Essentials of Biology

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Chapter 1
Lecture Outline

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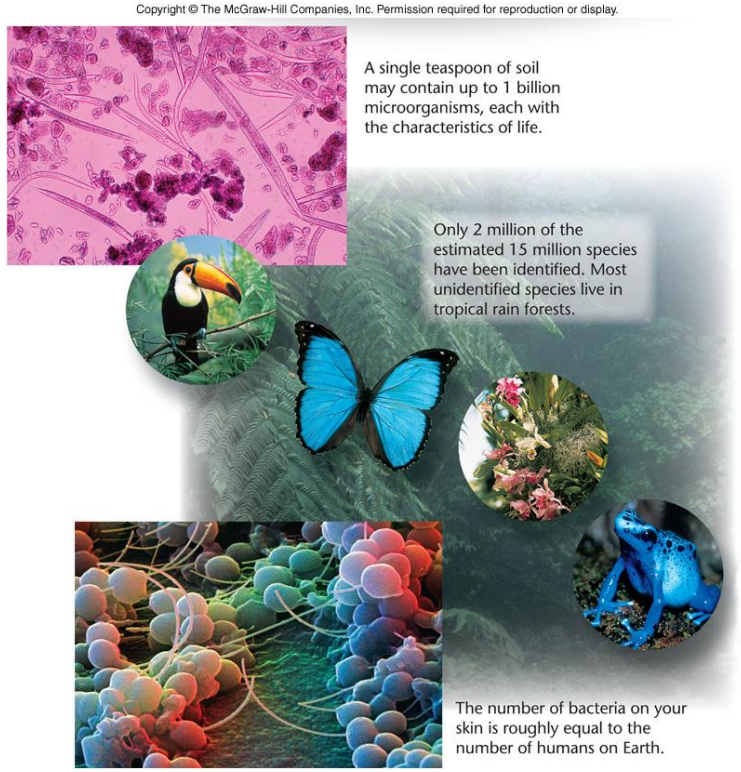


1.1 The Unity and Diversity of Life

- The living organisms on our planet show tremendous diversity in form and function.
- Despite this diversity, all organisms share certain characteristics that distinguish them from non-living things.
- The similarity in these characteristics provides evidence that all organisms descended, or evolved, from a common ancestor.

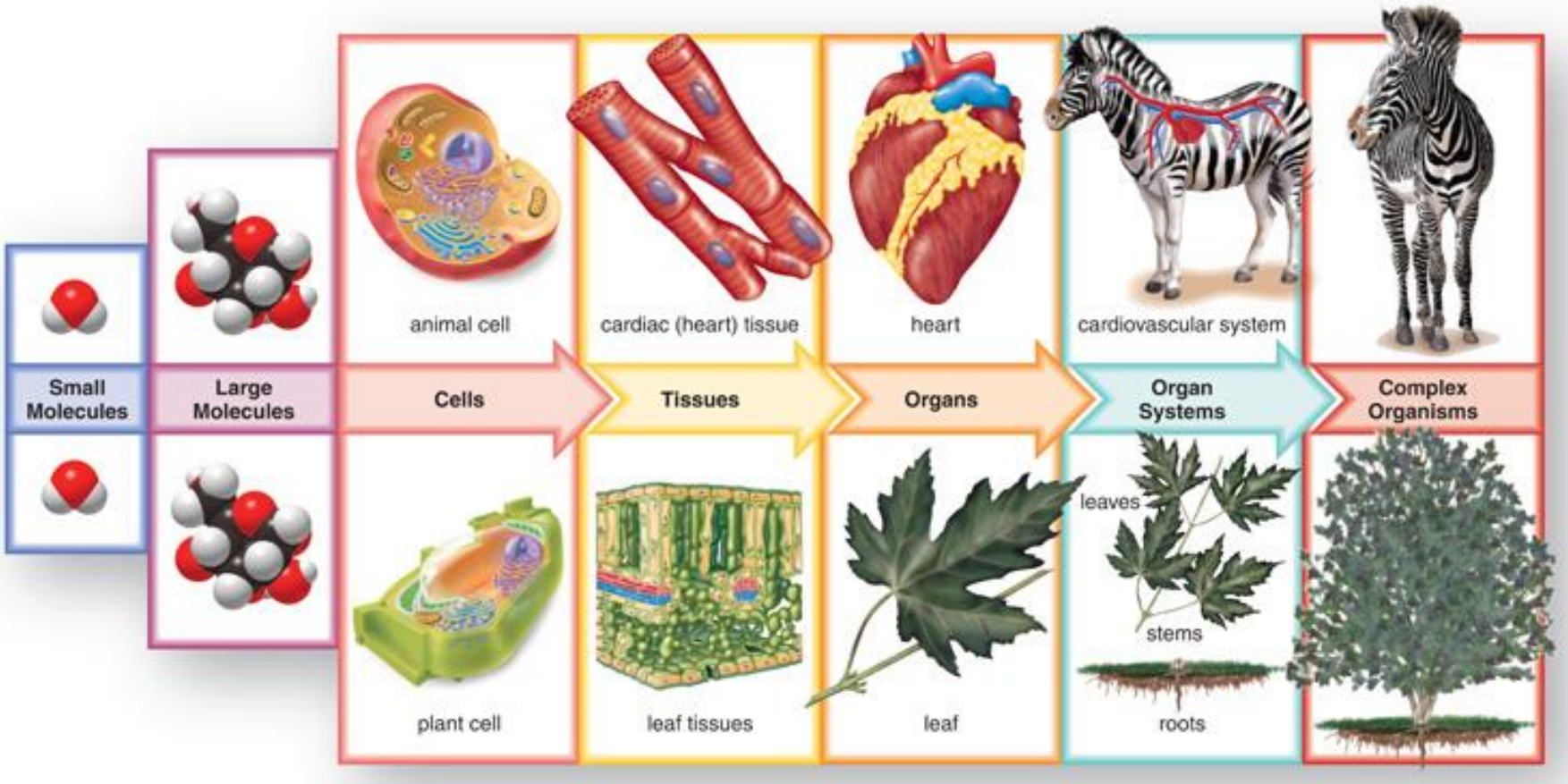
1.1 - Defining Life

- Living things vs. nonliving objects:
  - Comprised of the same chemical elements
  - Obey the same physical and chemical laws
- The cell is the smallest, most basic unit of all life
  - Familiar organisms are multicellular
  - Some cells independent – single-celled organisms

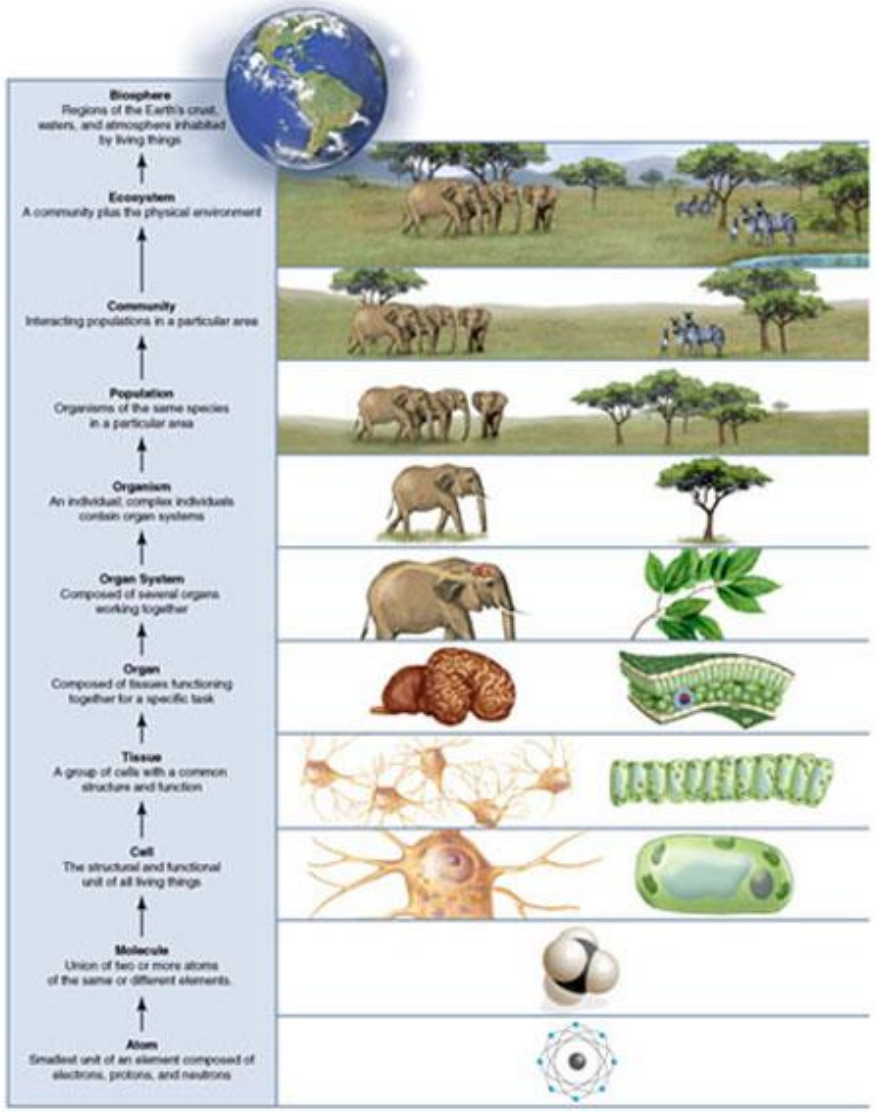
Living things are organized into levels of biological organization

- The **cell** is the most basic unit of life.
- Similar cells together form **tissues**.
- Different tissues together form **organs**.
- Organs work together in **organ systems**.
- Organ systems form complex organisms.
- Complex organisms together form higher levels of organization.

Levels of biological organization



1-Living things are Organized



- Organization of living systems begins with atoms, which make up basic building blocks called elements.
- The cell is the basic structural and functional unit of all living things.
- Similar cells combine to make up tissues (e.g., myocardial tissue).
- Tissues combine to make up an organ (e.g., the heart).
- Specific organs work together as a system (e.g., the heart, arteries, veins, etc.).

Levels of Biological Organization

- Some living organisms are made of one cell only , they are called unicellular organisms.
- Most of organisms are made of many cells and are called multicellular organisms.

2-Living things acquire materials and energy

- The chemical reactions that occur in cells are a part of **metabolism**. Some reactions extract nutrients, building materials and energy from food.
  - **Photosynthesis** involves chemical reactions that use solar energy to form chemical energy.

- For metabolism to continue in cells, all chemical reactions must be kept in a balance called **homeostasis**.

Living things acquire materials and energy (cont.)

a.

b.

3-Living things respond,

- Organisms interact with the environment and other living things. Then they respond to their environment, often with movement.

- Appropriate responses ensure organisms survival and allow it to carry on it is daily activities.

4- Living things reproduce, and develop

- Every type of living organism can **reproduce** (produce another organism like itself).

-Unicellular organisms reproduce by cell division.

-Multicellular organisms use sexual reproduction.

Living things respond, reproduce, and develop (cont.)

DNA

5-Living things have adaptations

- Adaptations are modifications that make a particular type of organism (i.e., a species) suited to its way of life.

- Species become modified over time by natural selection, which preserves genetic changes that make them better suited for their environment.

- Evolution is descent with modification, driven by the process of natural selection.

- Organisms, become modified by natural selection over time
- a. A species is a group of interbreeding individuals.
- b. In natural selection, members of a species may inherit a genetic change that makes them better suited to a particular environment.
- c. These members would be more likely to produce higher numbers of surviving offspring

- However, organisms are very similar at basic level

1.2 How the Biosphere is Organized

- The biosphere includes the land, sea, and air and all organisms on Earth.
  - Individuals of the same species belong to a population.
  - The populations of species in a given area are the community.
  - The interaction of communities with the environment forms an ecosystem.

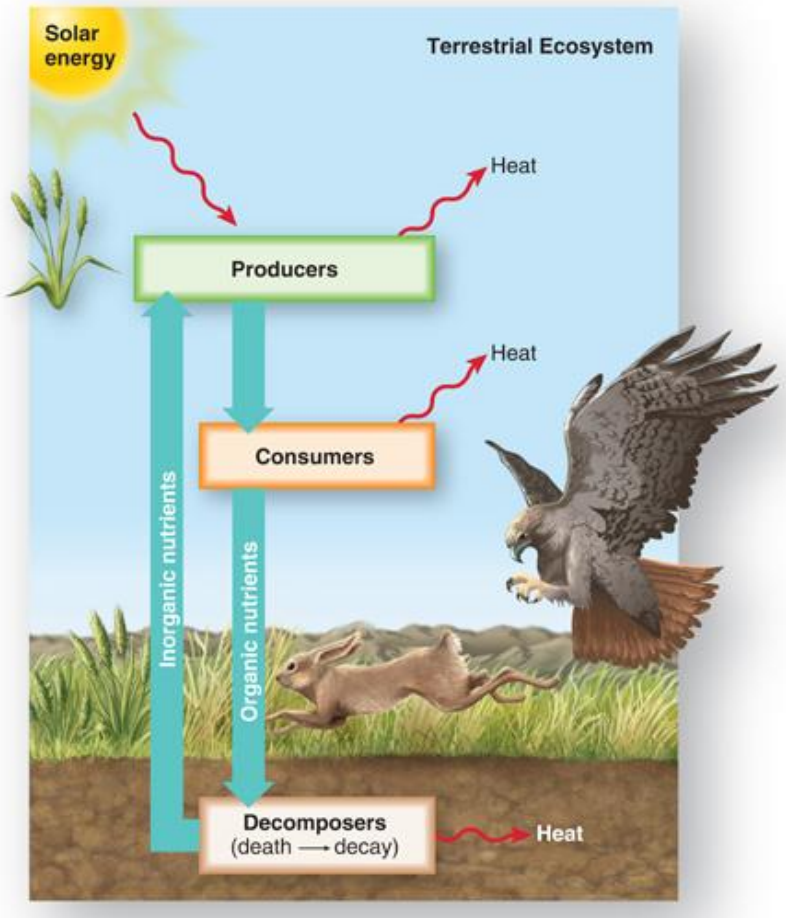
Terrestrial

Interactions between various food chains make up a food web.

Ecosystems are characterized by chemical cycling and energy flow.

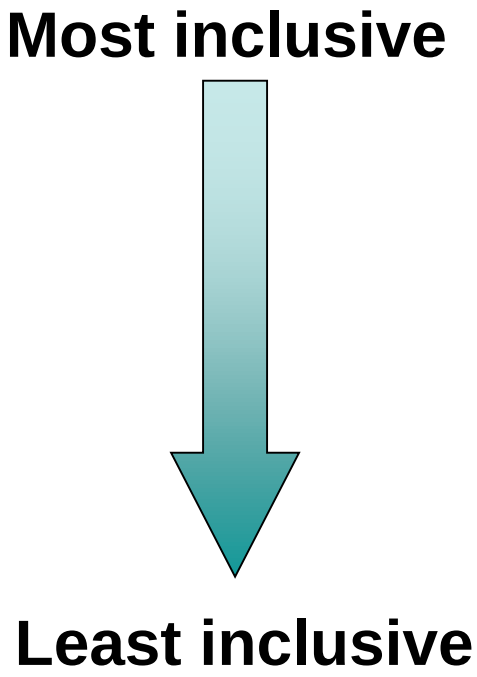
Ecosystems stay in existence because of a constant input of solar energy and the ability of photosynthetic organisms to absorb it.

1.2 How the Biosphere is Organized (cont.)



1.3 How Organisms Are Classified

- Because living things are diverse, taxonomy was created to group organisms into categories and to understand their evolutionary relationships.
  - Domain
  - Kingdom
  - Phylum
  - Class
  - Order
  - Family
  - Genus
  - Species



There are three domains of living organisms

- The Domains Archaea and Bacteria are both comprised of prokaryotic bacteria.
  - Archaea bacteria live in extreme environments.
    - Anoxic (no oxygen)
    - High salinity
    - High temperature

×20,000

×64,000

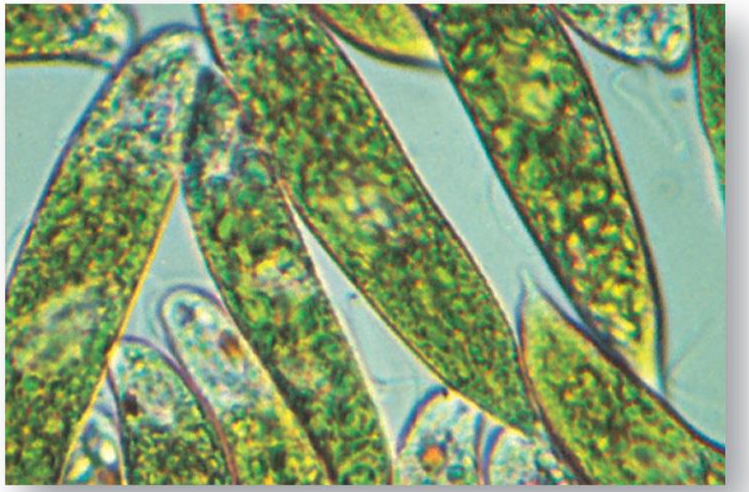
The Domains Archaea and Bacteria

There are three domains of living organisms (cont.)

- Domain Eukarya consists of all non-bacterial organisms.

- Eukarya is divided into four kingdoms.
  - Protista
  - Fungi
  - Plantae
  - Animalia

The four kingdoms of Eukarya



The naming of living organisms has revealed the biodiversity of the Earth

- Biodiversity is the sum total of all organisms and their genetic information.
  - 15 million organisms are believed to exist on the Earth
  - > 400 species per day are lost to extinction

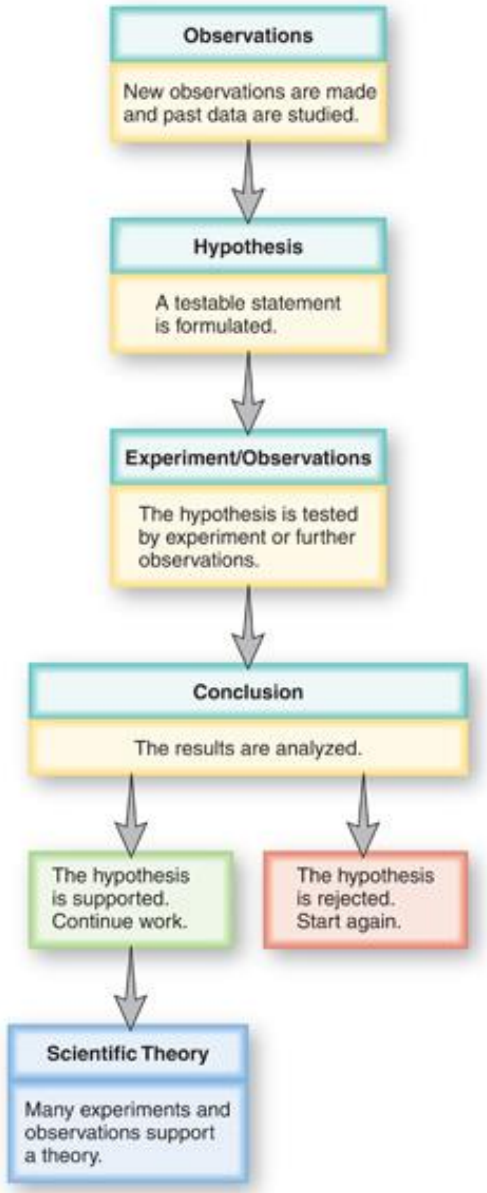
- Conservation biology includes efforts to protect biodiversity and ecosystems.

Biology: the study of life

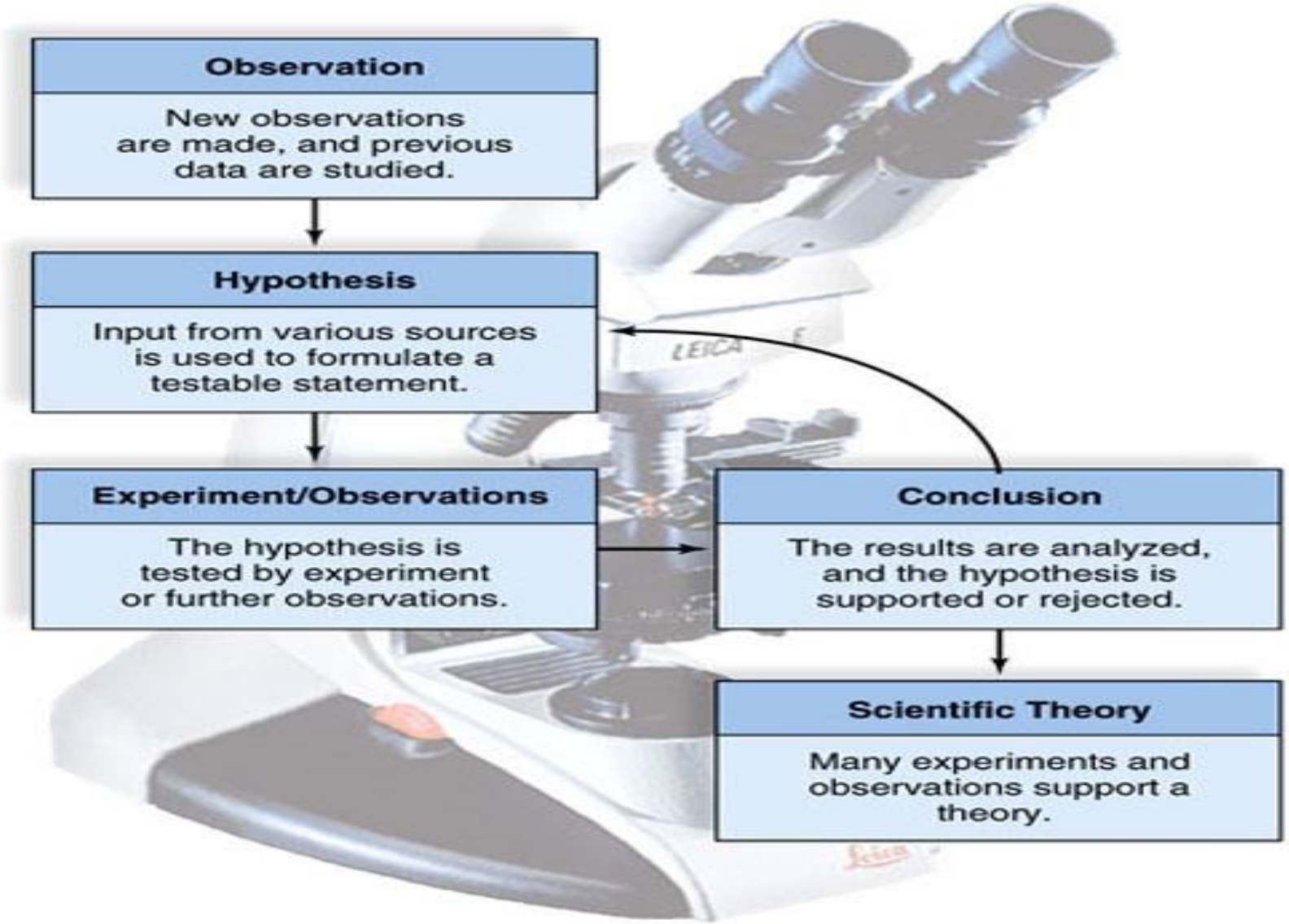
- Biology is the scientific study of life.

- Biology, like other sciences, studies life using the scientific method.
  - Make an observation
  - Form a hypothesis via inductive reasoning
  - Conduct an experiment, collect data, make further observations
  - Reach a conclusion
  - Formulate a theory

The scientific method



Method:
A Flow Diagram



Experiments performed in science have specific elements

- The experimental design is the well-conceived plan for a specific experiment.

- Experiments typically have two groups.
  - Experimental group: the group manipulated during the experiment
  - Control group: the reference group, left unmanipulated

- Experiments collect data.

An example of a controlled study

- Hypothesis: Pea plants grown in soil before winter and turned into the soil would provide a natural fertilizer for winter wheat.

- Control group: winter wheat planted with no treatment

- Experimental groups:
  - Wheat plants in soil with fertilizer (45 kg ha^{-1})
  - Wheat plants in soil with double fertilizer (90 kg ha^{-1})
  - Wheat plants in soil containing pea plants that were turned into the soil

An example of a controlled study (cont.)

a.

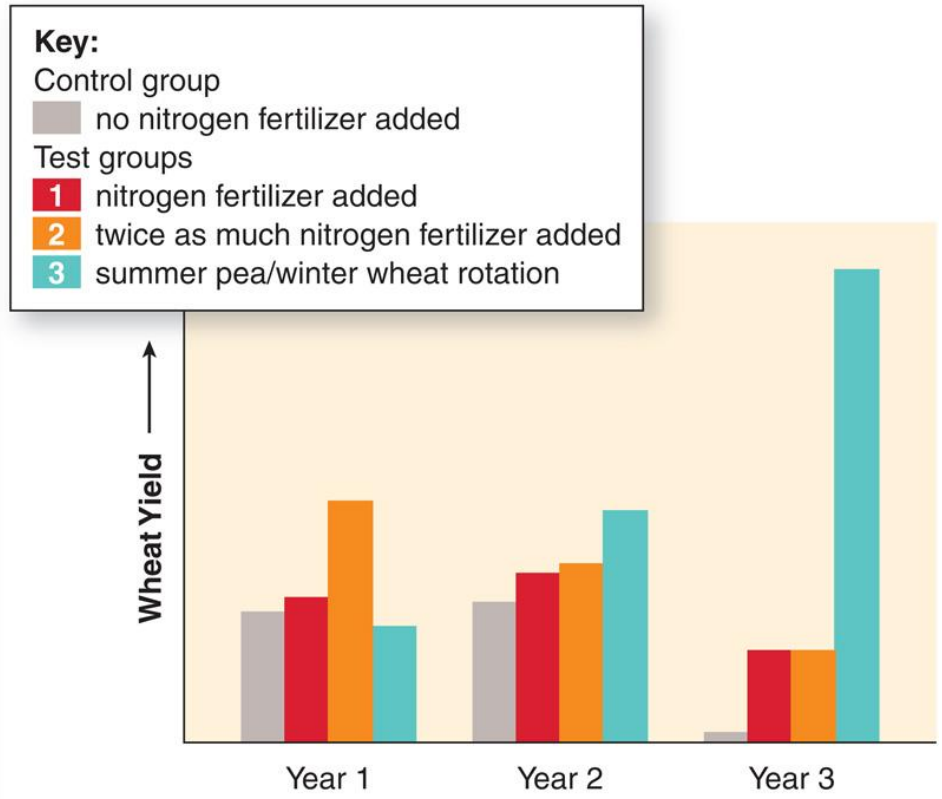
b.

An example of a controlled study (cont.)

- Conditions: all groups watered and exposed to same conditions
- Data collected: weight of wheat plants in the spring
- Conclusion: hypothesis not supported.

An example of a controlled study (cont.)

c.



d.

Science and society

- The application of science for a practical purpose is called technology.
- Science is impartial and does not make ethical or moral judgments.
- The role of society is to use scientific information to make informed decisions about the use of technology.