Principles of Life

Chapter Outline

1.1 – Living Organisms Share Common Aspects of Structure, Function, and Energy Flow
1.2 – Life Depends on Organization and Energy
1.3 – Genetic Systems Control the Flow, Exchange, Storage, and Use of Information
1.4 – Evolution Explains the Diversity as Well as the Unity of Life
1.5 – Science Is Based on Quantitative Observations, Experiments, and Reasoning

Living organisms share many structures and functions as the result of having evolved from a common ancestor. This chapter provides you with collective ideas of how life, genetics, and evolution operate.

You will begin to see how scientists make observations and design experiments. This chapter will help you succeed with the activities and curiosity-driven efforts that make up the laboratory portion of your course. You will soon be thinking like a scientist and understanding better how science knowledge grows from experiments. At the end of this and every subsequent chapter review, **Science Practices & Inquiry** will support you in developing and refining your own testable predictions of natural phenomena and explaining the results of experiments.

Chapter 1 ties principally with the AP Biology Curriculum Framework's **Big Idea 1:** The process of evolution drives the diversity and unity of life.

The specific parts of the AP Biology curriculum that are covered in Chapter 1 include:

- **1.A.1:** Natural selection is a major mechanism of evolution.
- **1.B.1:** Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.
- **1.B.2:** Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.
- **1.D.1:** There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.
- **1.D.2:** Scientific evidence from many different disciplines supports models of the origin of life.

Chapter Review

Concept 1.1 *is an overview of living organisms and how they are connected by their shared traits.*

1. Organisms share many conserved biological, chemical, and structural characteristics. Briefly outline the distinctive characteristics of life shared by all living organisms.

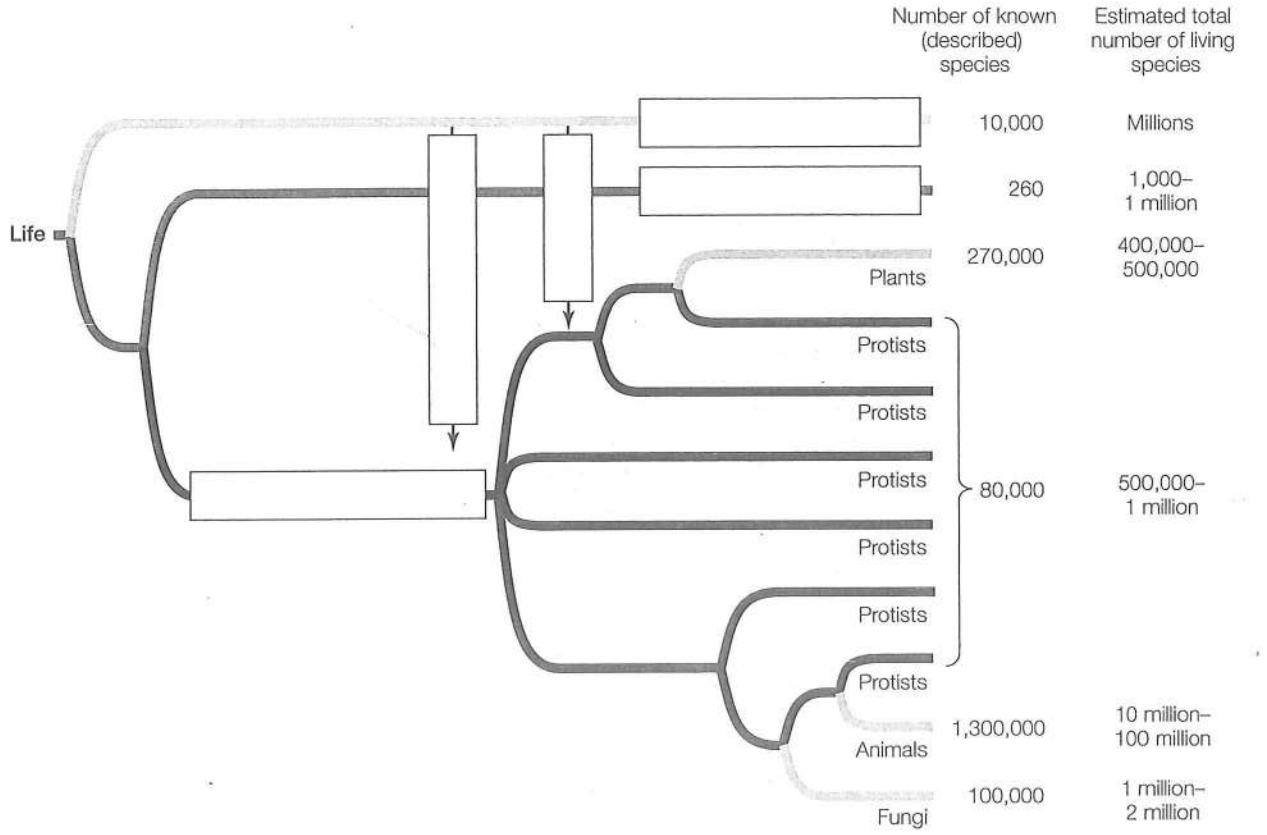
a. _____
b. _____
c. _____
d. _____
e. _____
f. _____
g. _____
h. _____

2. How do the shared characteristics on your list (in Question 1) provide evidence for evolution?

3. There are several competing hypotheses about the evolution of early life on Earth, but as life evolved, all cells clearly had requirements for raw materials and energy transfers. Briefly explain how the earliest living cells obtained raw materials and accomplished energy transfers.

4. Briefly describe and discuss how living organisms have altered the oxygen concentration in the atmosphere over the past three billion years.

5. Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested. In the figure below, the two vertical fill-in boxes represent endosymbiotic events; label one vertical box "mitochondria" and the other "chloroplasts." In each of the three horizontal boxes, write the name of the domain for that group of organisms.



Concept 1.2 *shows how life depends on organization and energy.*

6. Consider these two organizational hierarchies:

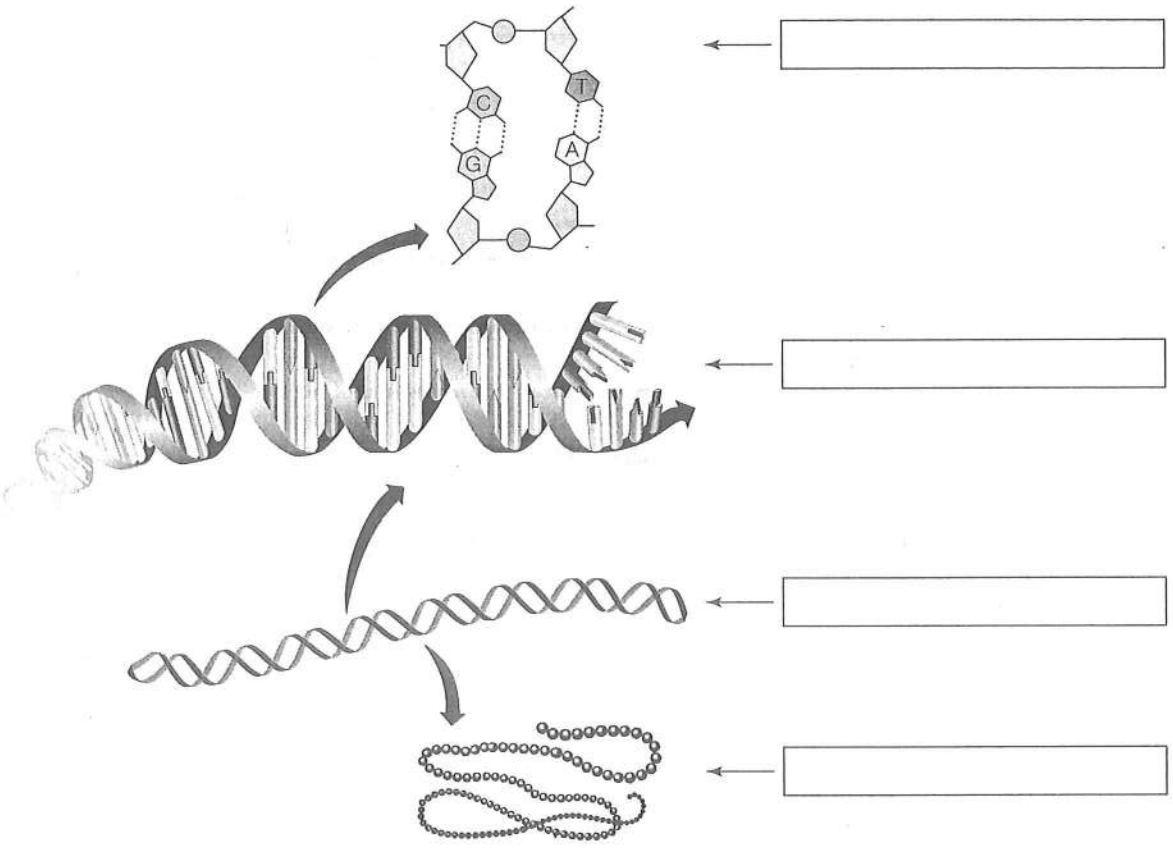
atoms → organisms populations → ecosystems

Describe one difference between the first hierarchy and the second. Then describe one similarity between the first hierarchy and the second.

7. Dynamic regulation is required for maintaining homeostasis. Explain how a cellular mechanism that regulates the quantity of a biochemical product in a cell resembles the regulation of a heating and cooling system that keeps your room temperature comfortable.

Concept 1.3 *helps you understand genetic information and its transmission from one generation to the next.*

8. In the fill-in boxes beside the figure below, label DNA, nucleotide, gene, and protein.



9. Each cell in an individual mouse contains the same genes, but the mouse has many different types of cells: muscle cells, nerve cells, skin cells, etc. Briefly describe how two cells in an embryo can become two different types of cells in an adult, even though both cells have the same DNA and genes.

Concept 1.4 *describes how evolution is the central unifying theme of biology and provides a framework for organizing how we think about living systems.*

10. "Theory" is an important term in science. How do scientists define a theory?

_____

_____

_____

11. Explain how evolution is both a fact and a theory.

_____

_____

_____

_____

_____

Concept 1.5 *focuses on how science is based on experiments, with observation, data collection, and analysis. Scientists are guided in their work by the principles of experimental design as they work to uncover the underlying characteristics of life.*

12. Biologist Tyrone Hayes and his co-workers investigated the effects of the herbicide atrazine on sexual development in frogs. In their experiments, they exposed each group of tadpoles to a specific amount of atrazine. To gain greater confidence in their results, they repeated each experiment multiple times for each treatment. Their observations suggest that frogs exposed to atrazine early in life developed multiple, mixed gonads or became demasculinized as a result.

Below is an excerpt describing the design of this experiment from the original paper, which can be found at www.pnas.org/content/99/8/5476.full.pdf+html.

> In Exp[eriment] 1, we exposed larvae to atrazine at nominal concentrations of 0.01, 0.1, 1.0, 10.0, and 25 parts per billion (ppb).... Concentrations were confirmed by two independent laboratories (PTRL West, Richmond, CA, and the Iowa Hygienic Laboratory, Univ. of Iowa, Iowa City, IO). All stock solutions were made in ethanol (10 ml), mixed in 15-gallon containers, and dispensed into treatment tanks. Controls were treated with ethanol such that all tanks contained 0.004% ethanol. Water was changed and treatments were renewed once every 72 h. Each treatment was replicated 3 times with 30 animals per replicate (total of 90 animals per treatment) in both experiments. All treatments were systematically rotated around the shelf every 3 days to ensure that no one treatment or no one tank experienced position effects. Experiments were carried out at 22°C with animals under a 12-h–12-h light-dark cycle (lights on at 6 a.m.).

Identify the following elements in the atrazine experiment.

a. Independent variable: _____

b. Range of the independent variable: _____

c. Dependent variable: _____

d. Control: _____

e. Constant conditions: _____

f. Repeated trials: _____

Science Practices & Inquiry

In the AP Biology Curriculum Framework, there are seven **Science Practices**. In this chapter, we focus on **Science Practice 4:** The student can plan and implement data collection strategies to answer a particular scientific question. More specifically, we look at **Science Practices 4.1** and **4.2:** The student can justify the selection of the kind of data needed and design a plan for collecting data to answer a particular scientific question.

Question 13 asks you to design a controlled experiment using goldfish as a model organism. One of the most important activities for scientists is to be able to design and conduct controlled experiments. A key component of any biology class is the laboratory experience; students must be able to design and plan experiments using inquiry.

13. After looking at many types of fish food available at a local store, a friend asks you which would make his goldfish grow faster, flake fish food or shrimp pellets. Design a controlled experiment to test this question.

(*Hint:* You are not simply writing the procedures in an experiment. In paragraph form, discuss all of the elements, a. through f., in Question 12. Begin by identifying your independent and dependent variables and writing a hypothesis. Your experimental design should include many goldfish in separate containers.)