Concepts & Methods in Biology

Chapter 1

Biology

Scientific study of life

Lays the foundation
for asking basic questions about life
and the natural world

Why Study Biology?

- To learn about organisms
- Understand life

What Is Life?

- Energy and raw materials
- Environment
- Grow, reproduce, and develop (DNA)
- Composed of cells
- Can evolve

Molecules of Life

- Atoms and molecules
  - nucleic acids, proteins, carbohydrates, lipids

Life is Organized (Hierarchical)

- Atoms
- Molecules
- Organelles
- Cells
- Tissues
- Organ
- Organ System
- Mulitcelled organism
- Population
- Community
- Ecosystem
- Biosphere

Unity of Life

All organisms:

- Are composed of the same substances
- Engage in metabolism
- Sense and respond to the environment
- Have the capacity to reproduce based on instructions in DNA

Diversity of Life

- Millions of living species
- Additional millions of species now extinct
- Classification scheme attempts to organize this diversity

Scientific Method

1. Observe phenomenon
2. Develop hypotheses
3. Make predictions
4. Devise test of predictions
5. Carry out test and analyze results
6. Make conculsions
7. Support or reject hypothesis
8. Conduct more tests
9. Theory

Role of Experiments

- Procedures used to study a phenomenon under known conditions
- Allows you to predict what will happen if a hypothesis is not wrong
- Can never prove a hypothesis 100% correct

Experimental Design

- Control group
  - A standard for comparison
  - Identical to experimental group except for variable being studied
- Sampling error
  - Non-representative sample skews results
  - Minimize by using large samples

Scientific Theory

- A general set of principles, supported by evidence, that explains some aspect of nature.

Example of the Scientific Method

- Spontaneous generation
- Louis Pasteur
- Life came from life
- Airborne microscopic organisms

Observation

- Start with a sterile flask.
- Put sterile broth inside.
- New living material will appear in broth.

Question

What is the source of the living material?

Develop hypotheses

- Hypothesis 1: the living material is derived from nonliving material

- Hypothesis 2: the living material is derived from living material outside of the flask that got in.

Predictions

- Hypothesis 1 (spontaneous generation): if particles from outside cannot get inside flask, living material will develop inside flask.

- Hypothesis 2: if flask is exposed to particles outside, living material will develop inside the flask.

Experiment 1

- Bend neck of sterile flask into an “s” shape.
- The bend becomes a particle trap.
- Result: No growth occurs inside flask.

Experiment 2

- Tip flask to mix trapped dust into broth.
- Result: growth occurs inside flask.

- Remove trap.
- Result: growth occurs inside flask.

Conclusion

- No growth appears in the broth unless dust is admitted from outside.
- Reject “spontaneous generation” hypothesis.

Limits of Science

- Scientific approach cannot provide answers to subjective questions
- Cannot provide moral, aesthetic, or philosophical standards

Asking Questions

- Scientists still ask questions that challenge widely held beliefs

- The external world, not internal conviction, is the testing ground for scientific beliefs