

1 INTRODUCTION

CHAPTER 1 A VIEW OF LIFE

Chapter Outline

1.1 How to Define Life

A. Living Things Are Organized

1. Organization of living systems begins with the **cell**; cells are made of **molecules** that contain **atoms**.
2. Cells combine to form a **tissue** (e.g., nervous tissue).
3. Different tissues combine to make up **organs** (e.g., the brain).
4. Organs work together as **organ systems** (e.g., the brain, spinal cord, etc.)
5. Multicellular organisms may have many **organ systems**.
6. A species in a particular area (e.g., gray squirrels, an oak forest) constitutes a **population**.
7. The populations inhabiting an area at the same time make up a **community**.
8. A community plus its physical environment constitutes an **ecosystem**.
9. Each level of organization has **emergent properties**; however, all new properties follow the laws of physics and chemistry.

B. Living Things Acquire Materials and Energy

1. Maintaining organization and carrying on life requires an outside source of energy.
2. Food provides nutrient molecules used as building blocks or for energy.
3. **Energy** is capacity to do work; it takes work to maintain organization of the cell and organism.
4. **Metabolism** is all chemical reactions that occur in a cell.
5. Ultimate source of energy for nearly all life on earth is the **sun** through **photosynthesis**.
6. Organisms must **remain homeostatic** or keep themselves stable in temperature, moisture level, acidity, etc. by physiology and behavior.

C. Living Things Respond

1. Living things interact with the environment in order to find nutrients or energy.
2. Response often results in movements of plant or animal.
3. Ability to respond helps organism survive.
4. Responses to environment altogether constitute the **behavior** of an organism.

D. Living Things Reproduce and Develop

1. **Reproduction** is the ability of an organism to make another organism like itself.
2. Bacteria, protozoans, and other unicellular organisms simply split into two.
3. Multicellular organisms often unite sperm and egg, resulting in an immature individual which develops to become the adult.
4. Organisms develop as result of blueprint of instructions encoded in their genes.
5. Genes are made of long molecules of DNA that specify how the organism is organized.

E. Living Things Have Adaptations

1. **Adaptations** are modifications that make an organism suited to its way of life.
2. **Natural selection** is process by which species become modified over time.
 - a. A **species** is a group of interbreeding individuals.
 - b. In natural selection, members may inherit a genetic change that makes them better suited to a particular environment.
 - c. Consequently, these members are more likely to produce more surviving offspring.
3. Evolution is **descent with modification**.
 - a. The fact that all life forms have DNA suggests all life has a common ancestor.
 - b. Adaptations to different conditions gives rise to different species.

1.2 How the Biosphere is Organized

A. Levels of Complexity

1. The **biosphere** is the zone of air, land, and water where life is found.
2. A **population** consists of all members of one species in a particular area.
3. A **community** consists of all of the local interacting populations.
4. An **ecosystem** includes all aspects of a living community and the physical environment, including soils, atmosphere, etc.
5. Ecosystems are characterized by chemical cycling and energy flow.
6. Climate is the major determining factor of where ecosystems occur.
7. Coral reefs are rich ecosystems using the solar energy that penetrates offshore shallows.

B. The Human Population

1. Humans modify ecosystems for our own purposes.
2. Some human activity threatens tropical rain forests and coral reefs.
3. Human beings depend on healthy working ecosystems for food, medicines, and raw materials.

C. Biodiversity

1. Biodiversity consists of the total number of species, their variable genes, and their ecosystems.
2. Extinction is the death of a species or larger group; perhaps 400 species go extinct each day.
3. Preserving our biosphere helps ensure the survival of our species.

1.3 How Living Things Are Classified

A. Taxonomy: the Discipline of Identifying and Classifying Organisms

1. Organisms are classified according to their evolutionary relationships.
2. As more is learned about organisms, the taxonomy changes.

B. Categories of Classification

1. From larger categories to smaller: kingdom, phylum, class, order, family, genus and species.
2. In the Kingdoms Plantae and Fungi, the category “phylum” is replaced by “division.”

C. Domains

1. Biochemical evidence breaks life into three domains: Bacteria, Archaea, and Eukarya.
2. Eukarya have a membrane-bounded nucleus.
3. The prokaryotes are structurally simple but have complex metabolisms.
4. Archaea vary from regular bacteria; all Archaea live in water, cannot tolerate oxygen, and have ability to survive harsh temperatures, salts, and acids similar to what was found on the primitive earth.

D. Kingdoms

1. The Archaea and Bacteria are not yet characterized into kingdoms.
2. Eukarya contains four kingdoms: Protista, Fungi, Plantae, and Animalia.

E. Scientific Name

1. A binomial is a two-part scientific name: the genus and the specific epithet.
2. Scientific names are in Latin.
3. Common names are imprecise but scientific names are well defined and avoid confusion.

1.4 The Process of Science

A. Scientific Method

1. Biology is the scientific study of life.
2. The general process of science is said to be characterized by this sequence of stages.

B. Observation

1. Scientists believe nature is orderly and measurable.
2. Science also considers that natural laws do not change with time.
3. Phenomena can therefore be understood from observations.
4. Actual science research may also involve chance (e.g., Alexander Fleming's discovery of penicillin).

C. Hypothesis

1. **Inductive reasoning** allows a person to combine isolated facts into a cohesive whole.
2. A **hypothesis** is a possible explanation for a natural event.
3. Scientists only consider hypotheses that can be tested.

D. Experiments/Further Observations

1. Testing a hypothesis involves either further observations or conducting an experiment.
2. Deductive reasoning involves "if, then" logic that predicts what will happen based on the hypothesis.
3. An experimental design is proposed that tests the hypothesis in a meaningful way.
4. Scientists may use a model; however the validity of the model always depends on whether it works in the real world.
5. If a model cannot be tested, it always will remain a hypothesis.

E. Data

1. **Data** are the results of experiments, and are observable and objective.
2. Data are often displayed in a graph or table.
3. Often the data must be inspected for the probability the data could show a relationship by chance; this is a measure of "significance."

F. Conclusion

1. Whether the data support or reject the hypothesis is the basis for the "conclusion."
2. The conclusion of one experiment can lead to the hypothesis for another experiment.
3. Science findings are reported in scientific journals so results are available to the research community.
4. The experiments and observations must be repeatable or the research is suspect.

G. Scientific Theory

1. The ultimate goal is to understand the natural world in scientific theories, conceptual schemes supported by a broad range of data.
2. Basic theories of biology are:
 - a. Cell theory: all organisms are made of cells.
 - b. Biogenesis theory: life only comes from life.
 - c. Evolution theory: living things have a common ancestor and are adapted.
 - d. Gene theory: Organisms contain coded information that determines their form, function, and behavior.
3. The terms "principle" and "law" are also used for generally accepted theories.

H. A Controlled Study

1. Some investigations are managed where conditions can be kept constant, as in the case of the nitrogen fertilizer and pea plant experiment).
 - a. A **variable** is a factor that can cause an observable change.
 - b. The **experimental variable** is the step that is deliberately manipulated (nitrogen fertilizer).
 - c. A **dependent variable** is component of an experiment that changes due to the experimental variable (yield).
2. Study I
 - a. The hypothesis that pigeon peas will increase winter wheat production, compared to nitrogen fertilizer, is tested in clay pots using both treatments and a control group without treatment.
 - b. Although both treatments exceed the control in wheat growth, the fertilizer-only treatment exceed the use of pigeon peas.
3. Study II
 - a. To test the hypothesis that pigeon pea residues will build up over time and will increase winter wheat production, compared to nitrogen fertilizer, the test is continued.
 - b. The fertilizer-only treatment no longer exceeded biomass production with the use of pigeon peas.
 - c. All results and conclusions were then reported in a science journal.

I. A Field Study

1. Observations led the researcher to the hypothesis that male bluebirds vary their aggressiveness toward other males depending on the time during the cycle of breeding.
2. To test the hypothesis, a male bluebird model was placed by the nest while the male was gone and observations were made upon his return.
3. A control consisted of a model of a robin placed in the same position for some nests.
4. Resident male bluebirds did not bother the control model but were aggressive toward the male bluebird model depending on the stage in nesting.
5. The conclusions confirmed the researchers hypothesis and were published in a science journal.