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Human Biology, Science, and Society

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The Characteristics of Life

- Living things
  - Have a different molecular structure than nonliving things
  - Require energy and raw materials
  - Are composed of cells
  - Maintain homeostasis
  - Respond to their external environment
  - Grow and reproduce
  - Populations of living things evolve
Childhood Vaccinations

- Childhood vaccination programs have been effective in all but eliminating certain communicable diseases.
- All 50 states have childhood vaccination programs as a requirement for school attendance—all states also allow for certain exemptions.
- Exemptions from vaccinations are on the rise. Many parents object to mandatory vaccination programs out of concern that the vaccines may cause autism or certain other chronic childhood diseases.
- The available scientific evidence does not support the argument that vaccinations can cause childhood diseases, including autism.
Studying unusual species such as this deep sea glass squid allows biologists to understand the processes by which a species successfully survives. Many different environments exist in the world, but the same physical and chemical laws govern them all.

The natural world comprises all matter and energy. An erupting volcano spewing liquid rock and heat is the result of energy that still remains from the creation of Earth nearly 4.6 billion years ago.

Jane Goodall has dedicated her life to studying the needs and behaviors of chimpanzees. The DNA of humans and chimps is almost the same, yet important physical and behavioral differences are obvious. Evolution examines how these differences arose.
Living Things Are Grouped According to Characteristics

- Three domains
  - Domain Bacteria
  - Domain Archaea
  - Domain Eukarya: includes four kingdoms
    - Kingdom Prostista
    - Kingdom Animalia
    - Kingdom Fungi
    - Kingdom Plantae
Earliest Organisms

BACTERIA
(Bacteria; Single cells, no nucleus)

ARCHAEA
(Bacteria; primitive single cells, no nucleus, live in extreme conditions)

EUKARYA
Protista (Protozoans and algae)
Animalia (Animals)
Fungi (Fungi)
Plantae (Plants)

Kingdoms

DOMAINS
Fundamental Criteria Used for Classification

- Presence or absence of a nucleus
  - Domain Bacteria and Domain Archaea lack a membrane-bound nucleus
  - Domain Eukarya have a membrane-bound nucleus
- Number of cells
  - Unicellular
  - Multicellular
- Type of metabolism
Domain Eukarya

- **Protista**: unicellular and simple multicellular, eukaryotic (protozoa, algae, slime molds)
- **Plantae**: multicellular, eukaryotic, photosynthetic
- **Animalia**: multicellular, eukaryotic, heterotrophic
- **Fungi**: (molds, yeasts, mushrooms) eukaryotic, decomposers
Classification of Humans \( (\textit{Homo sapiens}) \)

- Classification of humans:
  - Domain: \textit{Eukarya}
  - Kingdom: \textit{Animalia}
  - Phylum: \textit{Chordata}
  - Class: \textit{Mammalia}
  - Order: \textit{Primates}
  - Family: \textit{Hominidae}
  - Genus: \textit{Homo}
  - Species: \textit{sapiens}
Living Things Are Grouped According to Characteristics

- Smallest unit of classification system is *species*
  - One or more populations of organisms
    - Similar physical and functional characteristics
    - Can interbreed and produce fertile offspring
- Second smallest unit is genus
- All living human beings belong to the same *genus* and *species*
  - *Homo sapiens*
Defining Features of Humans

- **Bipedalism**: able to stand upright and walk on two legs
- **Opposable thumbs**: able to grasp objects between thumb and tips of fingers
- **Large brain**: relative to body size
- **Capacity for language**: both spoken and written
Figure 1.5

Human

Chimpanzee
Human Biology Can Be Studied On Any Level of Biological Organization

- Atom and molecule
- Cell
- Tissue
- Organ
- Organ system
- Organism
- Population
- Community
- Ecosystem
- Biosphere
Science Is Both a Body of Knowledge and a Process

- Science is the study of the natural world
- Science is two things
  1. Knowledge about the natural world
  2. The process used to acquire knowledge
     - Called the scientific method
The Scientific Method Is a Process for Testing Ideas

- Steps in the scientific method
  1. Observe and generalize
  2. Formulate a hypothesis
  3. Make a testable prediction
  4. Experiment or observe
  5. Modify the hypothesis as necessary and repeat
Figure 1.8

1. Observe and generalize
2. Formulate a hypothesis
3. Make a testable prediction
4. Experiment or observe
5. Modify hypothesis as necessary and repeat steps 3 and 4

Direction of increasing confidence in hypothesis

Inductive reasoning
Deductive reasoning
The Scientific Method Is a Process for Testing Ideas

- Observe and generalize
  - *Inductive reasoning*: make generalizations based on observations about the world
  - *Example*:
    - Observation: “Every winter in the past was colder than the preceding summer.”
    - Generalization: “Winter will always be colder than summer.”
The Scientific Method Is a Process for Testing Ideas

- Formulate a hypothesis
  - A hypothesis is a tentative statement about the natural world
The Scientific Method Is a Process for Testing Ideas

- Make a testable prediction
  - Hypotheses should be tested under many different conditions
  - Testable predictions
    - Should be based on the hypothesis
    - Should employ deductive reasoning
    - Are often in the form of “if…then” statements
    - Should be specific in order to be testable
The Scientific Method Is a Process for Testing Ideas

- Experiment and observe
  - Truth or falsehood of prediction is tested by observation and experimentation
  - *Experiment*: a carefully planned and executed manipulation of the natural world.
    - In *controlled experiments*, all but one variable are accounted for
Select a large number of appropriate subjects.

Randomly divide the subjects into two groups.

Treat the groups equally in all ways but one.

Observe or make measurements.

Are blood pressures lower in the experimental group?

Compare results.

Group 1
- Experimental group: receives treatment

Group 2
- Control group: receives placebo

Hypothesis received support.

Modify hypothesis to fit the new findings.
The Scientific Method Is a Process for Testing Ideas

- Modify the hypothesis as necessary and repeat Steps three and four
  - If prediction is false, the hypothesis must be modified.
  - If the prediction is true, only one small part of the hypothesis has been tested. Further testing required.
  - *Hypotheses cannot be proved true, only supported or disproved.*
Making Findings Known

- Findings can be disseminated in
  - Peer-reviewed journals
    - Experts must approve articles before publication
    - Results are assumed to be valid only for conditions under which experiment was done
  - Popular press
  - Electronic publications
    - Internet is less regulated than print and broadcast media
Hypothesis Becomes a Theory

- For a hypothesis to become a theory it must:
  - be broad
  - be extensively tested
  - be supported over time
  - explain a broad range of facts
  - have a high degree of reliability

- Theories may be refuted in the future
Learning to Be a Critical Thinker

- Become a skeptic
- Appreciate the value of statistics
- Learn to read graphs
- Distinguish anecdotes from scientific evidence
- Separate facts from conclusions
- Understand the differences between correlation and causation
The Role of Science in Society

- Science improves technology and the human condition
- Science has limits
- Science helps us to make informed choices