Name _____ Class _____ Date _____

CHAPTER 1 The Nature of Life Science

SECTION 4

Scientific Models and Knowledge

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- How do scientists use models?
- What are scientific theories and laws?

California Science Standards

7.7.c, 7.7.d

Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.

What Are Models?

You need a microscope to see inside most cells. How can you learn about the parts of a cell if you don't have a microscope? Scientists use models to learn about things that they cannot see or touch.

A **model** is something scientists use to represent an object or event in order to make it easier to study. Scientists study models to learn how things work or are made in the natural world. However, you cannot learn everything by studying a model, because models are not exactly like the objects they represent. Some types of scientific models are physical models, mathematical models, and conceptual models. ☑

STUDY TIP

Compare As you read, make a table to show the features of physical models, mathematical models, and conceptual models.

READING CHECK

1. Explain Why can't you learn everything about an object or event by studying a model?

Models are not exactly like the objects they represent.

PHYSICAL MODELS

A toy rocket and a plastic skeleton are examples of physical models. *Physical models* are models that you can see or touch. Many physical models look like the things they represent. The figure shows students using a model of a human body to learn how the body works. However, because the model is not alive, the students cannot learn exactly how the body functions.

This physical model looks a lot like a real human body. But it is easier to see inside this model than to see inside a real human body.

TAKE A LOOK

2. Compare Give two ways that the model is like a person and two ways the model is not like a person.

Like:
1. size and shape
2. colors

Different:
1. the model is plastic
2. people are made of cells

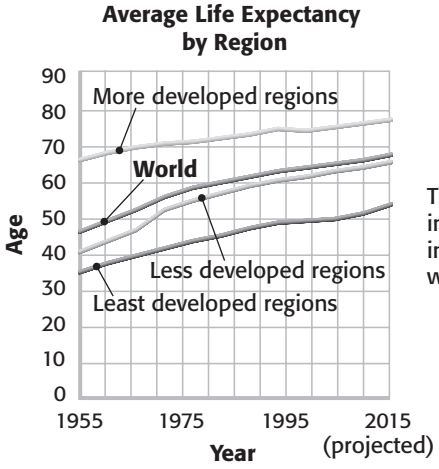
MATHEMATICAL MODELS

A mathematical model is made up of mathematical equations and data. Some mathematical models are simple. These models help you to calculate things such as how far a car will travel in an hour. Other models are more complicated. These models can have many different parts related by complicated equations. ☑

READING CHECK

3. Define What is a mathematical model?

mathematical equations, formulas and data that can calculate future predictions like the weather



This mathematical model measures the increase in life expectancy in the past. This information is used to predict, or project, what life expectancy will be in the future.

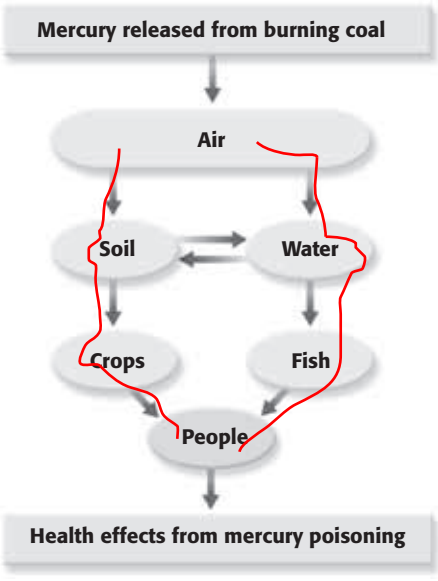
CONCEPTUAL MODELS

A *conceptual model* is a diagram, drawing, or spoken description of how something works or is put together. The conceptual model below describes how mercury is released when coal is burned. It traces how the mercury travels through the environment and affects humans. Scientists often use conceptual models to show how one part of a system affects another part. ☑

READING CHECK

4. Explain Why do scientists use conceptual models?

to show how one part of a system affects another part, like a food chain or food web.



TAKE A LOOK

5. Use a Model Use a colored pen or marker to trace two different paths between mercury in the air and mercury in people.

WHY SCIENTISTS USE MODELS

Scientists use models to study things that are very small, such as atoms, or things that are very large, such as Earth. Some scientists use models to predict things that haven't happened yet or to study events that happened long ago. For example, some scientists use computers to produce models of dinosaurs. These models are based on information from fossils and other observations. They can show how dinosaurs may have looked and moved.

How Are Sizes Shown in Models?

Imagine that you see a model of your school with a new addition for a swimming pool. In the model, the building that will house the swimming pool is the same size as the cafeteria. You expect that a large pool will be built. However, when the addition is finished, the pool is only as large as the principal's office. Why is the pool so small?

The model that you saw was not drawn to scale. **Scale** shows how the size of a model is related to the size of the object it represents. In a scale model of your school, the new pool would be the same size as the principal's office.

Maps and diagrams should also be drawn to scale. Scale is always shown on a map. The figure shows a map of California. The scale is 1 cm:100 miles. This means that 1 cm on the map represents 100 miles in California. Because the map is drawn to scale, it shows accurate information about the relative locations of places in California.

This map of California is drawn with a scale of 1 cm:100 miles.

CALIFORNIA STANDARDS CHECK

7.7.d Construct scale models, maps, and appropriately labeled diagrams to communicate scientific knowledge (e.g., motion of Earth's plates and cell structure).

Word Help: construct
to build; to make from parts

Word Help: appropriately
in a correct or proper way

Word Help: labeled
marked with a name or a description

Word Help: communicate
to make known; to tell

Word Help: structure
the arrangement of the parts of a whole

6. Describe You want to make a drawing of a room in your school. The room is 7 m long and 10 m wide. You want to make your drawing with a scale of 2 cm:1 m. Give the length and width of your scale drawing.

7m X 2 cm = 14 cm long
10m x 2 cm = 20 cm wide

Critical Thinking

7. Infer Why can two scientists study the same data but come to different conclusions about it?

New technology is developed to gather and sort data to reveal new patterns that lead to new conclusions.

How Does Scientific Knowledge Grow?

Science is always changing. Two scientists can study the same data and have different conclusions. When new technology is developed, scientists often review old data and come to new conclusions. By observing patterns in the world, scientists can create scientific theories and laws.

A scientific **theory** is a scientific explanation that connects and explains many observations. Scientific theories are based on observations. They explain all of the observations about a topic that scientists have at a certain time. Theories are conceptual models that help organize scientific thinking. They are used to explain and predict situations.

A scientific **law** is a statement or equation that can predict what will happen in certain situations. Unlike theories, scientific laws do not explain why something happens. They only predict what will happen. Many people think that scientific theories become scientific laws, but this is not true. Actually, many scientific laws provide evidence to support scientific theories.

TAKE A LOOK

8. Identify Fill in the blanks in the table with the terms *scientific theory* and *scientific law.*

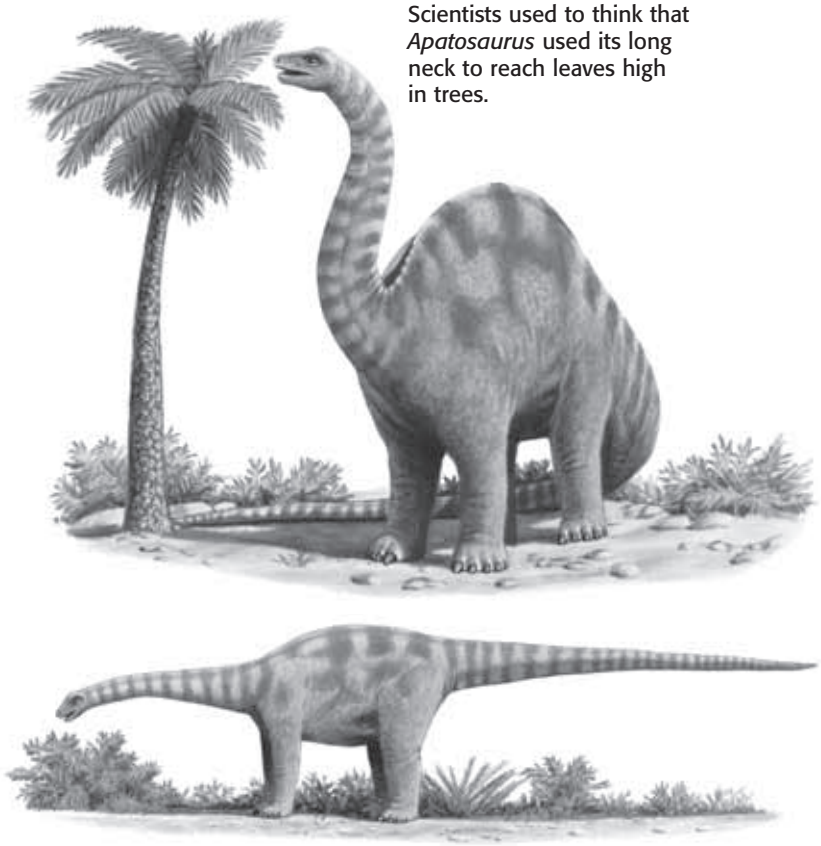
Name	What it is
theory	an explanation that connects and explains evidence and observations
law	a statement or equation that predicts what will happen in a certain situation

How Do Scientific Ideas Change?

Sometimes, new technology changes how scientists think about a topic. For example, scientists use to think that the dinosaur *Apatosaurus* could hold its head high up on its long neck. To test this idea, the scientists used a computer model to study how *Apatosaurus* may have moved.

The model showed that *Apatosaurus* could not have held its head up. Instead, it must have stood and moved with its head held horizontally. The figure on the next page shows the new idea about how *Apatosaurus* moved.

An Example of How Scientific Ideas Can Change



Scientists used to think that *Apatosaurus* used its long neck to reach leaves high in trees.

Computer models show that *Apatosaurus* could not hold its head high. It probably held its head out horizontally.

EVALUATING SCIENTIFIC THEORIES

Scientists are always discovering new information. This new information may show that a theory is incorrect. When this happens, the theory must be changed so that it explains the new information. Sometimes, scientists have to develop a totally new theory to explain the new and old information.

Sometimes, more than one new theory is given to explain the new information. How do scientists know that a new theory is accurate? They use scientific methods to test the new theory. They also examine all the evidence to see if it supports the new theory. Scientists accept a new theory when many tests and pieces of evidence support it. ☑

Say It

Investigate Use the Internet or the library to learn about a scientific idea that interests you. Study how the idea has changed with time. Share your findings with your class.

TAKE A LOOK

9. Infer Why did scientists have to use computer models to study how *Apatosaurus* moved?

The computer was able to model the motion of the bones, muscles and ligaments of Apatosaurus and revealed that it could not physically move it's head very high.

READING CHECK

10. Explain When do scientists decide that a new theory is accurate?

When many tests and pieces of evidence (about 40 - 100) *support the new theory and the new theory explains the new information.*

Name _____ Class _____ Date _____

Section 4 Review

7.7.c, 7.7.d 

SECTION VOCABULARY

law a descriptive statement or equation that reliably predicts events under certain conditions

model a pattern, plan, representation, or description designed to show the structure or workings of an object, system, or concept

scale the relationship between the measurements on a model, map, or diagram and the actual measurement of distance

theory a system of ideas that explains many related observations and is supported by a large body of evidence acquired through scientific investigation

1. Identify How are scientific theories related to observations and evidence?

A scientific theory is a statement that explains the observations. It is supported by evidence. For example the theory of evolution explains why there are so many different species and is supported by fossil evidence.

2. Explain Why do scientists use models?

Models help to understand something that is very complex.
They help to visualize large or small things.
They can be used to make predictions in science.

3. Describe Why is scale important in models and maps?

Scale models have the same dimensions as the real thing. This aids in the correct representation of directions on maps and building from model to the real thing.

4. Describe What effect can new observations have on a scientific theory?

New observations can lead to the need to change old theories into new theories in order to explain better the new observations.

5. Identify Give three types of models and an example of each type.

1. Physical model - a model airplane.
2. Mathematical model - a formula to calculate the weather for tomorrow.
3. Conceptual model - the concept of a slinky spring as the way air moves in a sound wave.

6. Compare How is a scientific theory different from a scientific law?

A theory is substantiated by 40 -100 tests or pieces of evidence,
A theory is not as strong as a law. We believe theories to work most of the time.
We believe laws to work ALL of the time.
For example the law of gravity always works.
If there is one exception to the law, then it is demoted to a theory and needs to be revised.