The Science of Biology

Chapter 1

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Properties of Life

Living organisms:

- are composed of cells
- are complex and ordered
- respond to their environment
- can grow and reproduce
- obtain and use energy
- maintain internal balance
- allow for evolutionary adaptation

Characteristics of Living Things.

- **1. Cellular Organization or Made up of cells**. One cell (unicellular) or many cells (Multicellular)
- **2. Ordered Complexity**. All living things are both complex and Highly ordered.
- **3. Grow and Develop Reproduce**: Make new cells or new offspring.
- **A. Asexual Reproduction**. Cells divide to form new cells.
- **B. Sexual Reproduction:** New Organisms reproduce from two parent organisms.
- *Both animals and some plants reproduce this way.

Characteristics of Living Things.

- **4. Energy utilization or Obtain and use energy**. To give off heat, move and allow cells to grow and develop
- **5. Sensitivity to stimuli or Respond to their environment.** To allow the organism to move and interact with other organism in their environment.
- Could be flight, attack, talk or any other gestures.

Characteristics of Living Things.

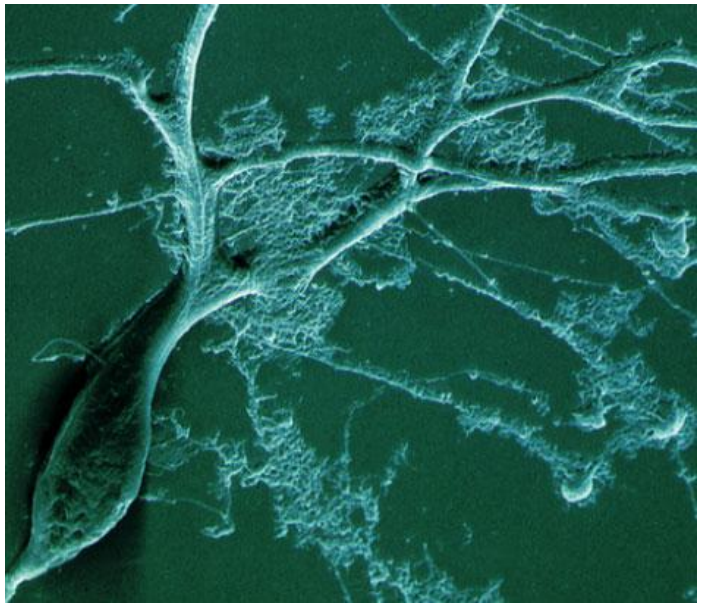
- **6. Homeostasis**: All organisms maintain constant internal conditions that are different from their environment.
- **7. Evolutionary adaptation**: All organisms interact with biotic and abiotic factors. These factors influence their survival, and adaptations.

Levels of Organization

Cellular Organization

atoms → molecules → organelles → cells

The **cell** is the basic unit of life.



Levels of Organization

Organismal Level

tissues → organs → organ systems → organism

Levels of Organization

Population Level

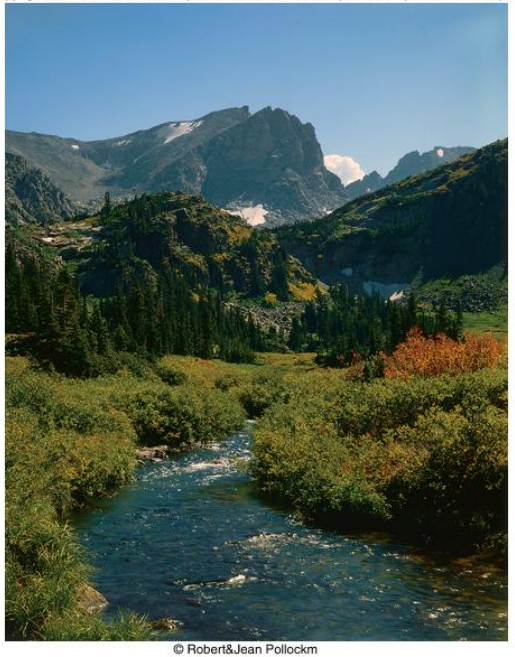
ecosystem

community

species

population

(n)



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Levels of Organization

Each level of organization builds on the level below it but often demonstrates new features.

Emergent properties: new properties present at one level that are not seen in the previous level

The Nature of Science

Science aims to understand the natural world through observation and reasoning.

Science begins with observations, therefore, much of science is purely descriptive.

Science uses both deductive and inductive reasoning.

The Nature of Science

Deductive reasoning uses general principles to make specific predictions.

Inductive reasoning uses specific observations to develop general conclusions.

The Nature of Science

Scientists use a systematic approach to gain understanding of the natural world.

-Observation
-Hypothesis formation
-Prediction
-Experimentation
-Conclusion

The Nature of Science

A **hypothesis** is a possible explanation for an observation.

A hypothesis

-must be tested to determine its validity

-is often tested in many different ways

-allows for predictions to be made

The Nature of Science

The **experiment**

-tests the hypothesis

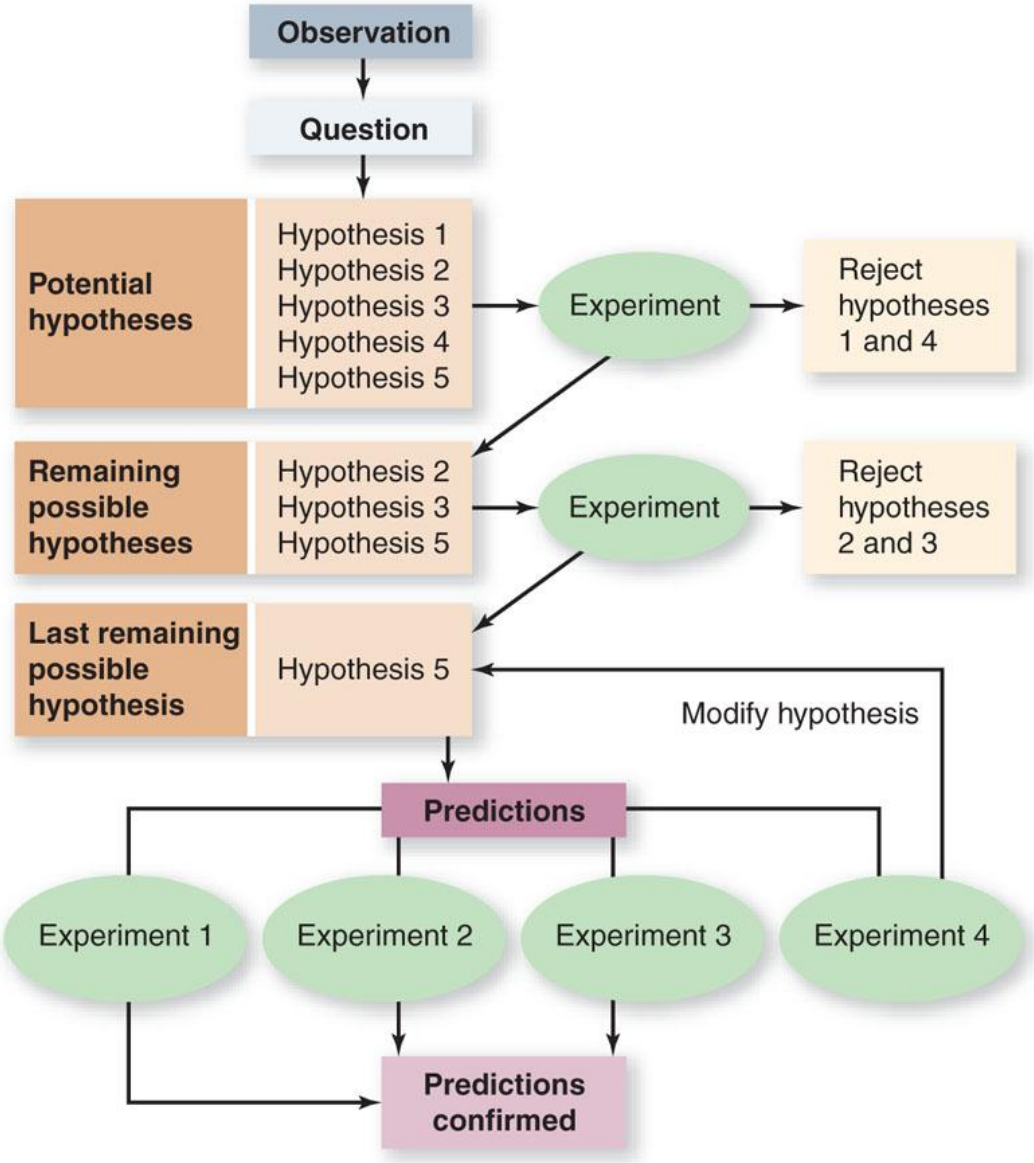
-must be carefully designed to test only one **variable** at a time

-consists of a **test experiment** and a **control experiment**

The Nature of Science

If the hypothesis is valid, the scientist can predict the result of the experiment.

Conducting the experiment to determine if it yields the predicted result is one way to test the validity of the experiment.



The Nature of Science

Scientists may use

reductionism - to break a complex process down to its simpler parts

models – to simulate phenomena that are difficult to study directly

The Nature of Science

A scientific **theory**

-is a body of interconnected concepts

-is supported by much experimental evidence and scientific reasoning

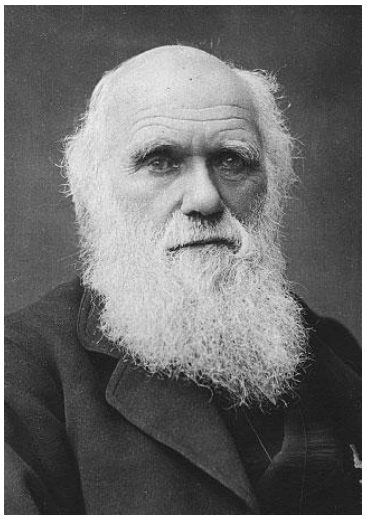
-expresses ideas of which we are most certain

Charles Darwin

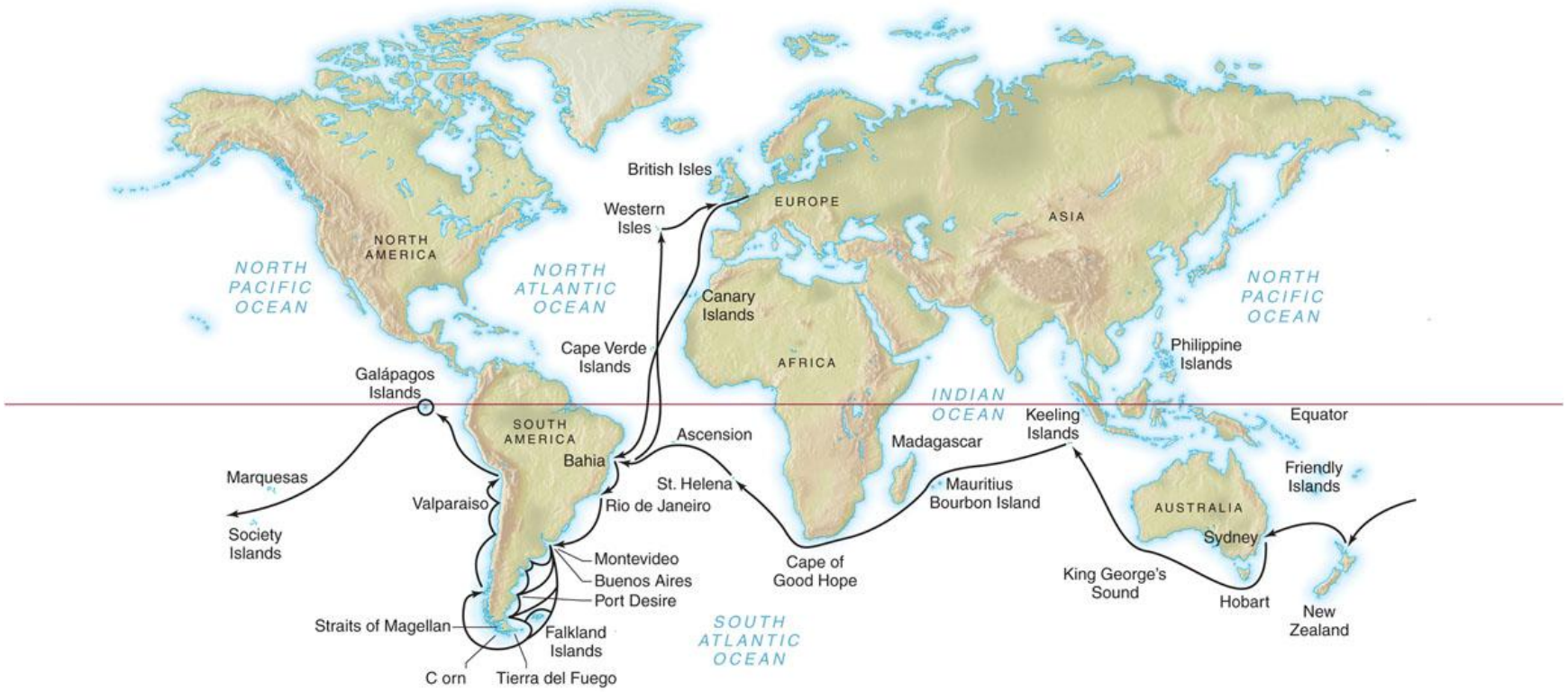
Served as naturalist on mapping expedition around coastal South America.

Used many observations to develop his ideas

Proposed that evolution occurs by **natural selection**



Voyage of the *Beagle*



Charles Darwin

evolution: modification of a species over generations

-“descent with modification”

natural selection: individuals with superior physical or behavioral characteristics are more likely to survive and reproduce than those without such characteristics

Darwin's Evidence

Similarity of related species

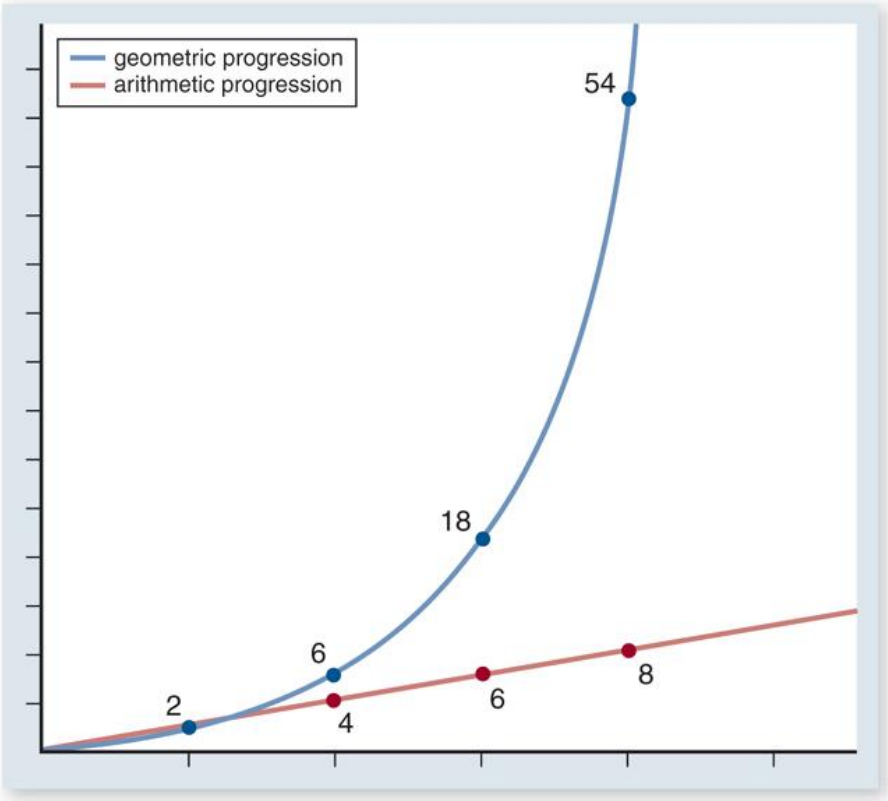
- Darwin noticed variations in related species living in different locations

Darwin's Evidence

Population growth vs. availability of resources

-population growth
is geometric

-increase in food
supply is arithmetic



Darwin's Evidence

Population growth vs. availability of resources

- Darwin realized that not all members of a population survive and reproduce.

-Darwin based these ideas on the writings of Thomas Malthus.

Post-Darwin Evolution Evidence

Fossil record

- New fossils are found all the time
- Earth is older than previously believed

Mechanisms of heredity

- Early criticism of Darwin's ideas were resolved by Mendel's theories for genetic inheritance.

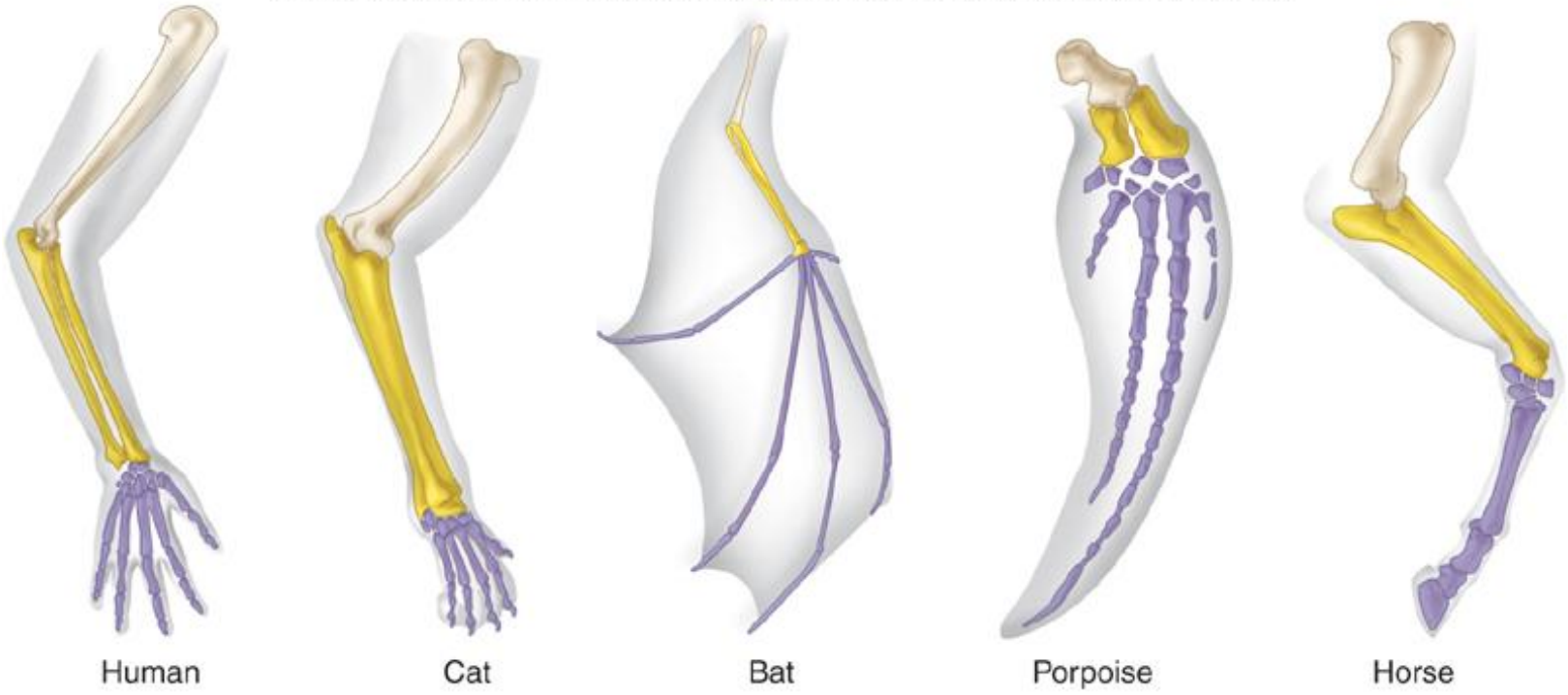
Post-Darwin Evolution Evidence

Comparative anatomy

- **Homologous structures** have same evolutionary origin, but different structure and function.

- **Analogous structures** have similar structure and function, but different evolutionary origin.

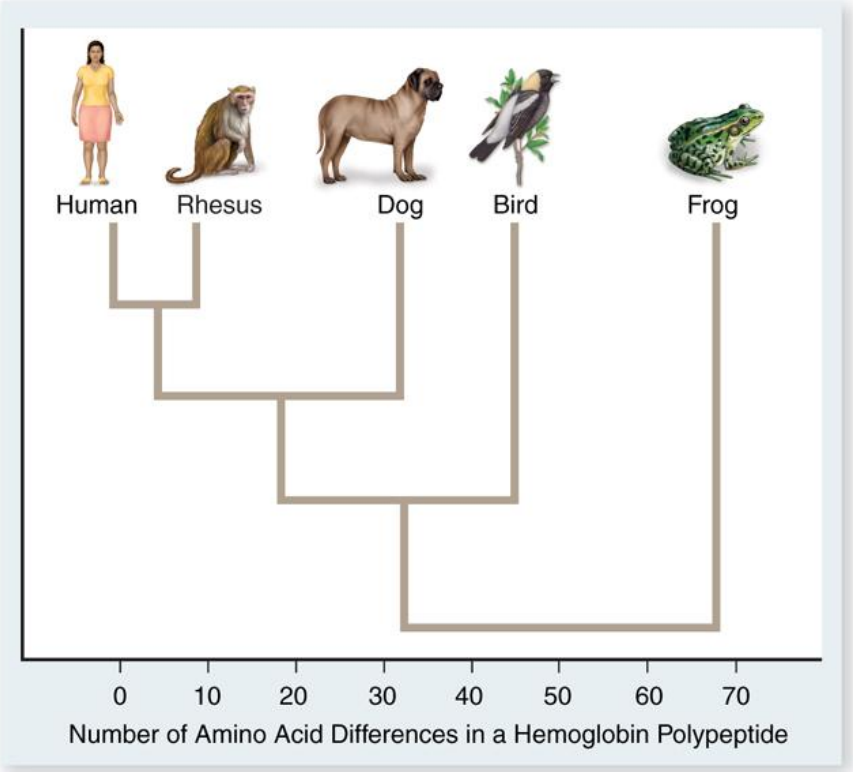
Homologous Structures



Post-Darwin Evolution Evidence

Molecular Evidence

- Our increased understanding of DNA and protein structures has led to the development of more accurate **phylogenetic trees**.



Unifying Themes in Biology

Cell theory

- All living organisms are made of cells, and all living cells come from preexisting cells.

Molecular basis of inheritance

- DNA encodes genes which control living organisms and are passed from one generation to the next.

Unifying Themes in Biology

Structure and Function

-The proper function of a molecule is dependent on its structure.

-The structure of a molecule can often tell us about its function.

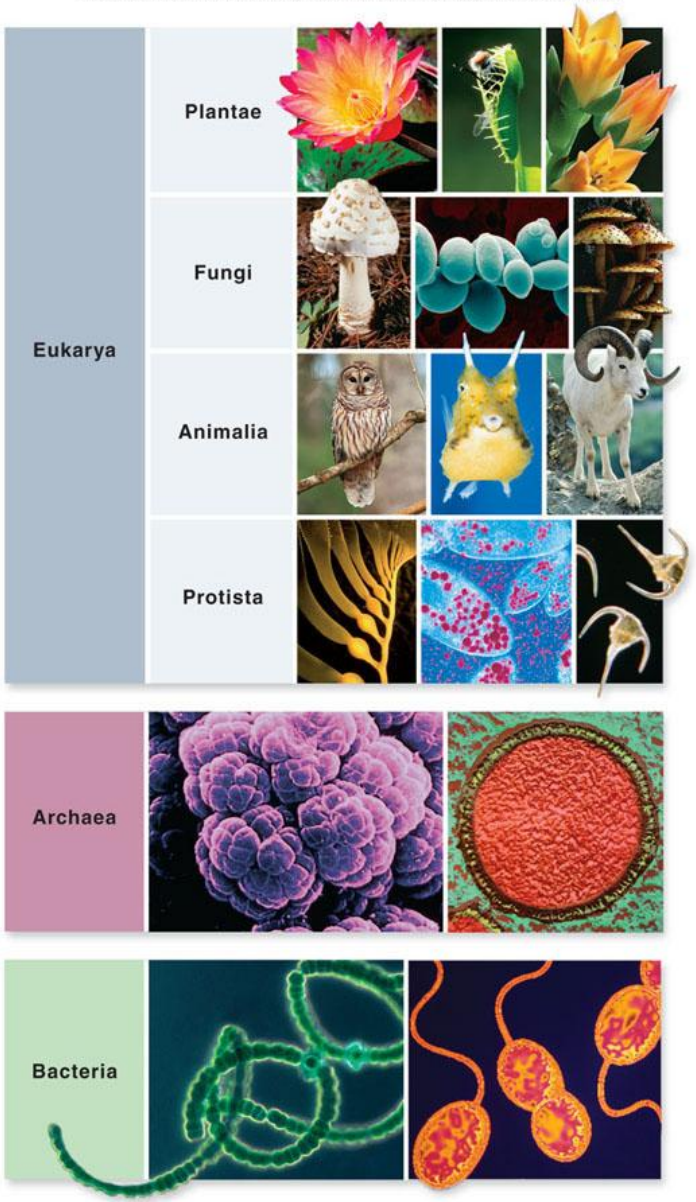
Unifying Themes in Biology

Evolutionary change

- Living organisms have evolved from the same origin event. The diversity of life is the result of evolutionary change.

Evolutionary conservation

- Critical characteristics of early organisms are preserved and passed on to future generations.



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Unifying Themes in Biology

Cells - information processing systems

- Cells process information stored in DNA as well as information received from the environment.

Emergent properties

- New properties are present at one level of organization that are not seen in the previous level.