

# CHAPTER 1

## A VIEW OF LIFE

### 1.1 How to Define Life

Living things are called **organisms**. Organisms are often hard to define because they are so diverse; however, they share many common characteristics:

1. *Living things are organized.*
2. *Organisms obtain and use energy.*
3. *Organisms respond to the environment.*
4. *Organisms reproduce and develop.*
5. *Organisms adapt.*

### 1.2 Evolution, the Unifying Concept of Biology

Life on Earth is diverse, but the theory of evolution unifies life and describes how all living organisms evolved from a common ancestor. **Taxonomy** is the study of identifying and classifying organisms into groups based on the characteristics an organism shares with others of its same kind.

From the least inclusive to the most inclusive category, or **taxa**, each **species** belongs to a **genus**, **family**, **order**, **class**, **phylum**, **kingdom**, and **domain**. As the taxa become more inclusive, the number of organisms in each increases according to the number of characteristics they share.

The three domains of life are **Archaea**, **Bacteria**, and **Eukarya**. The first two domains contain prokaryotic organisms that are structurally simple but metabolically complex. They lack membrane-bound organelles, such as a nucleus. Archaea and bacteria are different in the organization of their DNA and composition of their cell walls. As well, archaea live in more extreme environments than bacteria.

Organisms in domain Eukarya have membrane-bound organelles, and include the protists, fungi, plants, and animals. Protists range from unicellular to multicellular organisms and include the protozoans and most algae. Among the fungi are the familiar molds and mushrooms. Plants are well known as the multicellular photosynthesizers of the world, while animals are multicellular and ingest their food. An evolutionary tree shows how the domains are related by way of common ancestors. Neither archaea nor bacteria have been classified into kingdoms at this time.

**Take Note:** *It is important for the AP Biology exam that you are able to compare (i.e., describe similarities and differences among) the organisms in different kingdoms and/or domains. As you learn the characteristics and physiological processes of various organisms, be sure to make a chart or table for yourself that clearly shows these relationships.*

Charles Darwin defined evolution as “descent with modification.” According to scientific evidence, the mechanism that best explains how evolution occurs is natural selection. Natural selection describes the process by which living organisms are descended from a common ancestor. Mutations occur within a population, creating new traits. Some of these new traits are adaptive advantages for organisms; that is, the new traits help organisms to survive in a changing environment. As organisms adapt to their environments, species change over time and may create new species from existing ones.

**Take Note:** *Evolution is an overarching theme in your study of AP Biology that will be stressed on the AP Biology exam. As you proceed with your study, be sure to look for characteristics (physical adaptations, behavioral adaptations, and physiological processes) that are adaptive advantages for organisms and relate them to the survival of the species.*

### 1.3 How the Biosphere is Organized

The **biosphere** is the zone of air, land, and water where life exists. A **population** consists of all members of one species in a particular area. A **community** consists of all of the local interacting populations. An **ecosystem** includes all aspects of a living community and the physical environment (soil, atmosphere, etc.).

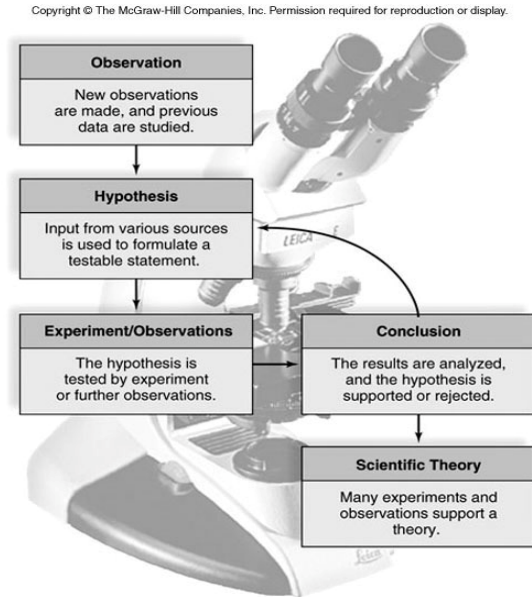
There are many interactions that occur within an ecosystem. Organisms interact with each other as well as with their environment. Ecosystems are characterized by chemical cycling and energy flow. Ecosystems stay in existence because of a constant input of solar energy and the ability of photosynthetic organisms to absorb it and convert it to chemical energy. The energy is passed through the ecosystem as the heterotrophs in a **food chain** consume the autotrophs and/or other heterotrophs, and convert it to metabolic energy by cellular respiration. Unused energy is released back into the ecosystem as heat. Interactions between various food chains make up a **food web**.

The human population modifies existing ecosystems for its own purposes. This can be dangerous not only for the modified ecosystem but also for humans, as we depend on healthy working ecosystems for food, medicines, and raw materials. Two biologically diverse ecosystems, **rain forests** and **coral reefs**, for instance, are severely threatened by the human population.

**Biodiversity** is the total number of species, their variable genes, and their ecosystems. There are many more species existing on Earth than have been identified. **Extinction** is the death of a species or larger group; perhaps 400 species become extinct every day due to human activities. The continued existence of all species and the preservation of biodiversity are both dependent on the preservation of ecosystems and the biosphere.

## 1.4 The Process of Science

When studying the natural world, scientists use the scientific process. The scientific method is the process used by scientists to gather information and reach conclusions about the natural world. The process includes observation, forming a hypothesis, performing an experiment, analyzing the results, and making conclusions. Conclusions may lead to new hypotheses which can be further tested to learn even more information about the world around us.



### *Flow diagram for the scientific method*

Observations, along with previous data, are used to formulate a hypothesis. Making **observations** requires using the senses to perceive an object of study or interest. A **hypothesis** is a *testable* explanation of your observations. New observations and/or **experiments** are carried out in order to test the hypothesis. A good experimental design includes an experimental variable and a control group. The experimental and observational results are analyzed, and the scientist comes to a **conclusion** as to whether the results support the hypothesis or do not support the hypothesis. If a hypothesis is supported, a scientist may ask additional questions to further his or her understanding. If a hypothesis is rejected, the experiment is repeated to ensure it was done correctly. If the hypothesis is rejected after repeating an experiment, it is revised and retested.

Several conclusions in a particular area may allow scientists to arrive at a **theory**, such as the cell theory, the gene theory, or the theory of evolution. The theory of evolution is a unifying concept of biology.

**Take Note:** *Experimental design is a very important aspect of the AP Biology exam. Be sure to consider the following criteria when answering a question that asks you to design an experiment:*

- *Clearly state a hypothesis using the “If..., then...” format.*
- *Set up a control group and indicate its purpose.*
- *Use a large sample size (dozens of organisms versus one or a few).*
- *Identify the dependent and independent variables.*
- *Indicate which variables you will hold constant.*
- *Indicate how you will manipulate the variable you will test. In other words, how will you conduct your experiment?*
- *Describe how the function you are testing is affected by the change in the variable. In other words, how is the dependent variable changing in response to the independent variable?*
- *Describe how you will measure the change in the variable (e.g., titration, measuring temperature every five minutes, etc.).*
- *Describe how you will verify your data (repeat the experiment many times).*
- *Indicate how you will analyze your data (e.g., run a Chi-square test, graph the data).*
- *Relate possible results to the hypothesis. In other words, what results will lead you to confirm OR reject your hypothesis?*

### Multiple Choice Questions

1. Which of the following terms includes the others?
  - A. ecosystem
  - B. population
  - C. community
  - D. biosphere
  - E. organism
2. Organisms from which of the following categories can survive in harsh environments devoid of oxygen?
  - A. Kingdom Plantae
  - B. Domain Eukarya
  - C. Domain Bacteria
  - D. Kingdom Fungi
  - E. Domain Archaea
3. A multicellular photosynthetic organism would be classified as a
  - A. plant.
  - B. animal.
  - C. fungus.
  - D. prokaryote.
  - E. bacteria.
4. Which of the following statements is NOT evidence that all living things have a common ancestor?
  - A. All life forms are composed of cells.
  - B. Similar metabolic processes occur in all life forms.
  - C. All life forms contain genes.
  - D. Amino acids are the genetic material of all life forms.
  - E. Life forms respond to their environment and maintain homeostasis.

5. Over time, one group of squirrels becomes separated from another due to erosion and the subsequent formation of a river the squirrels are unable to cross. Over time, the squirrels are unable to interbreed with one another. The inability of the squirrels to interbreed causes the squirrels to be classified as different
  - A. populations.
  - B. ecosystems.
  - C. communities.
  - D. organisms.
  - E. species.
  
6. Organisms in which of the following groups can be unicellular, colonial, or multicellular?
  - A. Domain Archaea
  - B. Kingdom Fungi
  - C. Kingdom Plantae
  - D. Kingdom Protista
  - E. Kingdom Animalia
  
7. Organisms of the same Family would NOT necessarily be classified in the same
  - A. kingdom.
  - B. phylum.
  - C. class.
  - D. order.
  - E. genus.
  
8. Interacting populations in a particular area comprise a
  - A. habitat.
  - B. ecosystem.
  - C. biosphere.
  - D. community.
  - E. species.

A student set up an experiment using *Drosophila* fruit flies. The student wished to determine the LC-50 dose of the exposure of caffeine to fruit flies. The lethal concentration is reached when 50% (LC-50) or more of the flies die when exposed to a toxin. The student mixed various concentrations of caffeine with the fruit fly media and then added 50 eggs to each vial. Results of the study are shown below.

Concentration of caffeine (micrograms of caffeine/10 grams of media)	Number of eggs added	Number of flies after 7 days in the vial
.001	50	45
.01	50	46
.1	50	35
1	50	6
5	50	2

9. What would be a major flaw in this experiment?
  - A. lack of a measureable value
  - B. too many different concentrations of caffeine
  - C. lack of a control
  - D. too low of an initial concentration of caffeine
  - E. too many trials

10. One way to improve this experiment would be to include
- a second toxin with the caffeine.
  - additional trials at each level of exposure.
  - additional eggs in each vial.
  - higher concentrations of caffeine.
  - eggs of another insect to compare results.

### Free Response Question

A farmer wishes to determine the minimum amount of fertilizer he needs to grow corn. You have been hired as an agricultural expert to conduct an experiment for the farmer.

- Design** an experiment to determine the minimum amount of fertilizer needed (in pounds per acre) to grow corn. For your experiment, be sure to **identify** your independent and dependent variables and **discuss** a clear hypothesis.
- A second farmer who grows soy beans comes to you after performing the following experiment. Three separate fields were planted with 3 different varieties of soy beans. Field one was given 2 pounds of fertilizer per acre, field two was given 4 pounds of fertilizer per acre, and field three was given 6 pounds of fertilizer per acre.
  - Identify** the independent and dependent variables in this experiment.
  - Identify** at least three ways that the experiment could be improved.

### Annotated Answer Key (MC)

- D**; While an ecosystem contains both abiotic and biotic factors, the biosphere contains all ecosystems of the world and is the most inclusive.
- E**; The Domain system of classification is based upon molecular differences between organisms. The Archaea include methanogens, extreme halophiles, and thermophiles. It is hypothesized that their membranes may be more stable than organisms in the other domains are more able to survive in various harsh environments.
- A**; While some bacteria are capable of photosynthesizing, they are not multicellular. Animals and fungi are not capable of photosynthesis.
- D**; Nucleic acids are the basis of the genetic code for all organisms.
- E**; Organisms from different communities, populations, and ecosystems are capable of interbreeding. The definition of *species* implies the ability breed with one another.
- D**; All organisms in Archaea are unicellular. All fungi, plants, and animals are multicellular. Organisms classified in Kingdom Protista can be unicellular, colonial, or multicellular.
- E**; Kingdom is the most inclusive group in the list. Therefore, if the organisms are in the same family they must be in the same kingdom, phylum, class, and order. Organisms can be in the same family, but not in the same genus. For example, dogs and wolves are in the same family (Canidae) but not the same genus.
- D**; Organisms of the same population must be of the same species. A habitat is not biotic and an ecosystem implies an interaction between abiotic and biotic factors, as does the biosphere.

9. **C**; The control serves as a comparison for the experimental value. In this case, a control would have been a vial with no caffeine added.
10. **B**; Science is repeatable. Without verification of repeated trials, science is meaningless.

## Answer to FRQ

### Part A (MAX 7 POINTS)

- Independent variable identification: amount of fertilizer
- Dependent variable identification: productivity of corn, with units, pounds of corn per acre
- Hypothesis: If more fertilizer is added, then the growth of corn will be maximized.
- At least one constant specified: type of corn, same soil, same amount of water on each field, same type of fertilizer on each field, equal sized patches of fields
- Repeated trials, at least two patches of field with each treatment
- Identification of a control: a field with no fertilizer added, or with the amount the farmer used last year
- Statistical treatment: repeated trials are averaged
- Range of independent variable (i.e., 1 pound per acre, 2 pounds per acre, 3 pounds per acre, 4 pounds per acre)

### Part B (MAX 5 POINTS)

1. INTERNAL MAX 2
  - Independent variable: amount of fertilizer
  - Dependent variable: growth or yield of soy beans
2. INTERNAL MAX 3
  - Control: plot with no fertilizer added
  - Constants identified
  - Repeated trials: multiple fields with each amount of fertilizer
  - Specify the hypothesis to be tested