Chapter 1 The Science of Biology

Section Objectives:

- Recognize some possible benefits from studying biology.
- Summarize the characteristics of living things.

The Science of Biology

- The concepts, principles, and theories that allow people to understand the natural environment form the core of biology, the study of life.
- A key aspect of biology is simply learning about the different types of living things around you.

The Science of Biology

- Life on Earth includes not only the common organisms you notice every day, but also distinctive life forms that have unusual behaviors.

The Science of Biology

- When studying the different types of living things, you'll ask what, why, and how questions about life.
- The answers to such questions lead to the development of general biological principles and rules.

Biologists study the interactions of life

- One of the most general principles in biology is that living things do not exist in isolation; they are all functioning parts in the delicate balance of nature.

Biologists study the interactions of life

- Living things interact with their environment and depend upon other living and nonliving things to aid their survival.

Biologists study the Diversity of Life

- Through your study of biology, you will come to appreciate the great diversity of life on Earth and the way all living organisms fit into the dynamic pattern of life on our planet.

Biologists study the interactions of the environment

- Because no living things, including humans, exist in isolation, the study of biology must include the investigation of living interactions.
- The study of one living thing always involves the study of the others with which it interacts.

Biologists study problems and propose solutions

- The study of biology will teach you how humans function and how we fit in with the rest of the natural world.
- It will also equip you with the knowledge you need to help sustain this planet's web of life.

Characteristics of Living Things

- Biologists have formulated a list of characteristics by which we can recognize living things.
- Only when something has all of them can it then be considered living.

Characteristics of Living Things

- Anything that possesses all of the characteristics of life is known as an organism.

Characteristics of Living Things

All living things:

- have an orderly structure
- produce offspring
- grow and develop
- adjust to changes in the environment

Living things are organized

- When biologists search for signs of life, one of the first things they look for is structure. That's because they know that all living things show an orderly structure, or organization.
- Whether an organism is made up of one cell or billions of cells, all of its parts function together in an orderly, living system.

Living things make more living things

- One of the most obvious of all the characteristics of life is reproduction, the production of offspring.

Living things make more living things

- Reproduction is not essential for the survival of an individual organism, but it is essential for the continuation of the organism's species.
- A species is a group of organisms that can interbreed and produce fertile offspring in nature.

Living things change during their lives

- Growth results in an increase in the amount of living material and the formation of new structures.
- All organisms grow, with different parts of the organism growing at different rates.
- All of the changes that take place during the life of an organism are known as its development.

Living things adjust to their surroundings

- Organisms live in a constant interface with their surroundings, or environment, which includes the air, water, weather, temperature, any other organisms in the area, and many other factors.

Living things adjust to their surroundings

- Anything in an organism's external or internal environment that causes the organism to react is a stimulus.
- A reaction to a stimulus is a response.

Living things adjust to their surroundings

- Regulation of an organism's internal environment to maintain conditions suitable for its survival is called homeostasis.
- Living things reproduce themselves, grow and develop, respond to external stimuli, and maintain homeostasis by using energy.
- Energy is the ability to cause change.

Living things adapt and evolve

- Any structure, behavior, or internal process that enables an organism to respond to environmental factors and live to produce offspring is called an adaptation.
- Adaptations are inherited from previous generations.
- The gradual change in a species through adaptations over time is evolution.

Section Objectives: Part 2

- Compare different scientific methods.
- Differentiate among hypothesis, theory, and principle.

Observing and Hypothesizing

- The knowledge obtained when scientists answer one question often generates other questions or proves useful in solving other problems.

The methods biologists use

- The common steps that biologists and other scientists use to gather information and answer questions are collectively known as scientific methods.
- Scientific methods usually begin with scientists identifying a problem to solve by observing the world around them.

The methods biologists use

- A hypothesis is an explanation for a question or a problem that can be formally tested.
- Hypothesizing is one of the methods most frequently used by scientists.
- A hypothesis is not a random guess.

The methods biologists use

- Eventually, the scientist may test a hypothesis by conducting an experiment.
- The results of the experiment will help the scientist draw a conclusion about whether or not the hypothesis is correct.

Experimenting

- To a scientist, an experiment is an investigation that tests a hypothesis by the process of collecting information under controlled conditions.

What is a controlled experiment?

- Some experiments involve two groups: the control group and the experimental group.
- The control is the group in which all conditions are kept the same.
- The experimental group is the test group, in which all conditions are kept the same except for the single condition being tested.

Designing an experiment

- In a controlled experiment, only one condition is changed at a time.
- The condition in an experiment that is changed is the independent variable, because it is the only variable that affects the outcome of the experiment.

Designing an experiment

- While changing the independent variable, the scientist observes or measures a second condition that results from the change.
- This condition is the dependent variable, because any changes in it depend on changes made to the independent variable.

Designing an experiment

- Controlled experiments are most often used in laboratory settings.
- However, not all investigations are controlled.
- An investigation such as this, which has no control, is the type of biological investigation most often used in field work.

Using tools

- Biologists use a variety of tools to obtain information in an investigation.

- Common tools include beakers, test tubes, hot plates, petri dishes, thermometers, balances, metric rulers, and graduated cylinders.

Using tools

- More complex tools include microscopes, centrifuges, radiation detectors, spectrophotometers, DNA analyzers, and gas chromatographs.

Maintaining safety

- Safety is another important factor that scientists consider when carrying out investigations.


Sharp Object Safety This symbol appears when a danger of cuts or punctures caused by the use of sharp objects exists.


Clothing Protection Safety This symbol appears when substances used could stain or burn clothing.


Eye Safety This symbol appears when a danger to the eyes exists. Safety goggles should be worn when this symbol appears.


Chemical Safety This symbol appears when chemicals used can cause burns or are poisonous if absorbed through the skin.

Maintaining safety

- A safety symbol is a symbol that warns you about a danger that may exist from chemicals, electricity, heat, or procedures you will use.


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Data gathering

- Information obtained from investigations is called data.
- Often, data are in numerical form.

Data gathering

- Numerical data may be measurements of time, temperature, length, mass, area, volume, or other factors. Numerical data may also be counts.
- Sometimes data are expressed in verbal form, using words to describe observations made during an investigation.

Thinking about what happened

After careful review of the results, the scientist must come to a conclusion:

- Was the hypothesis supported by the data?
- Was it not supported?
- Are more data needed?

Verifying results

- After results of an investigation have been published, other scientists can try to verify the results by repeating the procedure.
- When a hypothesis is supported by data from additional investigations, it is considered valid and is generally accepted by the scientific community.

Theories and laws

- In science, a hypothesis that is supported by many separate observations and investigations, usually over a long period of time, becomes a theory.
- A theory is an explanation of a natural phenomenon that is supported by a large body of scientific evidence obtained from many different investigations and observations.

Reporting results

- Results and conclusions of investigations are reported in scientific journals, where they are available for examination by other scientists.

Theories and laws

- In addition to theories, scientists also recognize certain facts of nature, called laws or principles, that are generally known to be true.

Section Objectives: Part 3

- Compare and contrast quantitative and qualitative information.
- Explain why science and technology cannot solve all problems.

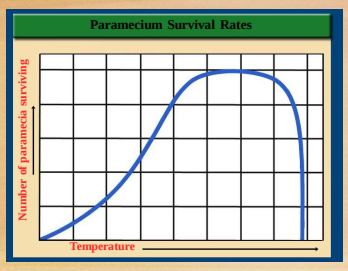
Kinds of Information

- Scientific information can usually be classified into one of two main types, quantitative or qualitative.

Quantitative information

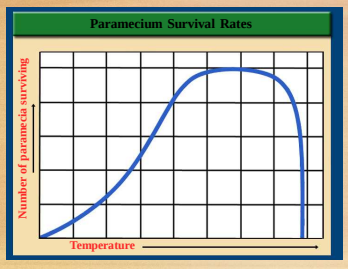
- Biologists sometimes conduct controlled experiments that result in counts or measurements—that is, numerical data.
- These kinds of experiments occur in quantitative research. The data are analyzed by comparing numerical values.

Quantitative information



- Quantitative data may be used to make a graph or table.

Quantitative information



- Graphs and tables communicate large amounts of data in a form that is easy to understand.

Measuring in the International System

- Scientists always report measurements in a form of the metric system called the International System of Measurement, commonly known as SI.

SI Base Units

Measurement	Unit	Symbol
Length	meter	m
Time	second	s
Temperature	kelvin	K
Intensity of light	candela	cd

Measuring in the International System

In biology, the metric units you will encounter most often are:

- meter (length),
- gram (mass),
- liter (volume),
- second (time), and
- Celsius degree (temperature).

Qualitative information

- Observational data—that is, written descriptions of what scientists observe—are often just as important in the solution of a scientific problem as numerical data.
- When biologists use purely observational data, they are using qualitative information.