unit of an element that still maintains the property of that element.	Carbon, Hydrogen, Oxygen
 Molecular Level	Atoms combine to form molecules which can have entirely different properties than the atoms they contain.	Water, DNA, Carbohydrates
 Cellular Level	Cells are the smallest unit of life. Cells are enclosed by a membrane or cell wall and in multicellular organisms often perform specific functions.	Muscle cell, Skin cell, Neuron

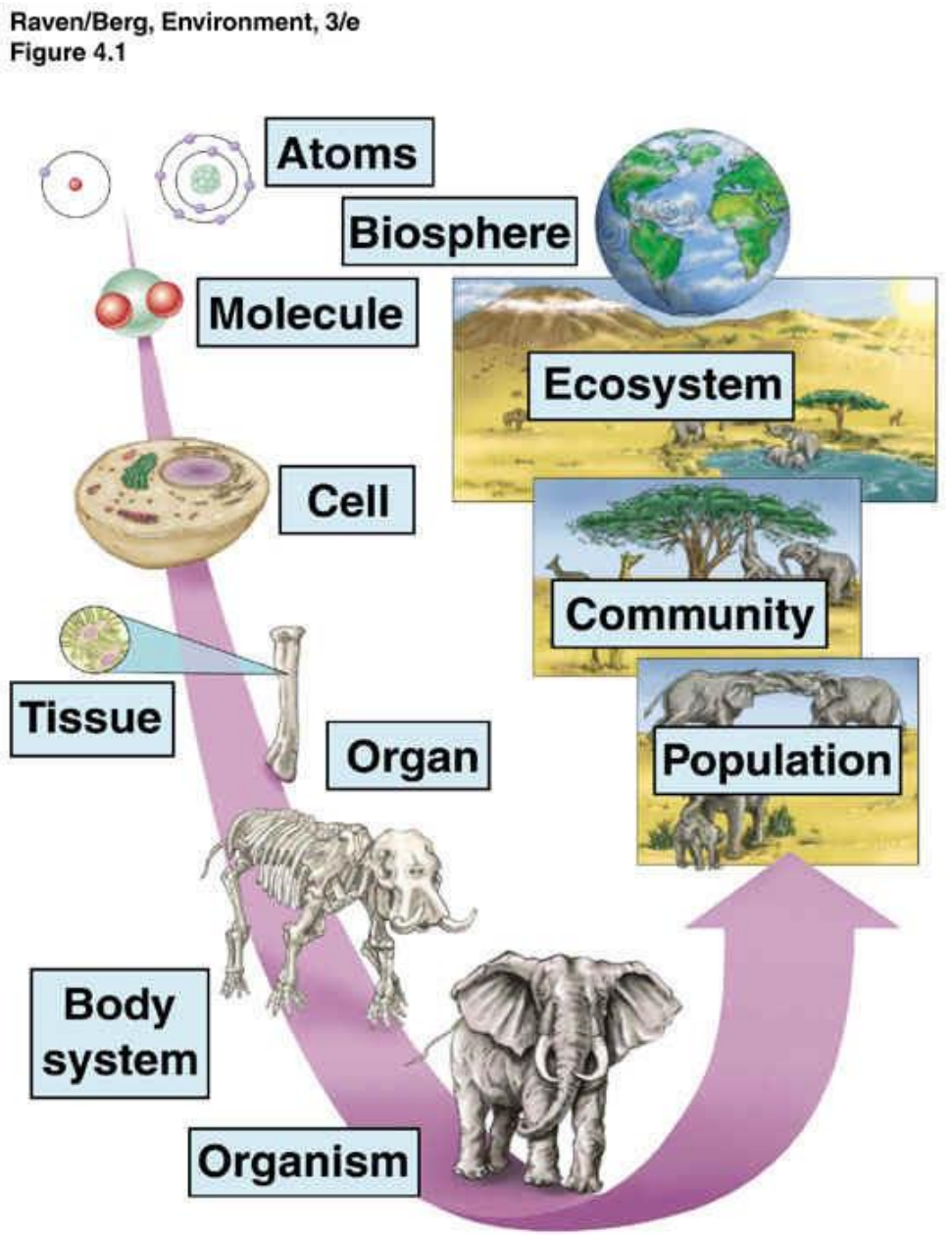
Levels of Biological Organization



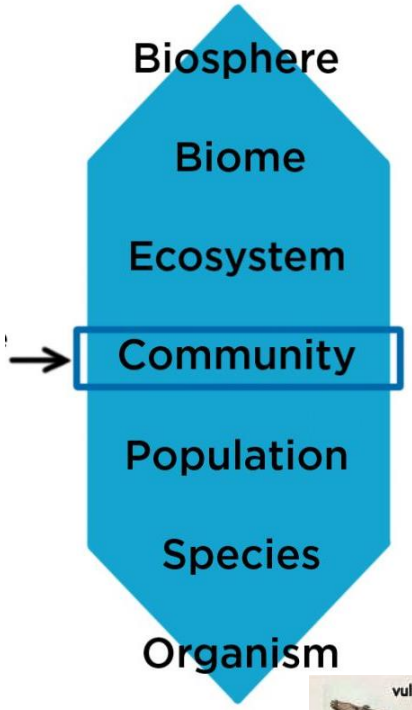
 Tissue Level	Tissues are groups of cells with similar functions	Muscle, Epithelial, Connective
 Organ Level	Organs are two or more types of tissues that work together to complete a specific task.	Heart, Liver, Stomach
 Organ System Level	An organ system is group of organs that carries out more generalized set of functions.	Digestive System, Circulatory System
 Organismal Level	An organism has several organ systems that function together.	Human

Levels of Biological Organization

- Population
  - a group of individuals of the same species living and interbreeding within a given area.
  - Example:
    - In a forest/grassland, there is a population of deer



Levels of Biological Organization: Community



What is a community?

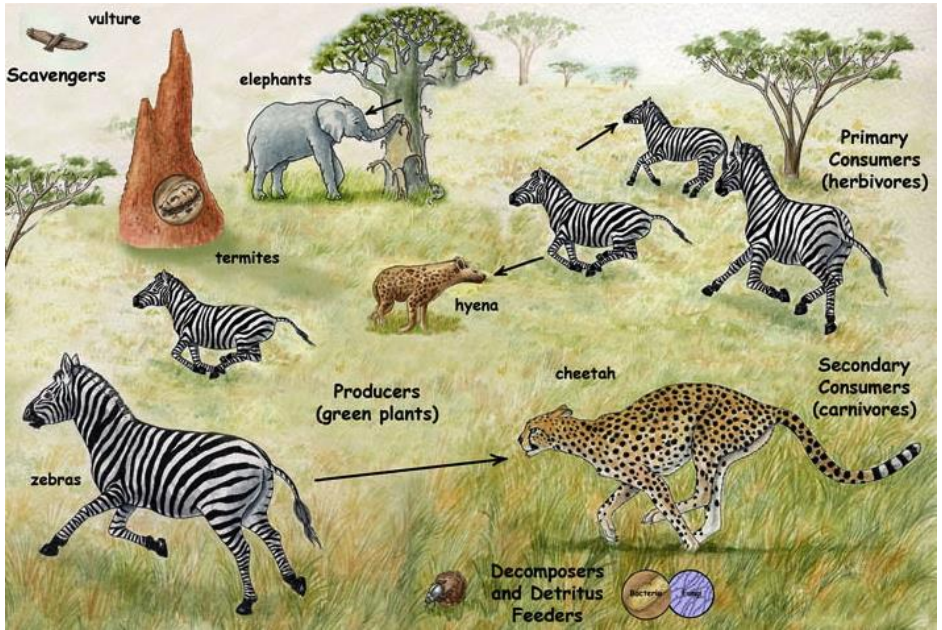
A community is made up of all the living organisms that reside within a given area and interact with one another.

How is it different from a population?

A population is made up of members of single species, which live in a particular area. A community is made up of populations of different species, which live in an area.

How is it different from an ecosystem?

While a community consists of all the living organisms within an area, an ecosystem also includes the nonliving components within the area, like water and sunlight.



Levels of Biological Organization: Ecosystem

Biosphere
Biome
→ Ecosystem
Community
Population
Species
Organism

What is an ecosystem?

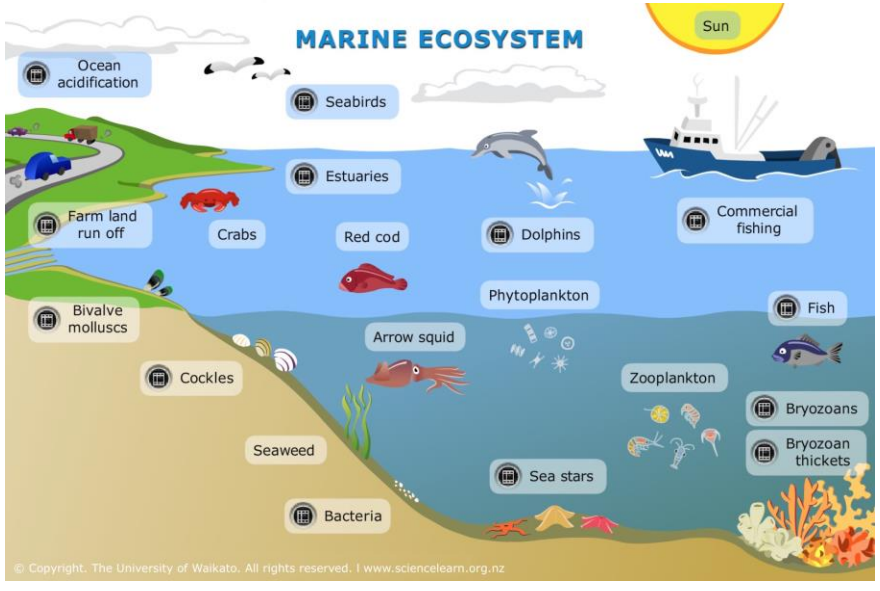
An ecosystem includes all the biotic (living) and abiotic (non-living) factors within a specific region. All these elements interact with one another to create a balanced system.

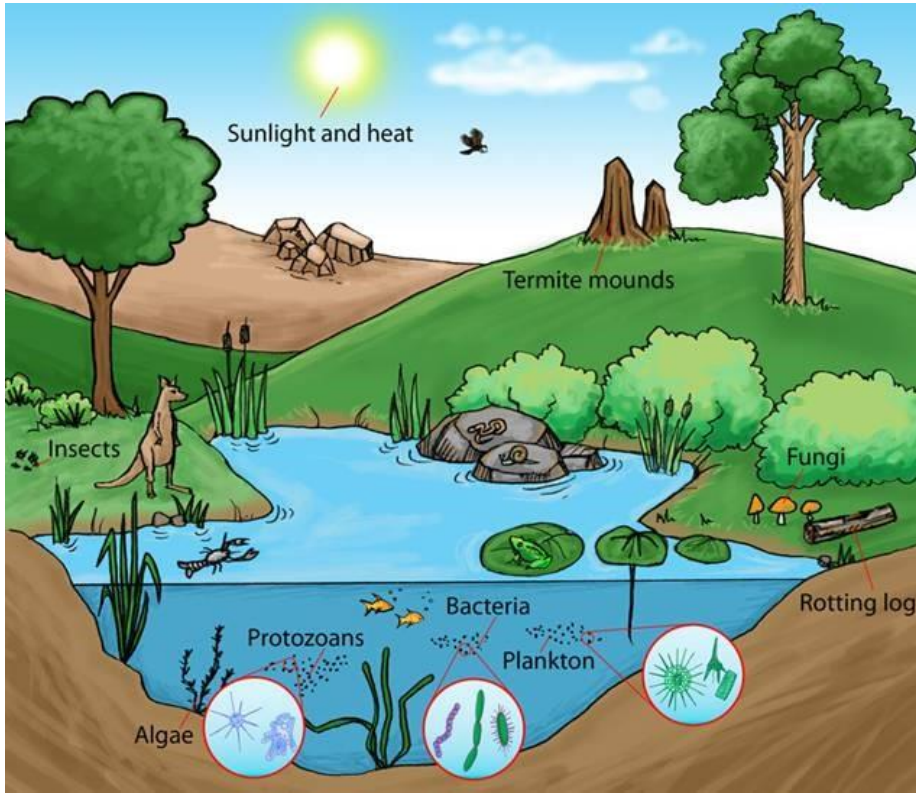
How is it different from a community?

A community consists of only the living parts of a specific region, like the plants and animals, and how they interact. The abiotic factors are not included.

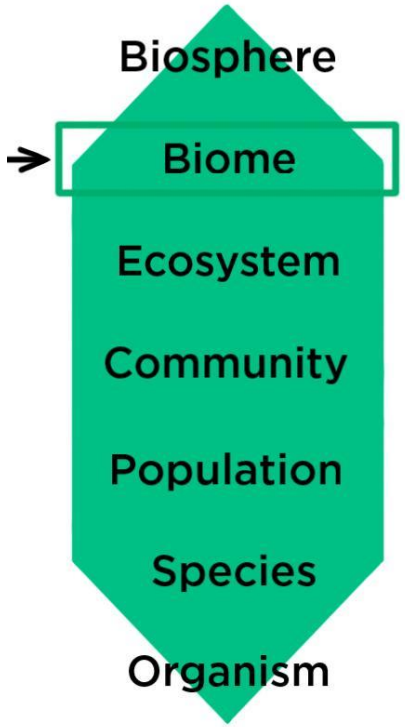
How is it different from a biome?

A biome spans a large geographical area and is defined by characteristic environmental conditions which determine what species can survive in it. In a biome, the biotic factors are specifically adapted to the given set of abiotic factors.





Levels of Biological Organization: Biome



What is a biome?

A biome is a region defined by specific environmental conditions, and plants and animals that are specifically adapted to those conditions.

How is it different from an ecosystem?

An ecosystems focuses on the interactions of biotic and abiotic components of a specific region. A biome can describe several regions around the world which share similar environmental conditions. Although these regions may have different plants and animals, the species face very similar environmental obstacles and share similar adaptations to overcome them.

How is it different from a biosphere?

The biosphere is the broadest level of biological organization. It encompasses all biomes.

Levels of Biological Organization: Biosphere

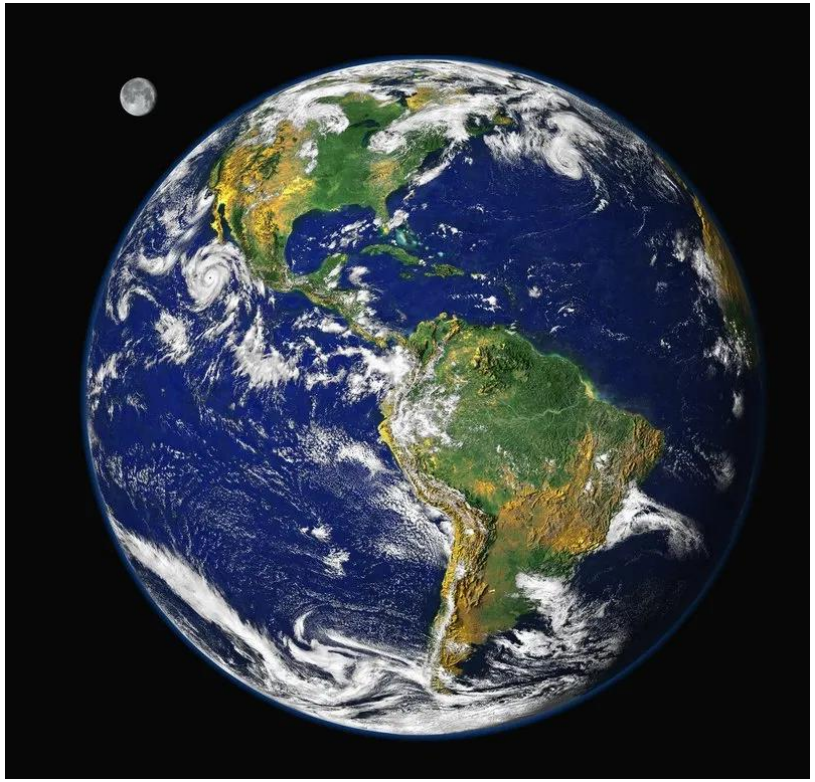
- **Biosphere**
- Biome
- Ecosystem
- Community
- Population
- Species
- Organism

What is a biosphere?

A biosphere is the broadest level of biological organization. It includes all life on Earth, as well as all the nonliving elements that influence it, like sunlight and water.

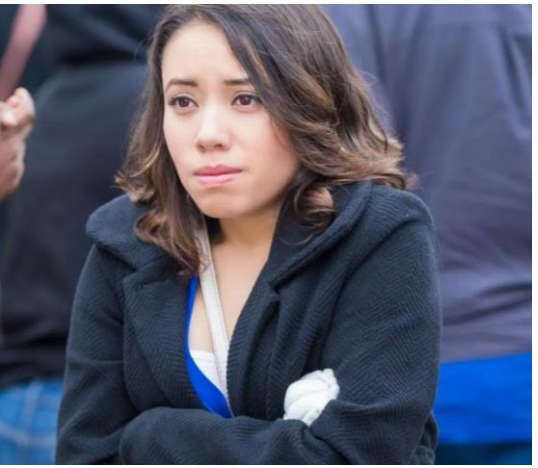
How is it different from a biome?

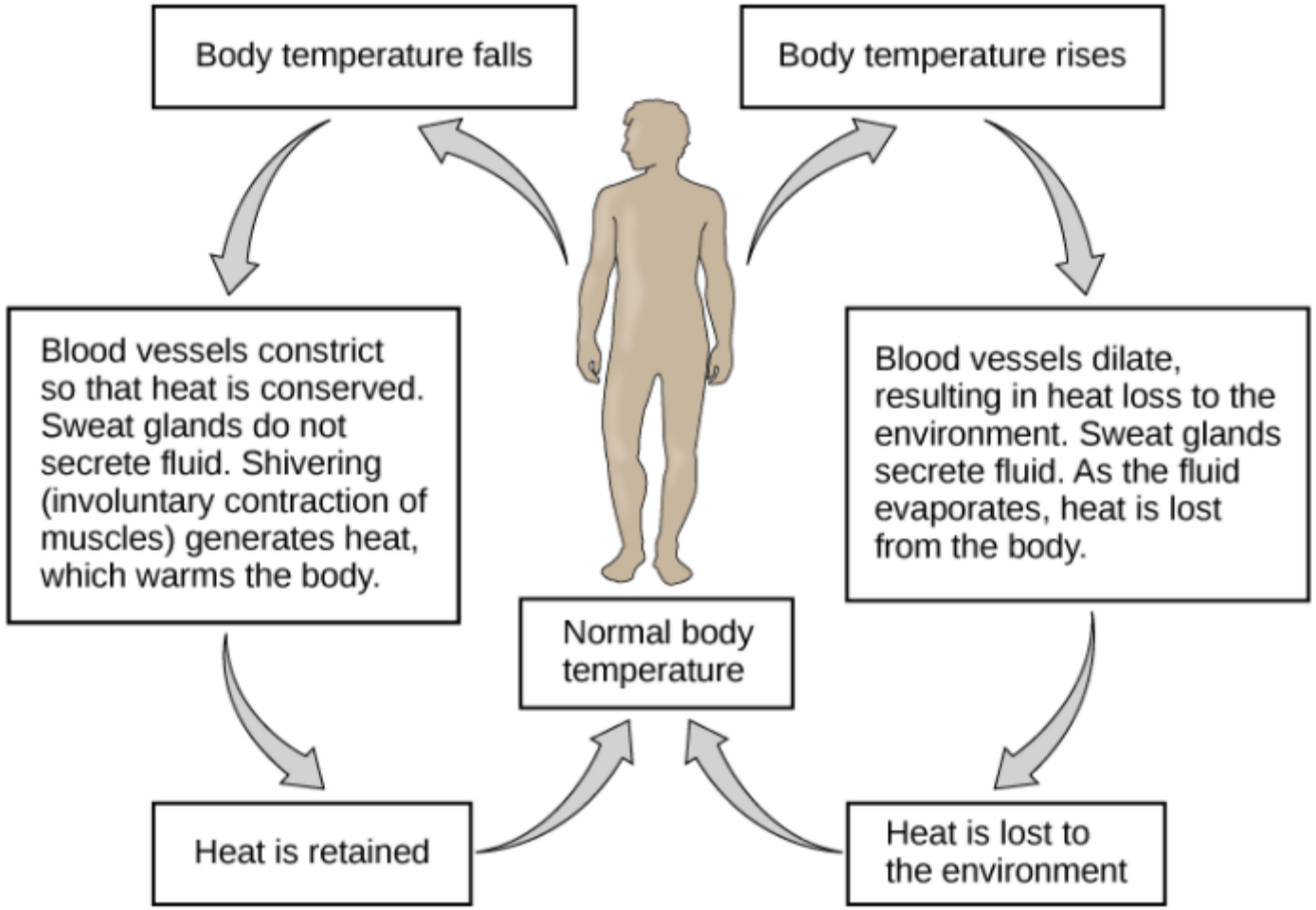
The biosphere is divided into several unique biomes. While the biosphere includes all living and nonliving elements on Earth, biomes organize all these components by different regions and how the organisms living there are adapted to specific conditions.



Homeostasis

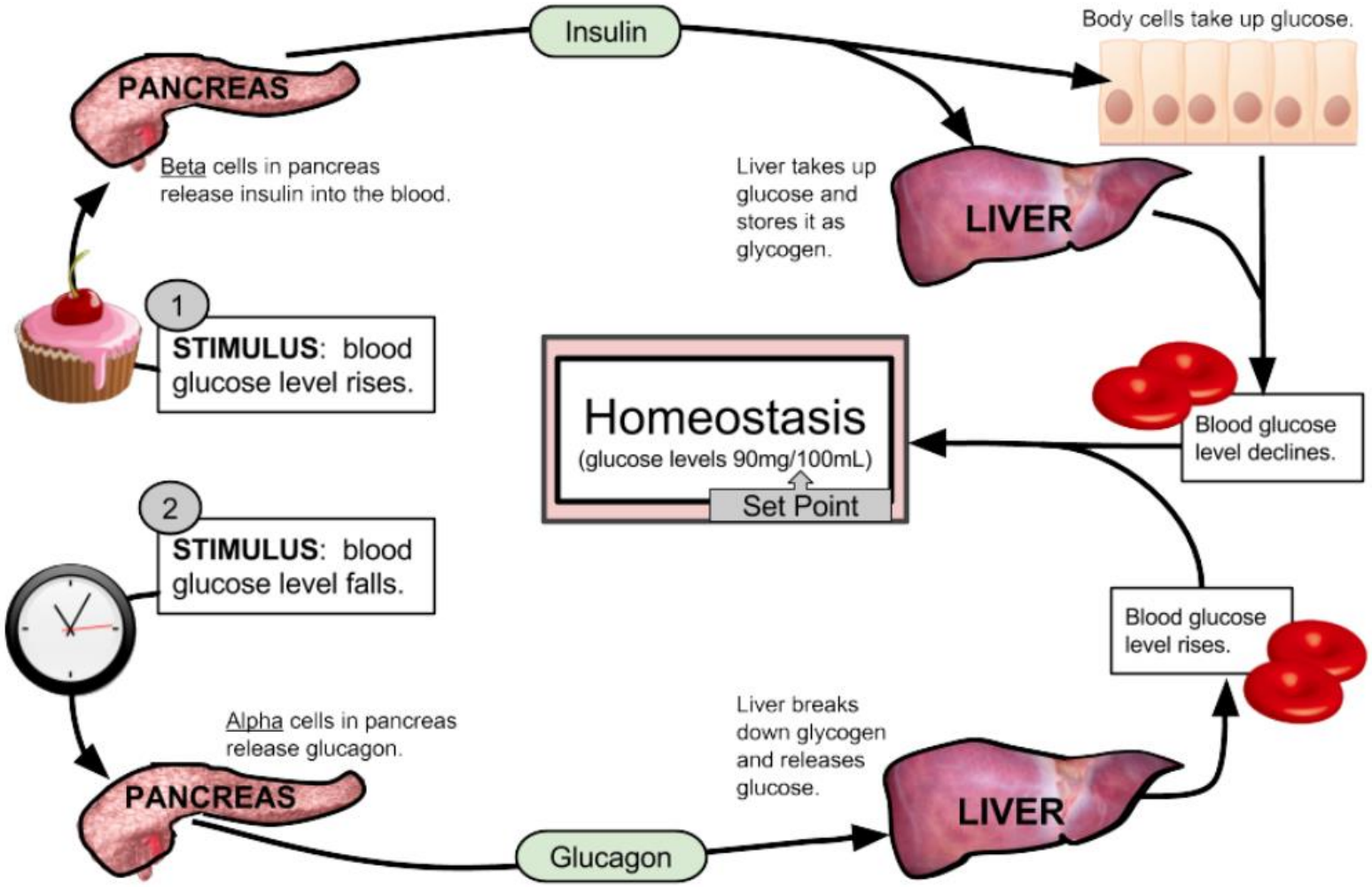
- Maintenance of relatively constant internal conditions.
- Regulation to maintain equilibrium.

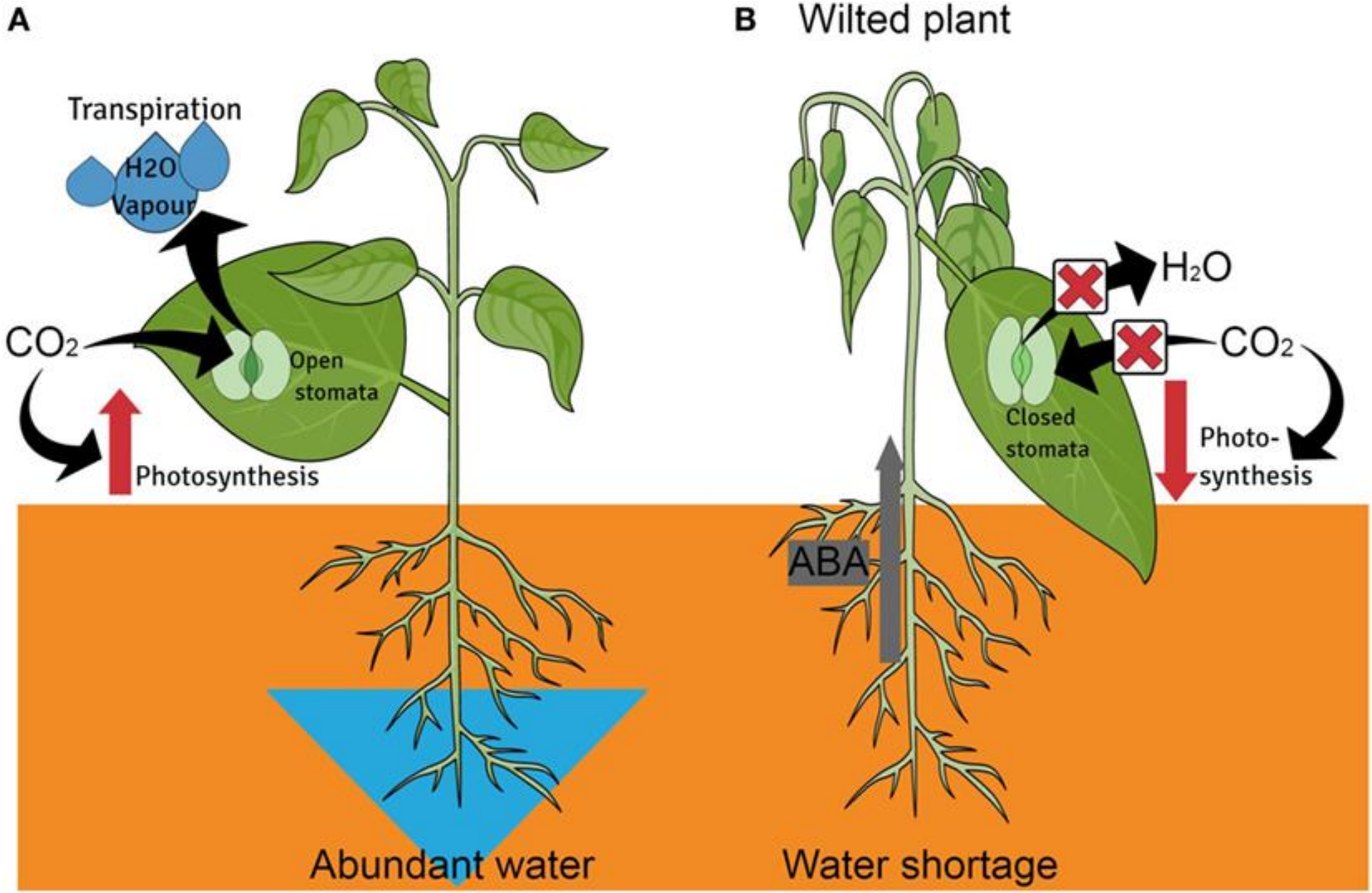




Homeostasis

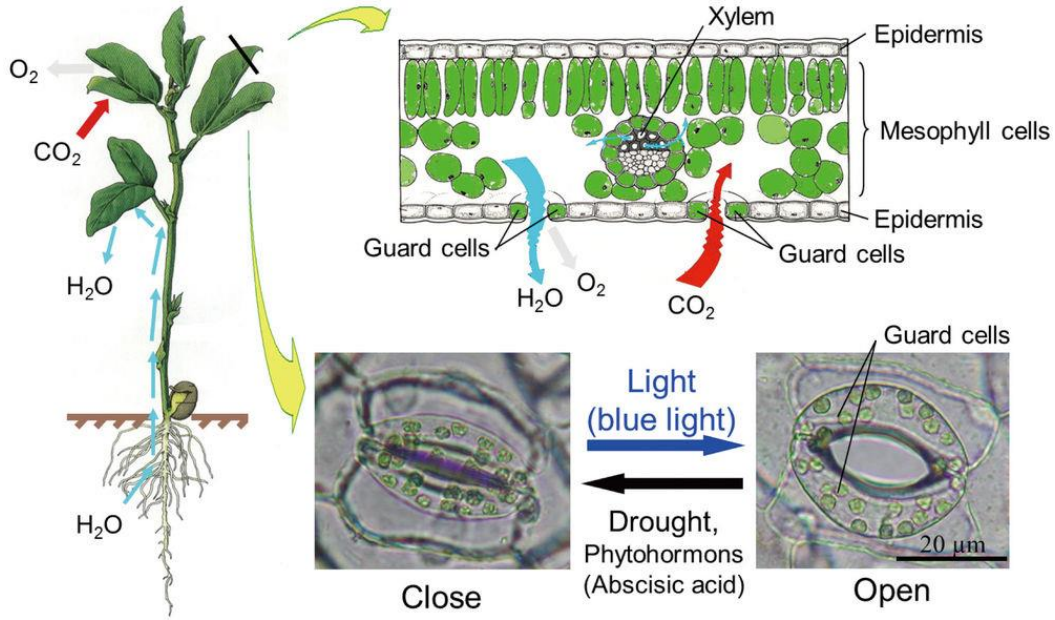
- relatively constant internal conditions




A
Transpiration
H2O
Vapour
CO2
Open
stomata
Photosynthesis
Abundant water
B
Wilted plant
H2O
CO2
Closed
stomata
Photo-
synthesis
ABA
Water shortage

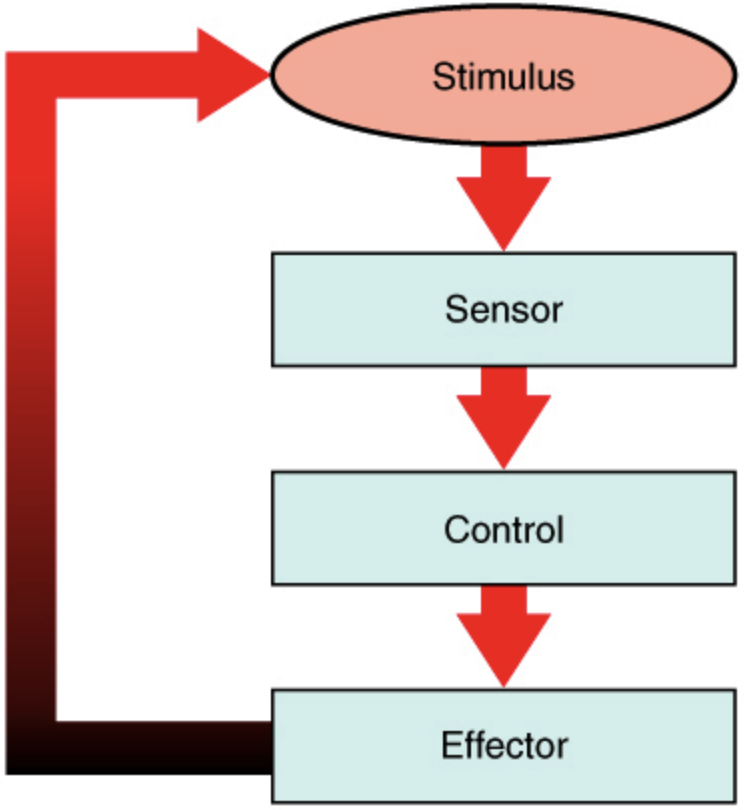
Homeostasis

- relatively constant internal conditions

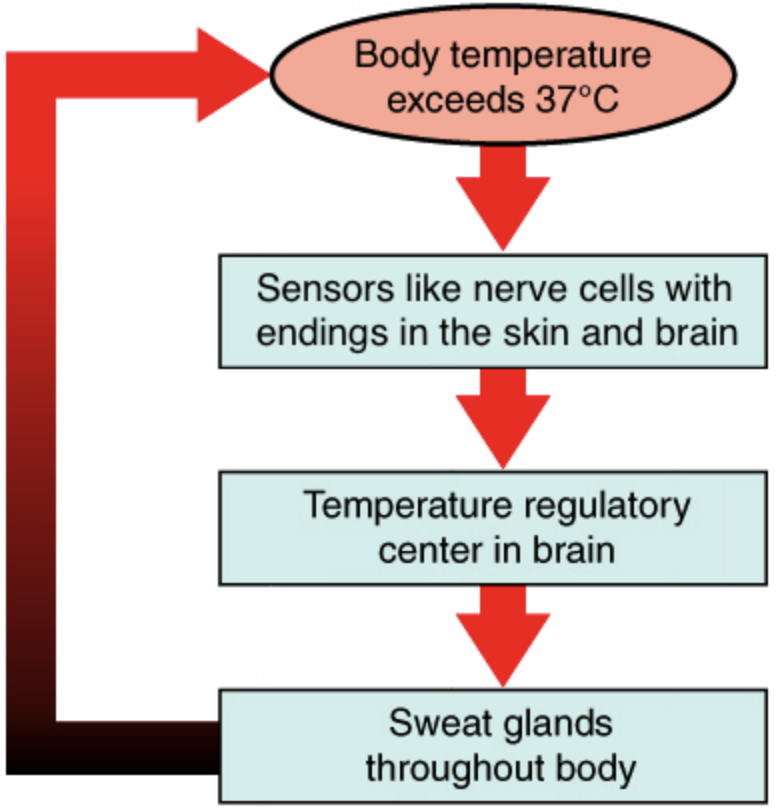


- Maintenance of homeostasis usually involves **negative feedback loops**. These loops act to oppose the **stimulus**, or cue, that triggers them. For example, if your body temperature is too high, a negative feedback loop will act to bring it back down towards the **set point**, or target value, 98.7°F/37°C.

- How does this work? First, high temperature will be detected by **sensors**—primarily nerve cells with endings in your skin and brain—and relayed to a temperature-regulatory **control center** in your brain. The control center will process the information and activate **effectors**—such as the sweat glands—whose job is to oppose the stimulus by bringing body temperature down.



Negative feedback loop

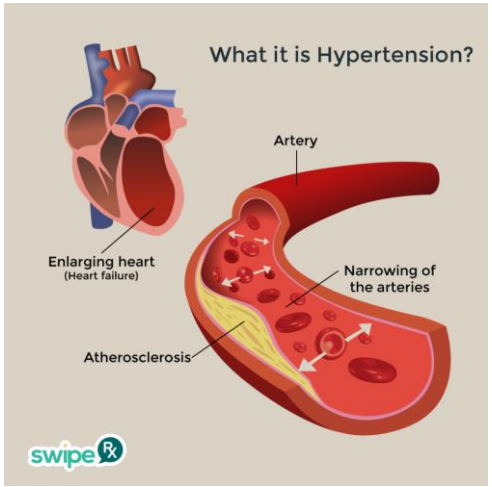


Body temperature regulation

What happens if there's disruption?

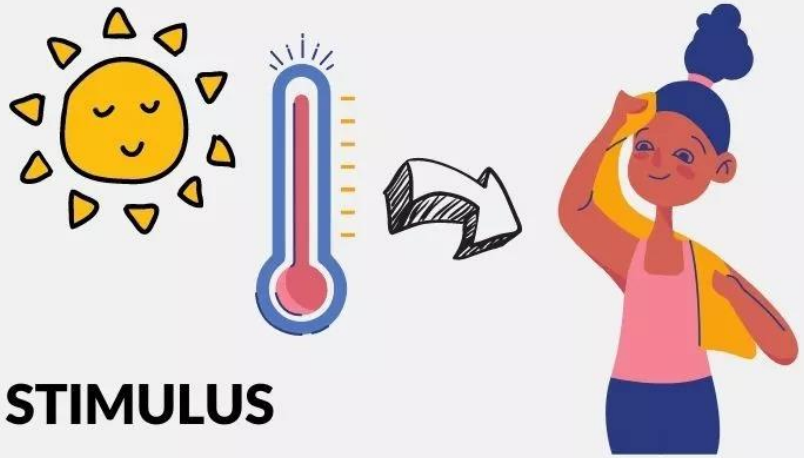
What if homeostasis is not maintained?

- If homeostasis is disrupted, it must be controlled or a **disease/disorder** may result.
- Your body systems work together to maintain balance. If that balance is shifted or disrupted and homeostasis is not maintained, **the results may not allow normal functioning of the organism**.



Sensitivity/Irritability

- The ability to respond to stimuli.
- the characteristic of living organisms in being **aware** of, and being able to **respond** to, a **stimulus** which tends to disturb the steady state or homeostasis which all organisms prefer for maintaining life.

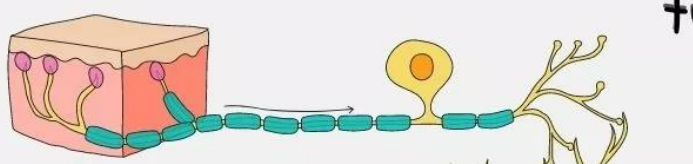


STIMULUS

RECEPTORS (SKIN)

SENSORY NEURON

The STIMULUS (heat) is detected by the receptors of the skin. They send signals to the BRAIN, which, in turn, instructs the body to cool off.

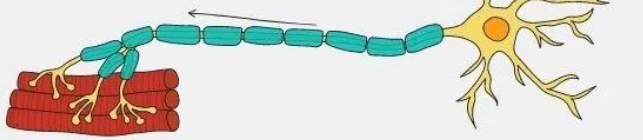


RELAY NEURON

BRAIN

RESPONSE

EFFECTOR (MUSCLE)



MOTOR NEURON

Biology Online

Reproduction

✓producing their own kind

_____

✓self-**perpetuation** of the **species**

✓Reproduction is important for the survival of all living things.

✓Without a mechanism for reproduction, life would come to an end.

Methods of Reproduction

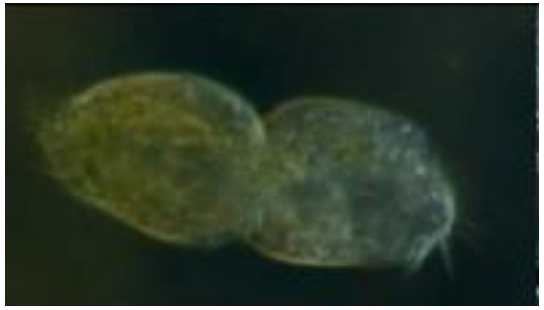
Asexual reproduction

- One parent is involved.
- Offspring are genetically identical to the parents and to each other.

- Types of Asexual Reproduction
  - Fission
  - Fragmentation
  - Budding
  - Vegetative Propagation
  - Spore formation

Types of Asexual Reproduction

- Fission
  - **Binary fission** is a type of asexual reproduction where a parent cell divides, resulting in two identical cells, each having the potential to grow to the size of the original cell.

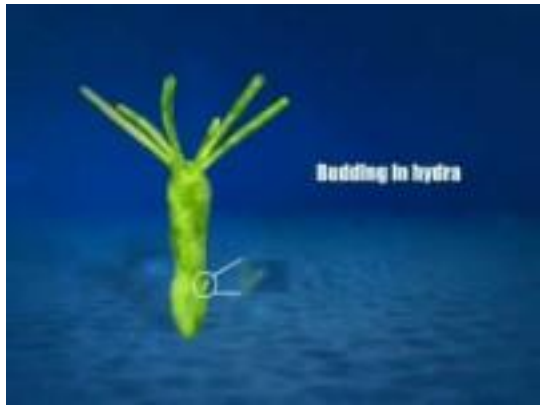


Types of Asexual Reproduction

- Fragmentation
  - a form of asexual reproduction wherein a parent organism breaks into fragments, each capable of growing independently into a new organism

Types of Asexual Reproduction

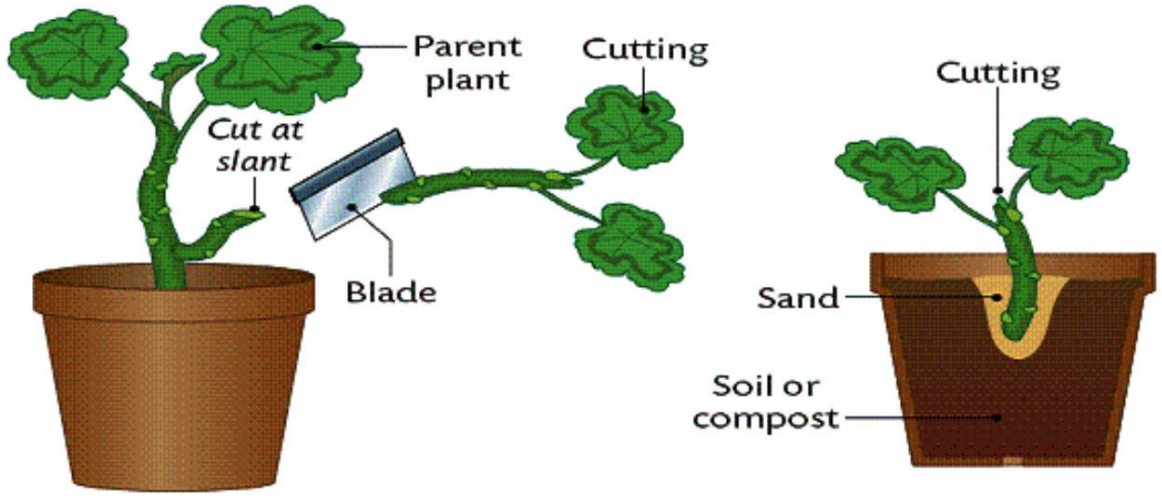
- Budding
  - a type of asexual reproduction in which a new organism develops from an outgrowth or bud due to cell division at one particular site.



Types of Asexual Reproduction

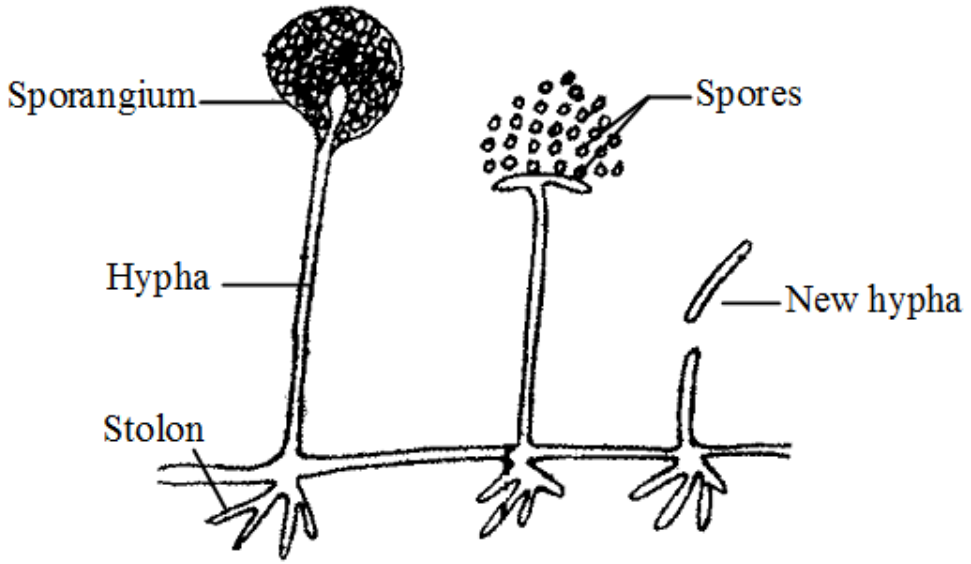
- Vegetative Propagation
  - Asexual propagation involves taking a part of one parent plant and causing it to regenerate itself into a new plant. The resulting new plant is genetically identical its parent. Asexual propagation involves the vegetative parts of a plant: stems, roots, or leaves.

  - Does not involve pollination



Types of Asexual Reproduction

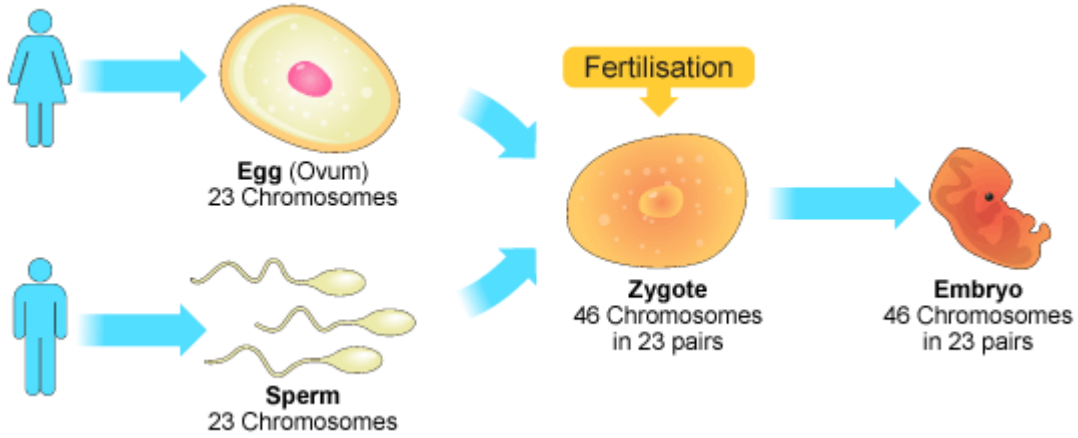
- Spore formation
  - In spore formation, the parent plant produces hundreds of reproductive units called spores in its spore case. When this spore case of the plant bursts, these spores travel in air and land on food or soil. Here they germinate and produce new individuals.



Spore Formation in a Fungus (Rhizopus)

Sexual Reproduction

- Two parents are involved
- Offspring are genetically distinct from the parents and from each other.



	Sexual Reproduction	Asexual Reproduction
Advantages	• High Genetic Variability • Facilitates adaptation • "Speeds" up evolution	• Saves energy • Courtship is a non-issue • Greatest increase in fitness for each individual
Disadvantages	• Energy Costly • Courtship is time/resource consuming • Usually sacrifices the fitness of one sex to the other.	• Low Genetic Variability • Adaptation to environment is difficult • "Retards" evolution

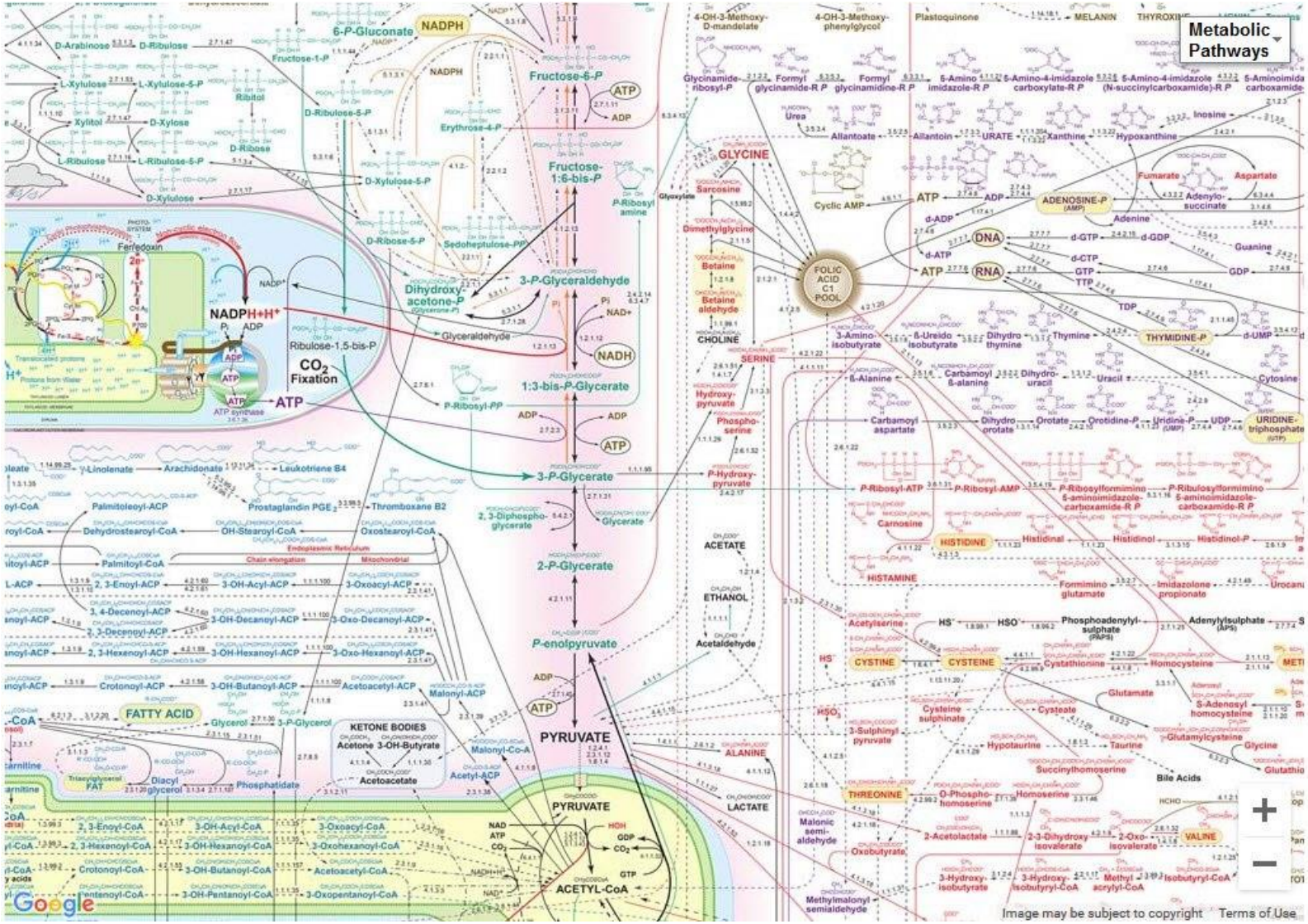
Growth and Development

GROWTH VERSUS DEVELOPMENT

GROWTH	DEVELOPMENT
The increases in cell size and number that take place during the life history of an organism	The progressive changes in size, shape, and function during the life of an organism by which its genetic potentials (genotype) are translated into functioning mature systems (phenotype)
The increase in size and mass over a period of time	The transform of an organism into a more complex form in function and organization wise
A part of development	Includes growth, morphogenesis, and differentiation
Quantitative	Quantitative and qualitative
Occurs at the cellular level	Occurs at the organizational level
Brings changes in the size, shape, form, and structure of the body	Brings changes in the organization and function
Stops at the maturation	Continues throughout life
Can be measured directly	A subjective interpretation

Metabolism

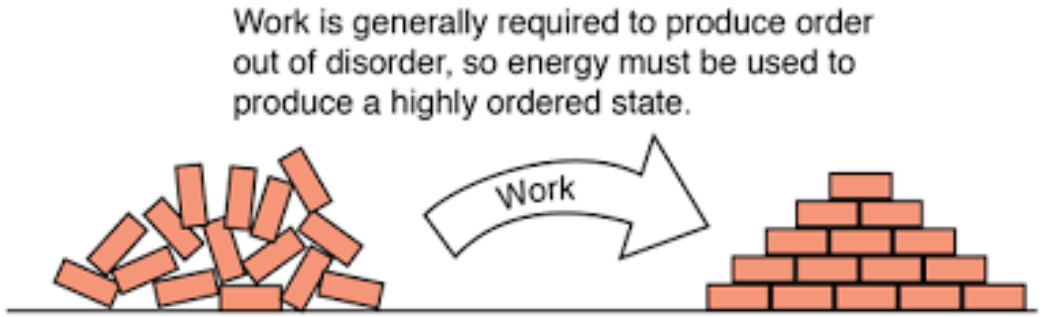
- the sum of chemical reactions occurring within the body (or cell).
- involves exchanges of chemical matter with the external environment and extensive transformations of organic matter within the cells of a living organism.
- involves the release or use of chemical energy.



Metabolic Pathways Map

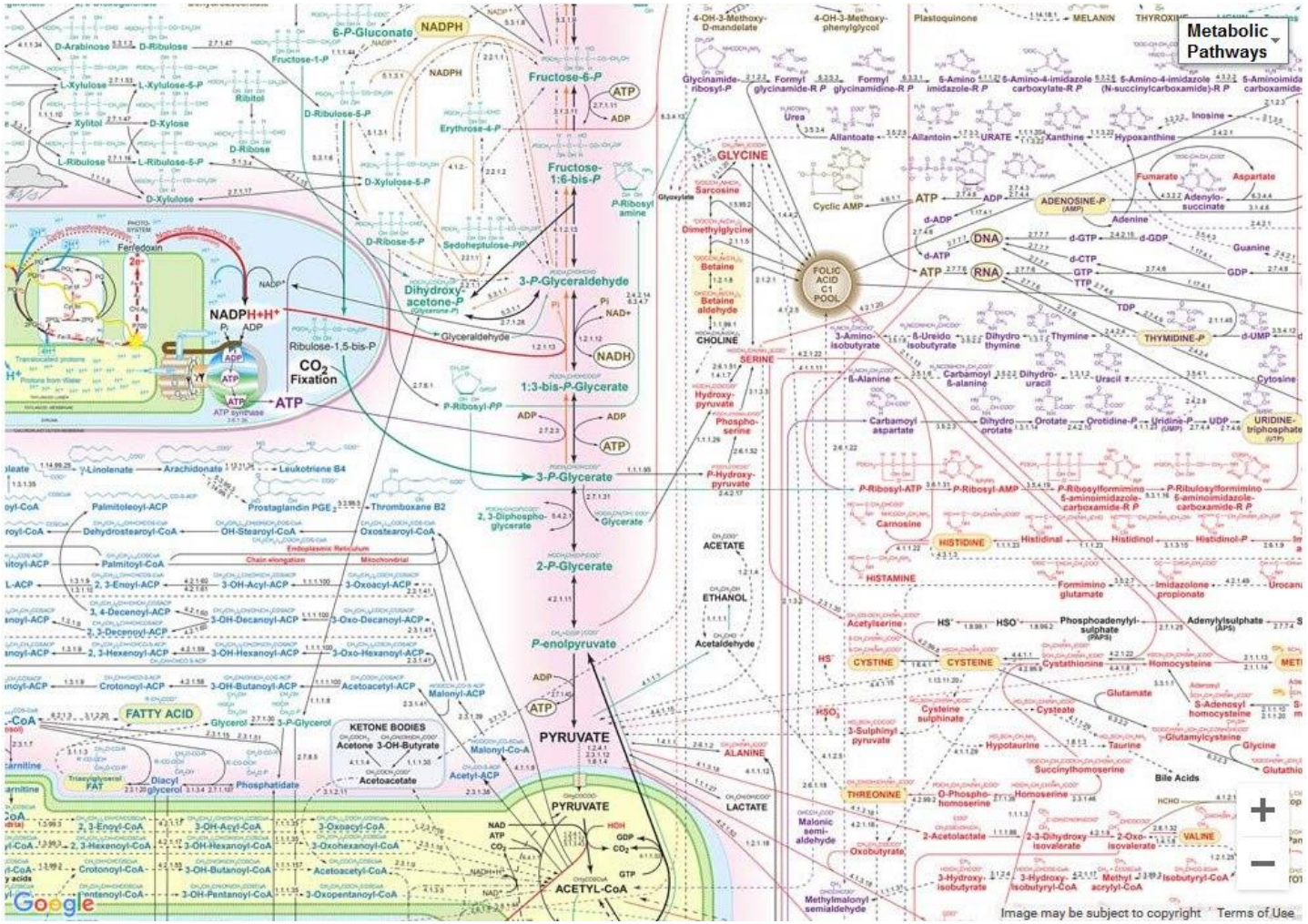
Why organisms (or cells) need to metabolize?

- Because all organisms need **energy and nutrients**.
  - Maintain their structures (order)
  - Respond to their environments
  - Maintain internal constancy
  - Reproduce
  - Grow
  - Develop

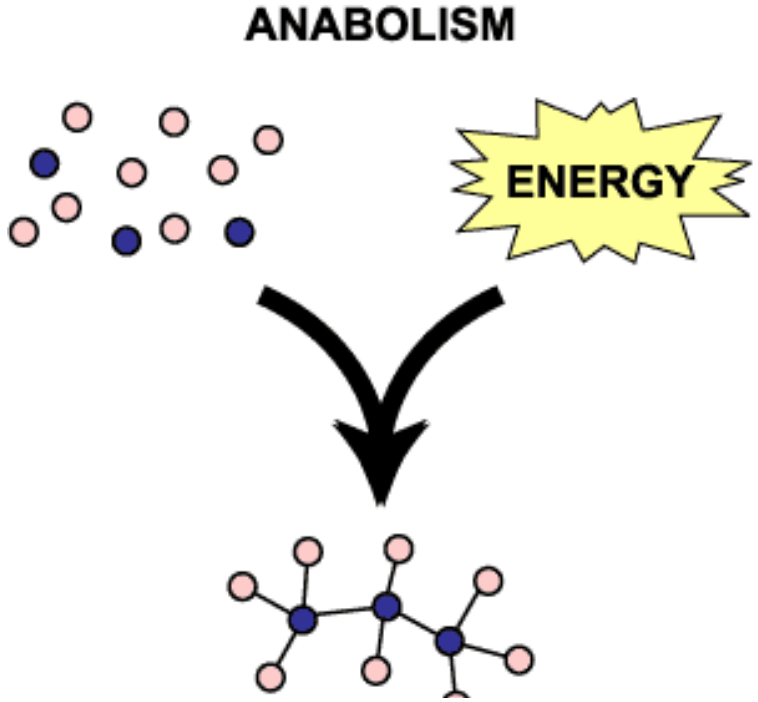


Metabolism can be subdivided into 2 categories

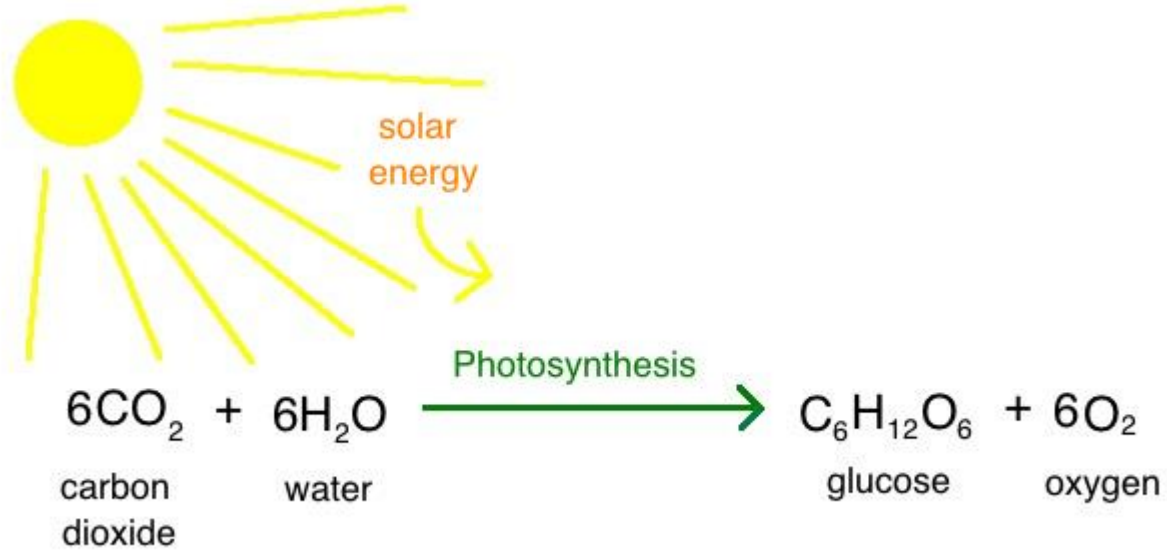
- Anabolism
- Catabolism



Anabolism (Anabolic Pathways)

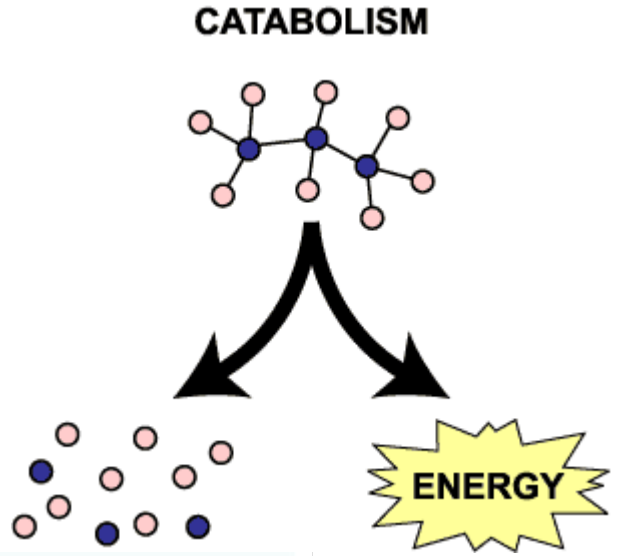


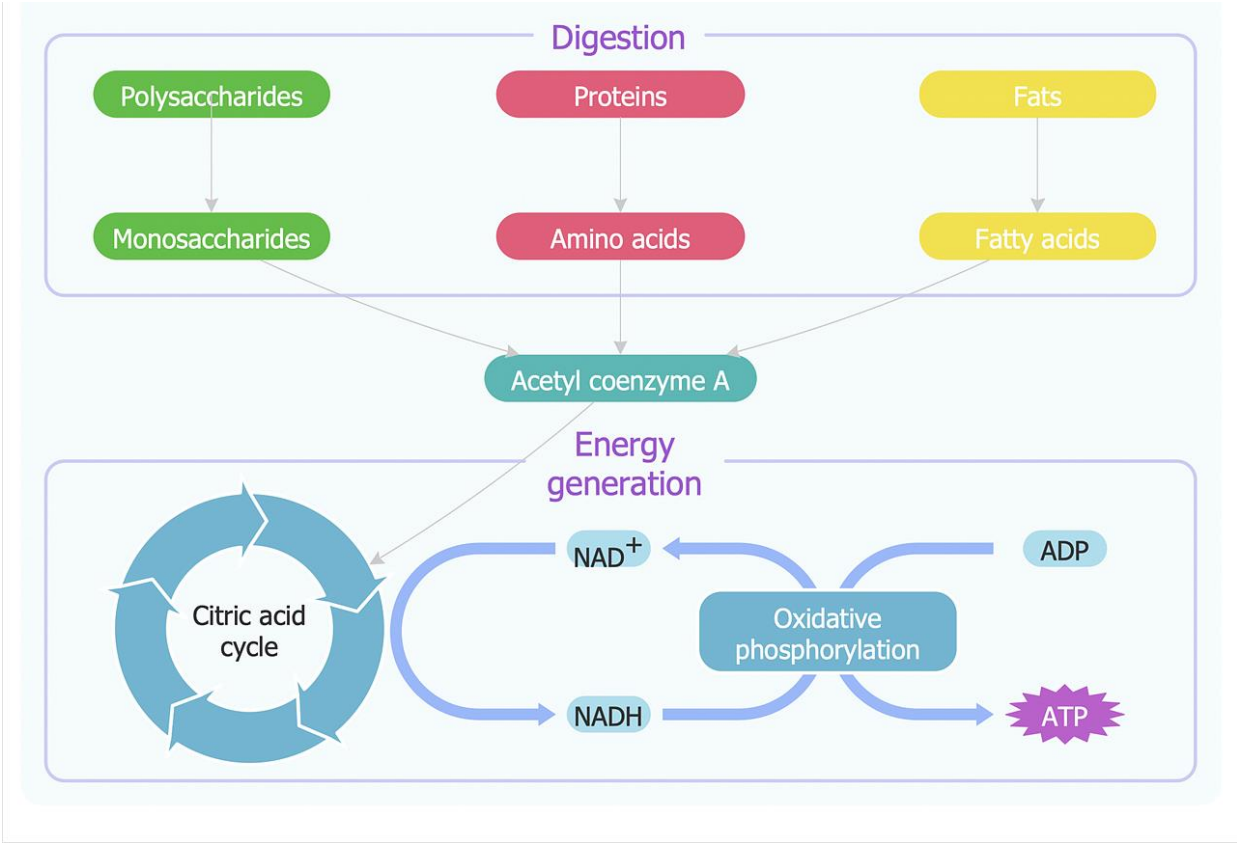
- **constructive** metabolism of the body
- building molecules
- Synthesis of large molecules (macromolecules) from small/simple molecules
- Requires energy (energy-consuming)



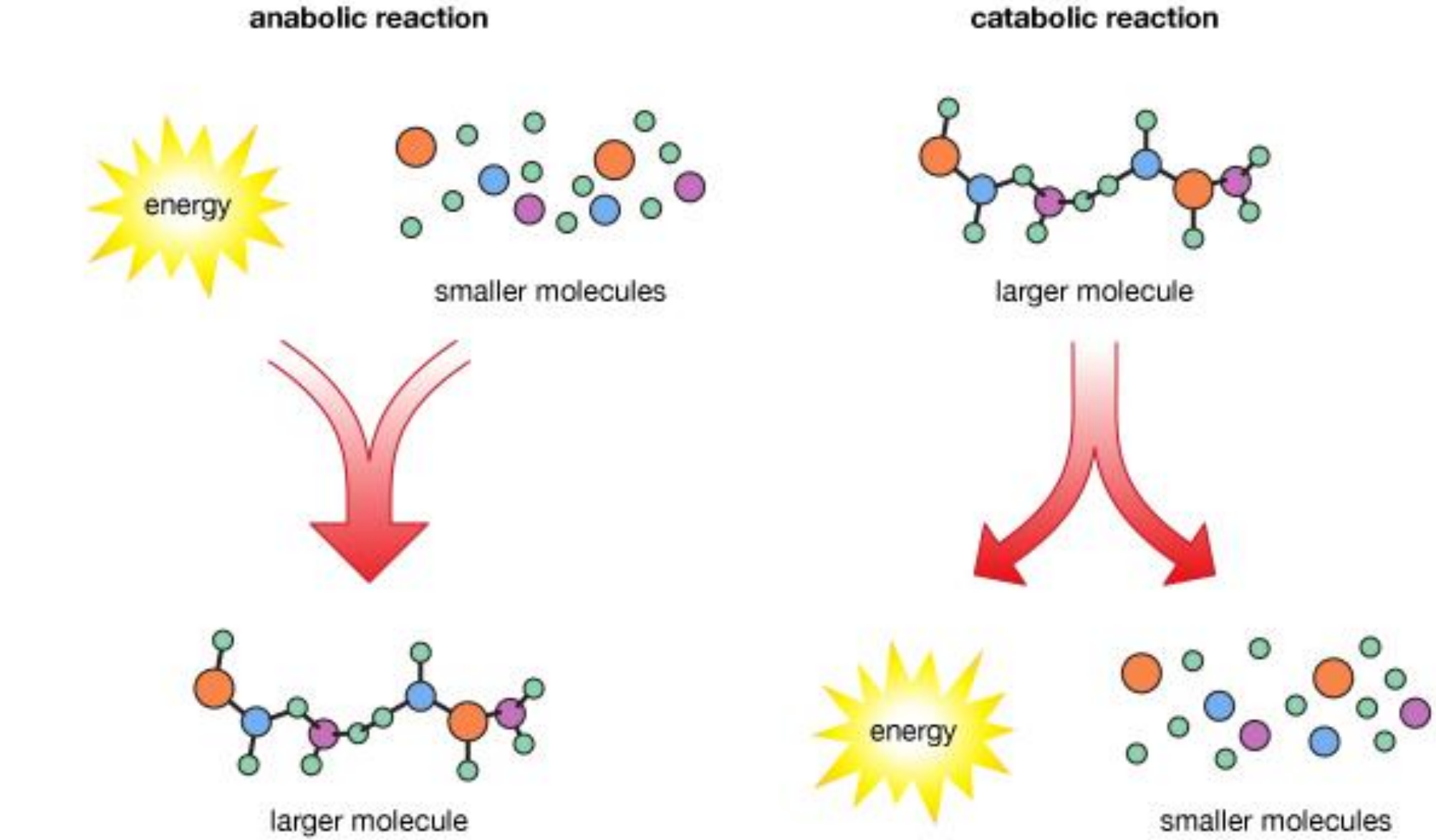
Catabolism (catabolic pathways)

- **destructive** metabolism
- breaks down large, complex molecules into smaller, simpler molecules.
- Releases energy





Metabolism



- At the ecosystem level, organisms can be categorized based on their source of energy and raw materials.

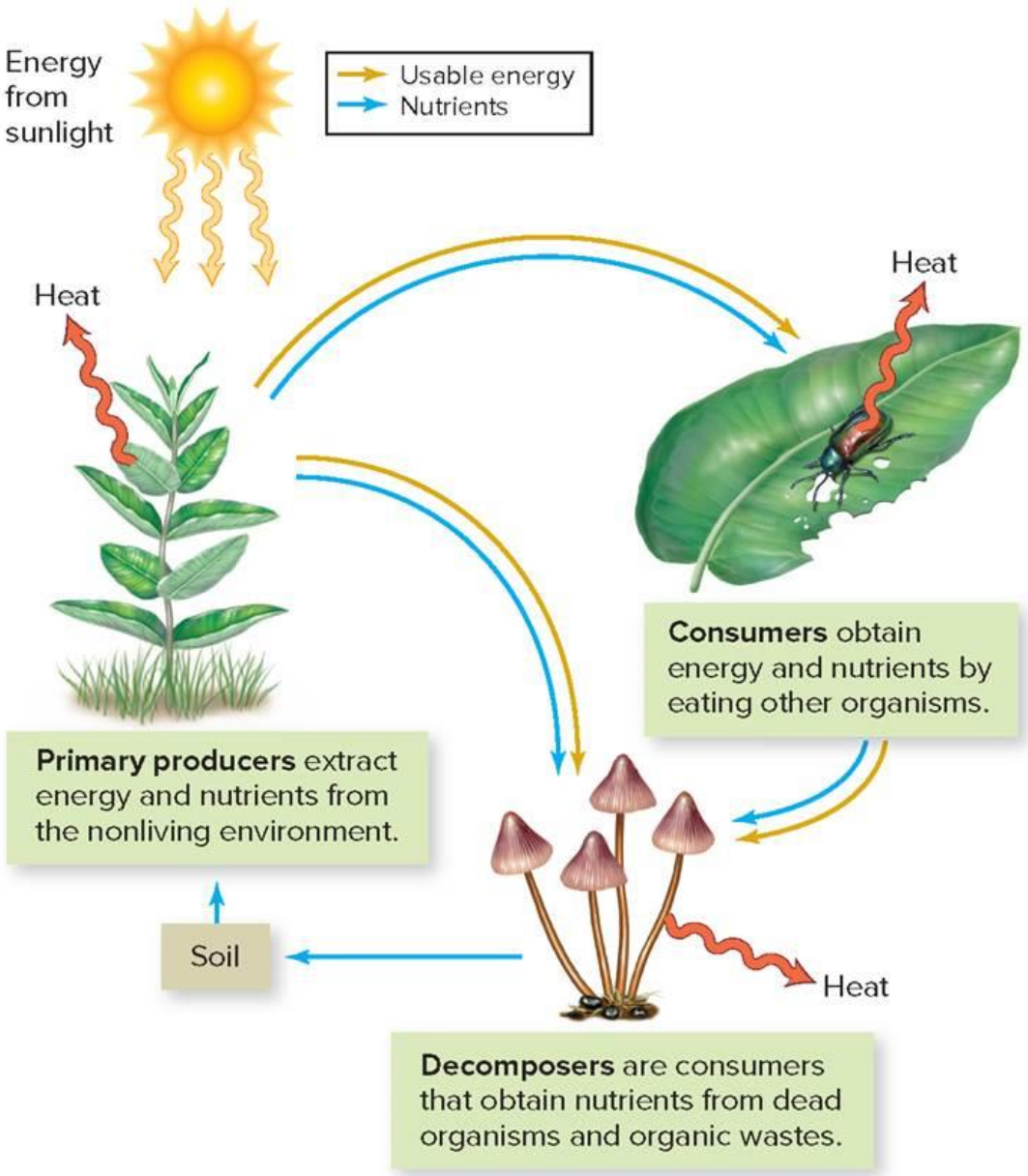
- Producers
  - **Auto**trophs = self feeding
  - Make their own food by extracting energy and nutrients from nonliving sources.

- **Hetero**trophs
  - Feeding on others (other organisms)

  - **Consumers**
    - Obtain energy and nutrients by eating other organisms.

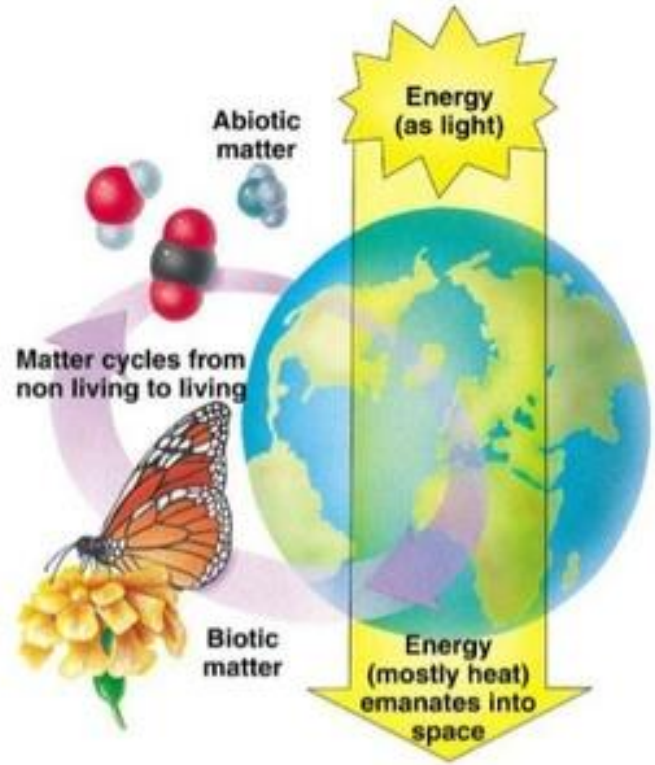
  - **Decomposers**
    - Absorbs energy and nutrients from wastes or dead organisms.

Producers	Consumers	Decomposers
Make their own food	Eat other organisms for food	Break down dead material
 	 	 



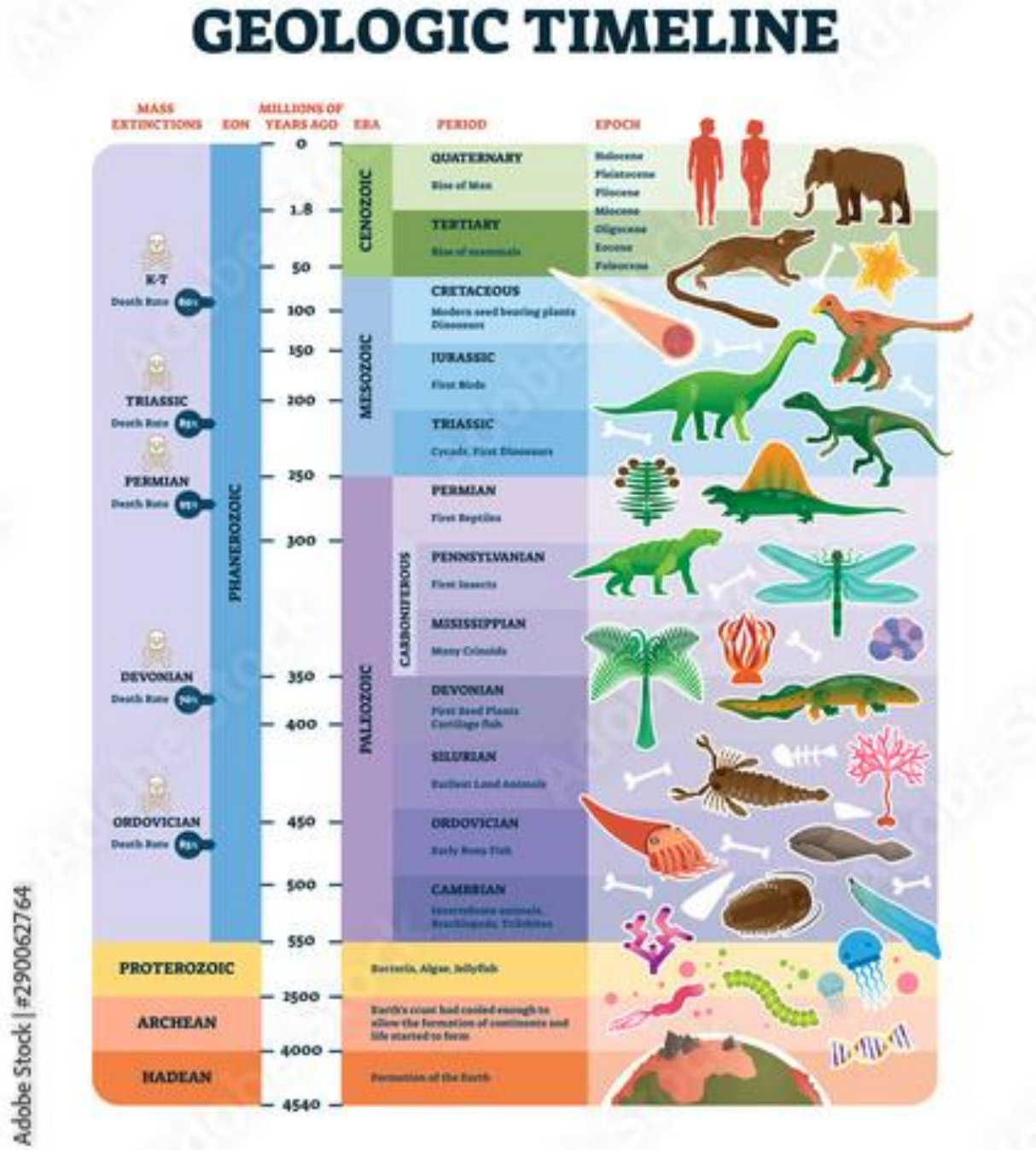
Flow of Energy and Matter

Energy **Moves Through Ecosystems, but** ***Matter*** **Cycles Within Ecosystems**



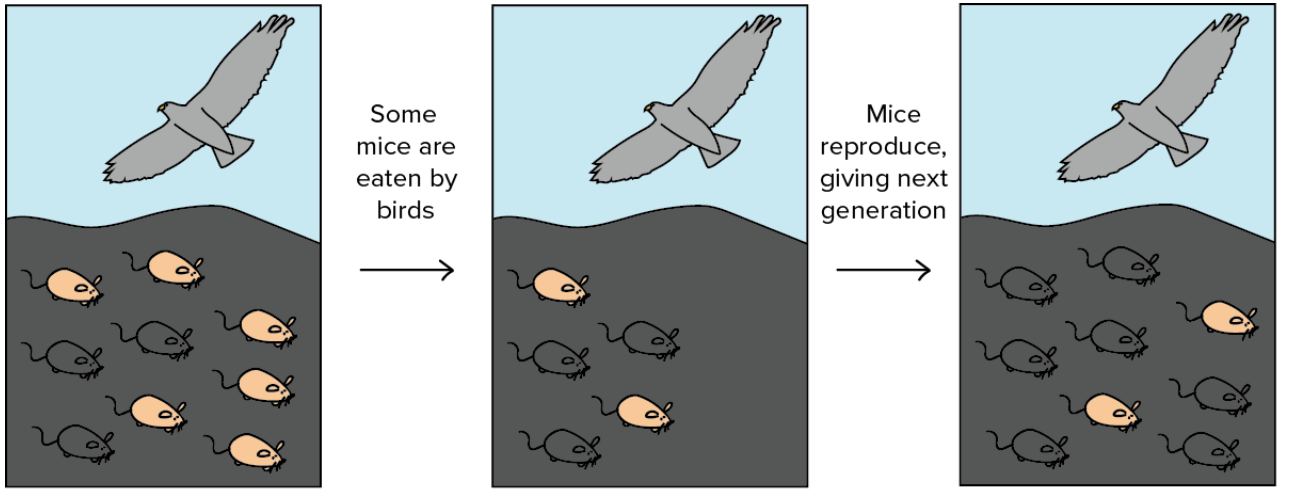
Evolution

- the change in the characteristics of a species over several generations and relies on the process of **natural selection**.



What is natural selection?

- Individuals in a species show variation in physical characteristics. This variation is because of differences in their genes.
- Individuals with characteristics best suited to their environment are more likely to survive, finding food, avoiding predators and resisting disease. These individuals are more likely to reproduce and pass their genes on to their children.
- Individuals that are poorly adapted to their environment are less likely to survive and reproduce. Therefore, their genes are less likely to be passed on to the next generation.
- As a consequence, those individuals most suited to their environment survive and, given enough time, the species will gradually evolve.



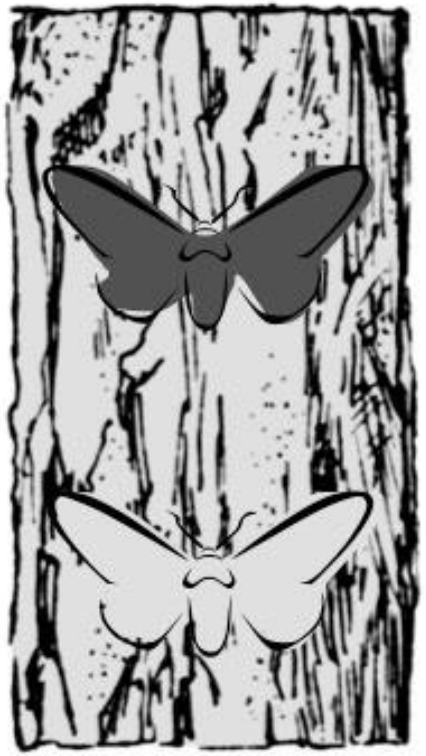
A population of mice has moved into a new area where the rocks are very dark. Due to natural genetic variation, some mice are black, while others are tan.

Tan mice are more visible to predatory birds than black mice. Thus, tan mice are eaten at higher frequency than black mice. Only the surviving mice reach reproductive age and leave offspring.

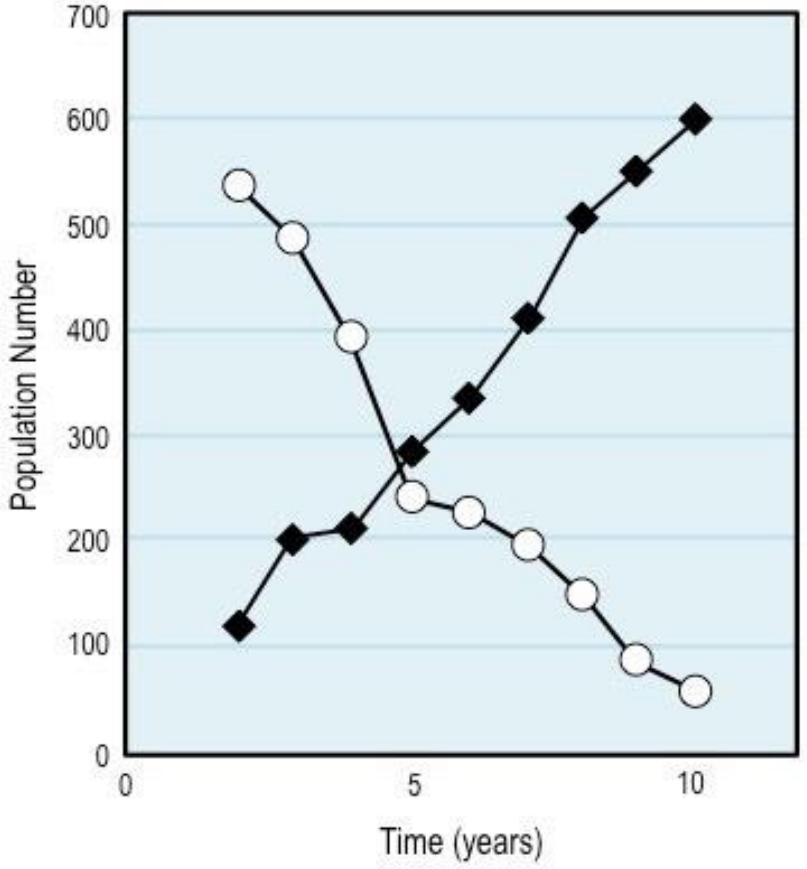
Because black mice had a higher chance of leaving offspring than tan mice, the next generation contains a higher fraction of black mice than the previous generation.

Evolution by Means of Natural Selection

- Example: Peppered Moth Case



Pre-Industrial Revolution



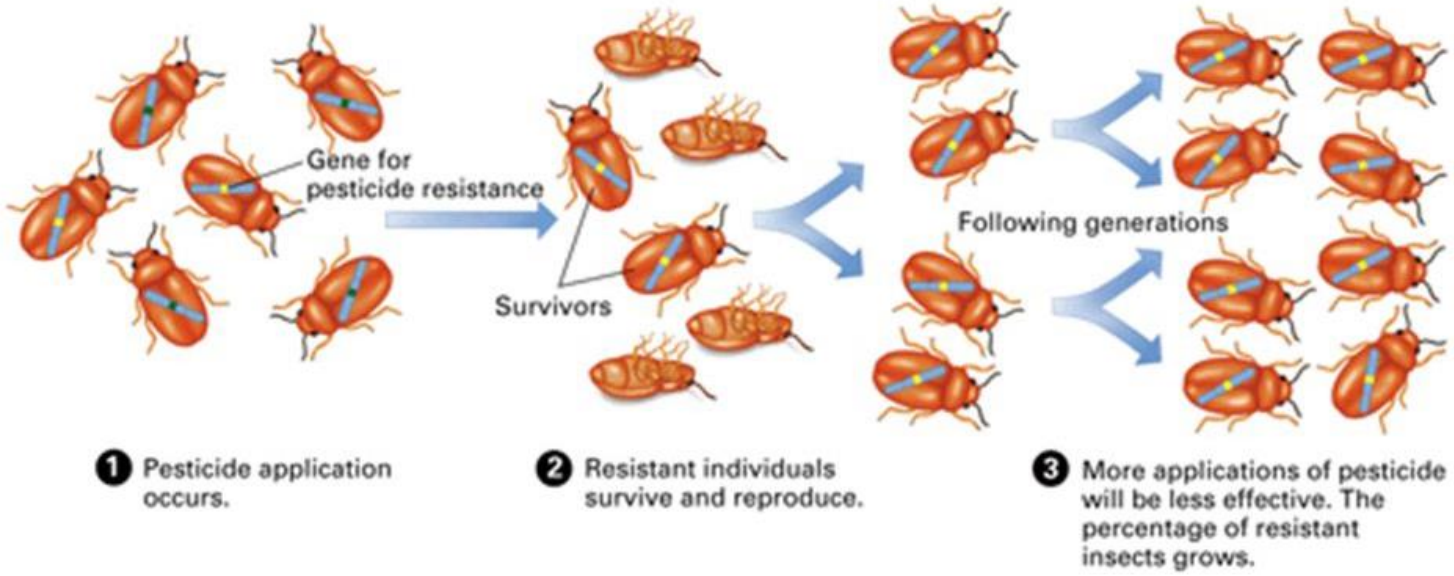
Post-Industrial Revolution

Before the Industrial Revolution, many peppered moths were dominant white in color, and were able to adapt to trees with white lichens. This caused them to thrive in their respective environment, as predators found it difficult to spot them.

During the Industrial Revolution, you can see a shift in population, as the white peppered moths suddenly decreased in population, after large quantities of carbon was released into the environment. This caused many trees to darken, making the moths more apparent.

After the Industrial Revolution, many peppered moths were dominant black in color, and were able to adapt to trees with dark soot. This caused them to thrive in their respective environment, while white moths suffered.

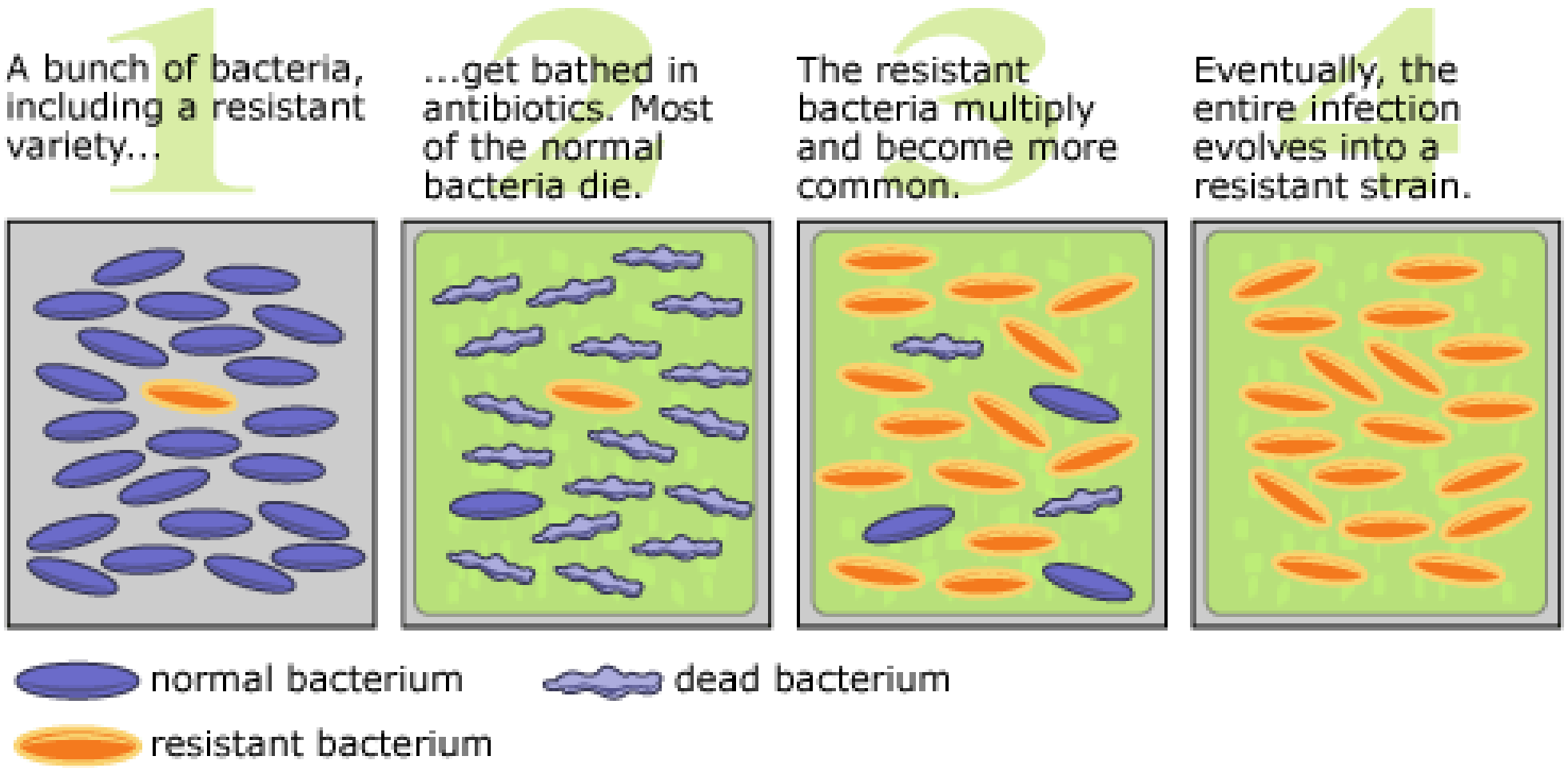
Pesticides
Natural Selection in Action!



Using pesticides against insects can cause resistance over time!

Evolution by Means of Natural Selection

Evolution by Means of Natural Selection



- What is life?
- What is considered as a living thing?

- Are Viruses Living?