Name_____ Class_____ Date _____

Summary

1–1 What Is Science?

Science is an organized way of using evidence to learn about the natural world. Scientific thinking usually begins with observation, which is the process of gathering information about events or processes in a careful, orderly way. The information gathered from observations is called data. Quantitative data are expressed as numbers, obtained by counting or measuring. Qualitative data are descriptive and involve characteristics that can't usually be counted. Scientists use data to make inferences. An inference is a logical interpretation based on prior knowledge or experience.

After making first observations, a researcher will propose one or more hypotheses. A hypothesis is a proposed scientific explanation for a set of observations. Scientists generate hypotheses using prior knowledge, logical inference, and informed, creative imagination. Scientific hypotheses must be proposed in a way that enables them to be tested. Some hypotheses are tested by performing controlled experiments. Other hypotheses are tested by gathering more data. The conclusions researchers draw from experiments or data must be valid. To be valid, a conclusion must be based on logical interpretation of reliable data.

1–2 How Scientists Work

Conducting a scientific investigation involves a series of steps. The first step is asking a question. The second step involves forming a hypothesis. The third step in conducting a scientific investigation is setting up a controlled experiment. Whenever possible, a hypothesis should be tested by an experiment in which only one variable is changed at a time. All other variables should be kept unchanged. This type of experiment is called a controlled experiment. The variable that is deliberately changed is called the manipulated variable. The variable that is observed and that changes in response to the manipulated variable is called the responding variable.

The fourth step in conducting a scientific investigation is recording and analyzing results. The fifth step is drawing a conclusion. A key assumption in science is that experimental results can be reproduced.

Sometimes, controlled experiments are not possible. When researchers design alternative investigations, they try to maintain the rigorous thinking associated with a controlled experiment. As evidence from numerous investigations builds up, a particular hypothesis may become so well supported that scientists consider it a theory. In science, a theory is a well-tested explanation that unifies a broad range of observations.

1–3 Studying Life

Although living things vary greatly, all living things share eight characteristics:

1. Living things are made up of units called cells. A cell is a collection of living matter enclosed by a barrier that separates the cell from its surroundings. Cells are the smallest units of an organism that can be considered alive.
2. Living things reproduce. In sexual reproduction, two cells from different parents unite to produce the first cell of the new organism. In asexual reproduction, a single-celled organism divides in half to form two new organisms.
3. Living things are based on a universal genetic code. The directions for inheritance are carried by a molecule called DNA.
4. Living things grow and develop. Multicellular organisms typically go through a process called development. As cells divide, they change in shape and structure in a process called differentiation.

5. Living things obtain and use materials and energy. The combination of chemical reactions through which an organism builds up or breaks down materials as it carries out its life processes is called metabolism.
6. Living things respond to their environment. Organisms detect and respond to stimuli from their environment. A stimulus is a signal to which an organism responds.
7. Living things maintain a stable internal environment. The process by which they do this is called homeostasis.
8. Taken as a group, living things change over time. Change over time in living things is called evolution.

Biology is divided into different fields of study. Some fields focus on the study of living systems at different levels. These levels include, from smallest to largest: molecules, cells, groups of cells, organisms, populations, communities, ecosystems, and the biosphere.

1–4 Tools and Procedures

Most scientists use the metric system when collecting data. The metric system is a decimal system of measurement whose units are based on certain physical standards and are scaled on multiples of 10. A revised version of the original metric system is called the International System of Units, or SI.

The simplest way to find out whether factors in an experiment changed or remained the same is to record data in a table and then make a graph.

A microscope is a device that produces magnified images of structures that are too small to see with the unaided eye. Light microscopes produce magnified images by focusing visible light rays. Compound light microscopes allow light to pass through the specimen and use two lenses to form an image. Electron microscopes use beams of electrons to produce magnified images. Biologists use two main types: the transmission electron microscope (TEM) and the scanning electron microscope (SEM).

A cell culture is a group of cells that develops from a single cell placed in a dish containing a nutrient solution. Cell fractionation is a technique in which cells are broken into pieces and different cell parts are separated for study.

Whenever you work in your biology laboratory, it's important for you to follow safe practices. The single most important rule for your safety is simple: Always follow your teacher's instructions and the textbook directions exactly. Because you may be in contact with organisms you cannot see, it is essential that you wash your hands thoroughly after every scientific activity.