

I. Introduction to Biology

A. What is Science?

1. The goals of science are to investigate (research), understand and explain nature and the physical universe so that predictions (inferences) could be made about the natural world in the future.
2. Science is the body of knowledge that researchers have compiled.

Science is constantly advancing and what was once believed to be true may no longer be so because of new discoveries. **In science, there is no such thing as proof. All scientific inquiry is used to disprove ideas.**

Section 1-3

- B. Definition of Biology: bios = life; logy = study of Biology is the study of living and once living things.

Q1. What are some examples of living things?

Q2. What are some examples of once-living things?

Biology is a science which means biologists follow established rules when studying biology. The rules are called the Scientific Method.

C. What are some specific disciplines of biology?

1. Zoology (zoo = animal) is the study of animals.
2. Botany (botanikos = plants) is the study of plants.
3. Ecology (oikos = house) is the study of how living things interact with each other and their environment.
4. Ethology (ethos = custom) the study of animal behavior.
5. Paleontology (paleo = ancient) is the study of life from the past.
6. Medicine

How do you use biology in your life?

D. Characteristics of Life

All living organisms share certain characteristics which distinguish them from nonliving things.

1. Made of cells – cells are the smallest units of life and can grow, reproduce and respond to their environments.

2. Reproduction – cells can either replicate or combine to produce new cells.
 - a. Asexual reproduction (a = not, no or without) is when a new cell develops from a single cell.
 - b. Sexual reproduction is when a cell from one parent combines with a cell from a second parent to form a new organism.
3. Metabolism (Need for Materials and Energy) – Materials are typically nutrients from food and energy comes from the sun for producers and from other organisms for consumers.
 - a. Metabolism is a bunch of chemical reactions that build up or break down materials as an organism performs its life processes. Both materials and energy are necessary.
4. Homeostasis – is maintaining a balance of internal conditions (e.g. water, temperature, nutrients, energy) regardless of the external environment.
5. Heredity (Based on a Genetic Code) – all living organisms contain DNA which is a code that determines the physical and behavior characteristics of an organism as well as determining all the functions of the organism.
 - a. DNA is based on a “4-letter alphabet.”
 - b. Heredity is the passing on of traits from parents to their offspring.
6. Growth and Development
 - a. Growth is a cell or organism getting larger
 - b. Development is when cells differentiate in an organism.
7. Response to the Environment – either by changing themselves or the environment.
8. Adaptation and Evolution – change over time
 - a. Adaptations are physical or behavioral changes in individuals to increase survival in the environment.
 - b. Evolution is changes in a group of organisms over time.
9. Interdependence – all organisms interact with other organisms within their ecosystem.

Section 1-1, 1-2**E. The Scientific Method**

There are 5 general steps to the scientific method.

1. Identifying and Stating a Problem:

Observations are made of the natural world using the senses (sight, hearing, touch, taste and smell) to gather information. From those observations, a problem or question is identified and stated.

2. Formulating a Hypothesis:

A hypothesis is a possible explanation for observed problems or questions. A scientific hypothesis must be testable. There are many forms a hypothesis may take. Two you must know are:

- a. "If..., then..." (e.g. If I don't water my African violet, then it will die.)
- b. Null hypothesis says there is no difference. (e.g. There is no difference between males and females in their ability to pass the biology SOL.)

3. Designing an Experiment:

Once a hypothesis is formulated, an experiment must be designed to test it. An experiment is a procedure to test a hypothesis under controlled conditions. Controlled experiments have a control group (a standard or zero with which to compare the changed variable responses) and one or more experimental groups which involve 3 types of variables (factors in an experiment that can change):

- a. Independent variables are ones that are manipulated or deliberately changed by the researcher.
- b. Dependent variables change in response to the independent variable. These are the responses that a researcher is measuring.
- c. Control variables are all the conditions in an experiment that remain the same or unchanged. Only one variable should be changed at a time or your results will not have much meaning. (e.g. If you test amount of light and amount of water on plant growth at the same time, you will not know which one truly had an affect on the plant.)

- d. Example: There will be no difference in the SOL biology test scores of males and females.
 - i. IV = Gender (male/female)
 - ii. DV = SOL test scores.
 - iii. CV = the particular test administered, the room where the test is taken, the time allotted to taking the test.
4. Conducting the Experiment (Recording & Analysing Results):

Once the experiment has been designed, the researcher runs the experiment. At this point the researcher records data (singular = datum). Data is the information gathered from an experiment. Data are then analyzed.

 - a. Quantitative Observations: data subjected to personal opinions and are not testable.
 - b. Qualitative Observations: data that are testable because they involve measurements.
5. Drawing a Conclusion:

Once data has been analyzed, the researcher decides what the data mean. A researcher can also make inferences (a logical interpretation based on prior knowledge and experience) from the data.

In addition it is important to know:
6. Replication:

Experiments are well done if they can be replicated (repeated). Write-ups of experiments can allow other researchers to repeat an experiment or manipulate a different variable to see results.
7. Publishing Results:

Dissemination of information is important. Others learn from what previous scientists did, so the best way of sharing information (and making sure the experiment was valid) is to publish in a peer-reviewed scientific journal.

Once a hypothesis has been repeated and accepted it becomes a theory. The term theory is often misused in place of hypothesis in everyday language. Theories are constantly changing or being modified.

Not all hypotheses can be tested using controlled experiments.

- a. Field studies of plants and animals make controlling all but one condition virtually impossible.
- b. Ethical dilemmas prevent scientists from experimenting on humans (and sometimes animals) in the area of disease.

F. Lab Write-Ups and Scientific Reporting

Section of a Scientific Paper:

1. **Abstract:** 500 or less word summary of methods, significant results and conclusions; includes statistical tests.
2. **Introduction:** Background on all variable or your topic, problem statement and hypothesis; includes cited references to prior research done on your topic.
3. **Methods:** Include variables, materials and procedures written in textual paragraph format; (NO LISTS!)
4. **Results:** Include only the data collected; do not present raw data – summarized data instead; NEVER draw conclusions in this section.
5. **Conclusions:** Accepts or rejects hypothesis and discusses significant results including interpreting what the data mean.
6. **Literature Cited:** a bibliography of all the research sources referred to in the Introduction and Conclusions sections.

Section 1 - 4

G. Biological Tools and Methods

1. Measurement

- a. Most scientists use the International System of units (SI) or the metric system to measure information.

b. Units of Measure

Measure	Definition	Metric Unit
Length	Distance between 2 points	Meter
Volume	Amount of space an object takes up	Liter
Mass	Amount of matter in an object	Gram
Weight	Gravities impact on mass	Gram
Temperature	The amount of heat in an object	Degrees Celsius
Time	The period between 2 events	Second

- c. Comparing Mass and Volume: Consider a balloon. An empty balloon has small volume. When you blow air into it, the balloon itself has the same mass as the empty balloon, but it takes up more volume.

2. Tools of Science

- a. Computers, notebooks, pens, pencils, cameras (video and still), tape recorders, microphones, scales, thermometers, rulers.
- b. Microscopes magnify small objects. (micro = small; skop = see)
- c. Cell cultures are laboratory specimens of a group of cells grown from a single original cell (cloning).
- d. Cell fractionation is a process that separates a cell so that its individual parts can be studied.

Preview of Biology to Come

A. Biochemistry and Cell Biology

1. We will see how biology and chemistry are related and explore the chemical molecules necessary for life.
2. We will study the general structure of plant and animals cells so that when we discuss classification, we can more closely look at the cellular differences of the different groups of organisms.
3. We will study the different functions of the cell including diffusion and osmosis, and cell processes such as photosynthesis, respiration and fermentation to understand how they are important to life.
4. We will learn how cells divide and create new cells through mitosis and cytokinesis so that later we can understand reproduction in simple organisms.

B. Genetics

1. The study of how traits (determined by genes) are passed on from parents to their offspring.
2. We will examine the genetic code and learn about its component (DNA) including how DNA was discovered as the genetic code, what makes up DNA, how it copies itself, and how it is involved in producing proteins to perform life functions using the assistance of RNA.
3. We will explore the work of Gregor Mendel and early assumptions of genetics that explain how traits are inherited.
4. We will learn about the formation of gametes (egg and sperm cells) through meiosis and how the process compares with mitosis.
5. We will look at human genetics including specific traits and discuss genetic disorders due to chromosome errors and mutations.

C. Classification, Taxonomy and Cladistics

1. We will understand why organisms are classified and explore the ways they are classified.
2. We will learn the 5 Kingdoms of Life system as well as the 6 Kingdoms of Life system.
3. We will learn about why viruses are not considered as living organisms, and how they impact life.

4. We will understand both the positive and negative roles of bacteria.
5. We will survey the different types of protists and see how they compare with fungi, plants and animals.
6. We will discuss the roles of fungi.
7. We will learn the basic concepts of botany and study plants.
8. We will compare and contrast invertebrate animals and vertebrate animals.

D. Evolution

1. Evolution is the change in species over time.
2. We will explore basic geology and how rocks can tell us the age of the Earth, past climates and provide us with fossils.
3. We will see how fossils can demonstrate evolution, and how they can tell us about organisms that lived in the past.
4. We will learn about how Darwin came up with his revolutionary concept of evolution based upon adaptations of individuals, survival of the fittest, natural selection and common descent.
5. We will explore the common descent and divergence of humans and other primates.

E. Ecology

1. The study of the interactions of organisms with each other and their environment.
2. We will study population dynamics and distinguish between populations and communities.
3. We will explore different types of ecosystems, how they change over time and the largest ecosystems on Earth (biomes).
4. We will understand ecological problems and how humans are both negatively and positively impacting the environment in terms of habitat destruction, pollution and endangered species.

F. Human Body Systems

1. We will learn about the parts and function of the many human body systems (digestive, respiratory, circulatory, excretory, and nervous system).