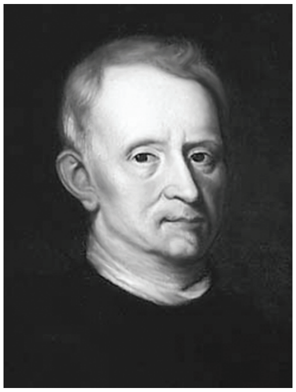
Name:____ Date: __________________

SKILL and PRACTICE 7.1

Robert Hooke

Robert Hooke was one of England's early scientific geniuses. He is remembered for his experiments across many fields of science. His book, Micrographia, gave everyday people their first view of life under a microscope.

Early years



Robert Hooke, an English scientist, was born on the Isle of Wight along the southern coast of England in 1635. His father, a minister in the local church, noticed that his son learned things quickly. Robert also had a remarkable ability to fix things and build useful tools. His father taught him school subjects at home and planned for him to become an artist.

When Robert was 13, his father died. He had very little money and went to work for Sir Peter Lely, a famous artist in London who painted landscapes and portraits.

Most of his life, Hooke's health was poor. He suffered from smallpox, which left scars on his face. His spine was crooked, perhaps from scoliosis or from an injury. He complained that artists' paint and varnishes made it hard for him to breathe. So, soon after arriving in London to study art, he changed his mind and enrolled at Westminster School to prepare for college.

England's Leonardo Da Vinci

Hooke did well at his studies. He learned Greek and Latin. He impressed his teachers by learning six old books on mathematics, called *Euclid's Elements*, in only one week. He even designed flying machines in his spare time! Because of his inventions and experiments, some people have called Hooke England's Leonardo Da Vinci.

University life

At age 18, Hooke started college at Oxford University in England. At the university, he met other people doing important scientific research. One of his first jobs was to design an air pump (without electricity!) to produce a vacuum for Robert Boyle who was studying gases. With Boyle and other English scientists like Isaac Newton, Edmond Halley, and Christopher Wren, Hooke helped to start the Royal Society in London which still exists today.

Microscopic world made known

Hooke is most well-known for his book, *Micrographia*, published in 1665. The book was printed in English so that scientists and non-scientists could appreciate his observations using a compound microscope.

His book contains a large collection of beautiful and accurate illustrations of tiny, everyday organisms; a flea, the compound eyes of insects, mold, the honeycomb-like structure of cork which he said was made up of "cells" like a monastery, and many other drawings.

Hooke's law

Students of physics and chemistry use Hooke's law. This law describes the force between two objects joined by a spring. It is used to solve problems about mechanical objects and to describe bonds between atoms in molecules.

Hooke worked on projects in many scientific fields throughout his life. In 1664, he became a professor of geometry. From 1662 until his death in 1703, he was also Curator of Experiments for the Royal Society. He demonstrated up to four experiments a week to the Society. He showed how a pendulum is used to measure gravity. He made major improvements to the compound microscope. He published a book about astronomy, *Cometa*, in 1666. He formulated a wave theory of light that led to a longstanding rivalry with Isaac Newton. Hooke also had an argument with Christiaan Huygens, a famous Dutch-born physicist, over his invention of the spring-balanced watch.

A genius worth remembering

Hooke's work is sometimes overlooked because many important scientists made discoveries in his lifetime. But his accomplishments make him one of the seventeenth century's greatest thinkers.

Reading reflection

1. What did Robert Hooke's father notice about him as a young boy?
2. How did Hooke's brief training in art become useful later in life?
3. What special abilities would it take to do a job like Hooke's—designing and presenting different experiments each week?
4. Describe one of Hooke's discoveries that is useful in two different fields of science.
5. Give an example of a technology we use today that did not exist at the time of Robert Hooke. One example is given in the reading.
6. **Research:** Find out when the technology you chose for the previous question was invented. How was it invented? Write a paragraph about it to read out loud to your class.

Name:_______________________________________ Date: ________________

SKILL and PRACTICE 7.1

Antonie van Leeuwenhoek

Antonie van Leeuwenhoek, with very little scientific training, designed his own simple microscopes and was one of the first to observe single celled organisms. His research showed that decaying matter does not spontaneously generate living organisms, but it took many years before scientists were convinced.

Working-class upbringing

Antonie van Leeuwenhoek (Layu-wen-hook) was born in Delft, Holland, in 1632. Antonie's real name was Thonis Philipszoon but as an adult he signed all of his writings as Antonie van Leeuwenhoek. Leeuwenhoek means, "from Lion's corner," which describes the location of the house where he was born in Delft.

His parents were tradespeople; his father made wicker baskets and his mother's family were brewers. His early education took place in the town of Warmond. Lacking money, his parents could not pay for him to go to university. In 1648, his father died and Leeuwenhoek was sent to be an apprentice in a fabric merchant's shop. There he developed an interest in magnifying lenses. Merchants used magnifying lenses to count the threads in woven linen cloth. In 1654, Leeuwenhoek returned to Delft and opened his own business as a fabric salesman.

Improved magnifying glasses

Leeuwenhoek's interest in magnifying lenses led him to improve the way lenses are made and ground. He assembled close to 250 microscopes. His simple microscopes were held by hand to the eye and could magnify objects up to 270 times their original size. Leeuwenhoek's technique for grinding lenses was far better than any other at the time. His secret technique and microscopes were ones "which I only keep for myself." He gave away some microscopes but never sold any of them during his lifetime. For this reason, nearly 100 years passed before anyone could view or recreate his microscopes. There are fewer than nine remaining today.

Corresponded with Hooke

With his microscopes, Leeuwenhoek observed bacteria, protozoa, ant pupae, and many other tiny organisms. He wrote over 100 letters to the Royal Society in London and the French Academy from 1673 until his death in 1723. Leeuwenhoek wrote in Dutch because he never learned Latin, the scientific language of the day. Leeuwenhoek also differed from other scientists because he did not travel to share his scientific work. He made one trip to London around 1668, where he picked up a copy of Robert Hooke's book, *Micrographia*. Leeuwenhoek was inspired to make microscopic observations and to begin writing to Robert Hooke.

Leeuwenhoek's observations are remarkably descriptive. In dental plaque, Leeuwenhoek wrote there were "many very little living animalcules, very prettily a-moving. The biggest sort had a very strong and swift motion, and shot through the water like a pike does through the water…."

Challenged theory of spontaneous generation

Leeuwenhoek's experiments and independent thinking led him to question the theory of spontaneous generation that said decaying organic matter spontaneously produced maggots and other small living organisms. In 1692 he wrote that animalcules formed from seeds or germs of other animalcules and, "we are too credulous and therefore assume that living creatures originate from putrefied materials and so on." Many years later, Louis Pasteur's work in the 1860's fully convinced scientists that spontaneous generation wasn't true.

Recognition

Leeuwenhoek's scientific work did not go unrecognized. In 1680 he was elected as a full member of the Royal Society of London. Today, the Dutch Royal Academy awards the Leeuwenhoek medal every ten years to the scientist who has made the most important discovery in microbiology for that decade.

Reading reflection

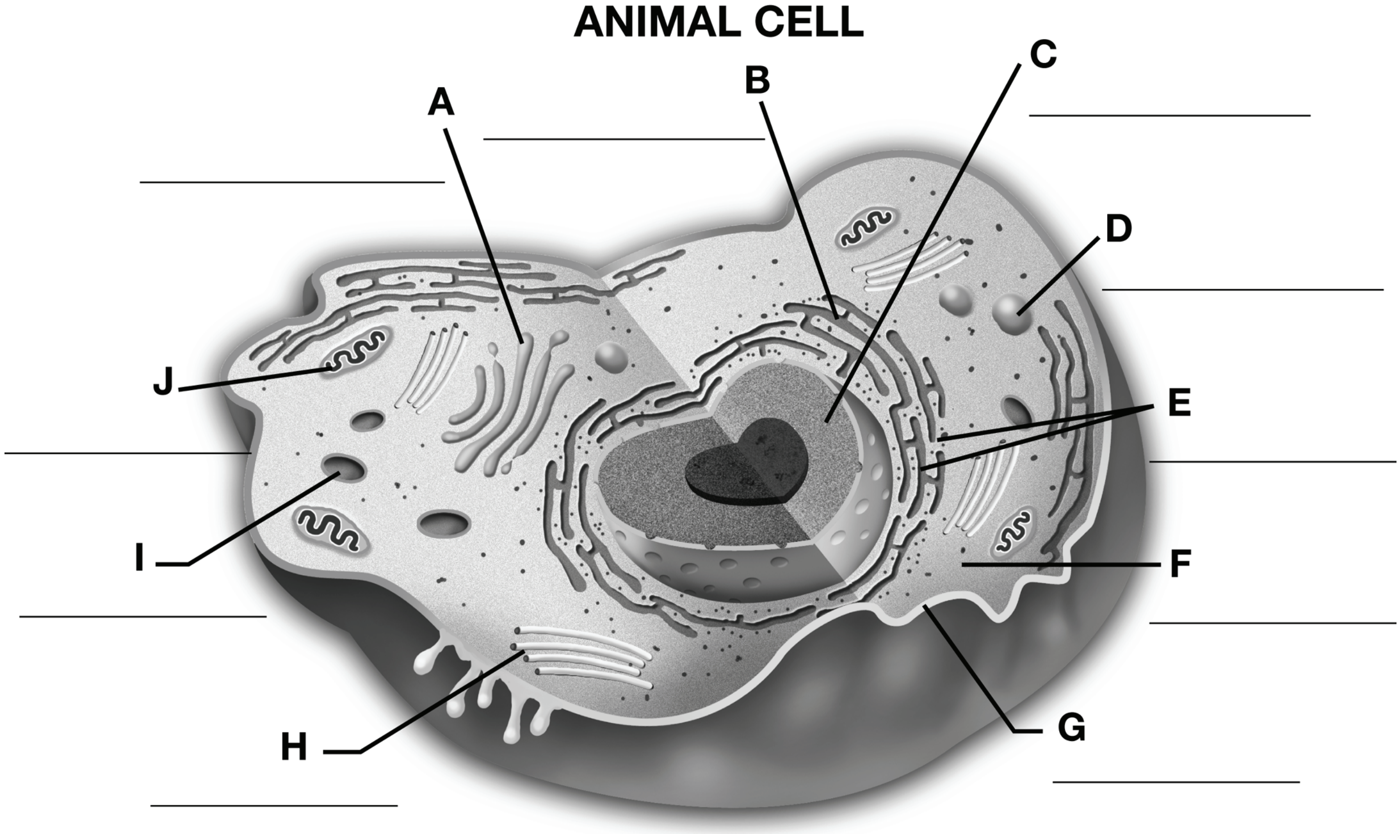
1. How long did Leeuwenhoek live? How many years was he writing to the Royal Society of London?
2. How did fabric merchants use magnifying lenses?
3. Why were Leeuwenhoek's microscopes better than others of his day? How would a better microscope be an advantage?
4. Leeuwenhoek did not let his language barrier or lack of education keep him from conducting scientific investigations. Give an example of a problem in everyday life you could try to solve using the scientific method.
5. Robert Hooke's book, *Micrographia*, inspired Leeuwenhoek to record and share his microscopic observations. Give examples of how scientists can work together to make scientific discoveries.
6. Leeuwenhoek found evidence that the theory of spontaneous generation was untrue. Why do you think it took so long for scientists to be convinced that it was untrue?
7. **Research:** Obtain a dental plaque sample and observe it under a microscope. Can you see what Leeuwenhoek observed? Draw and describe your findings.

Name: ______________________________ Date: ______________

SKILL and PRACTICE 7.2

Animal Cell Parts

Write the name of the part that corresponds to each letter in the diagram. Then, write the function of each part in the spaces below the diagram.



a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

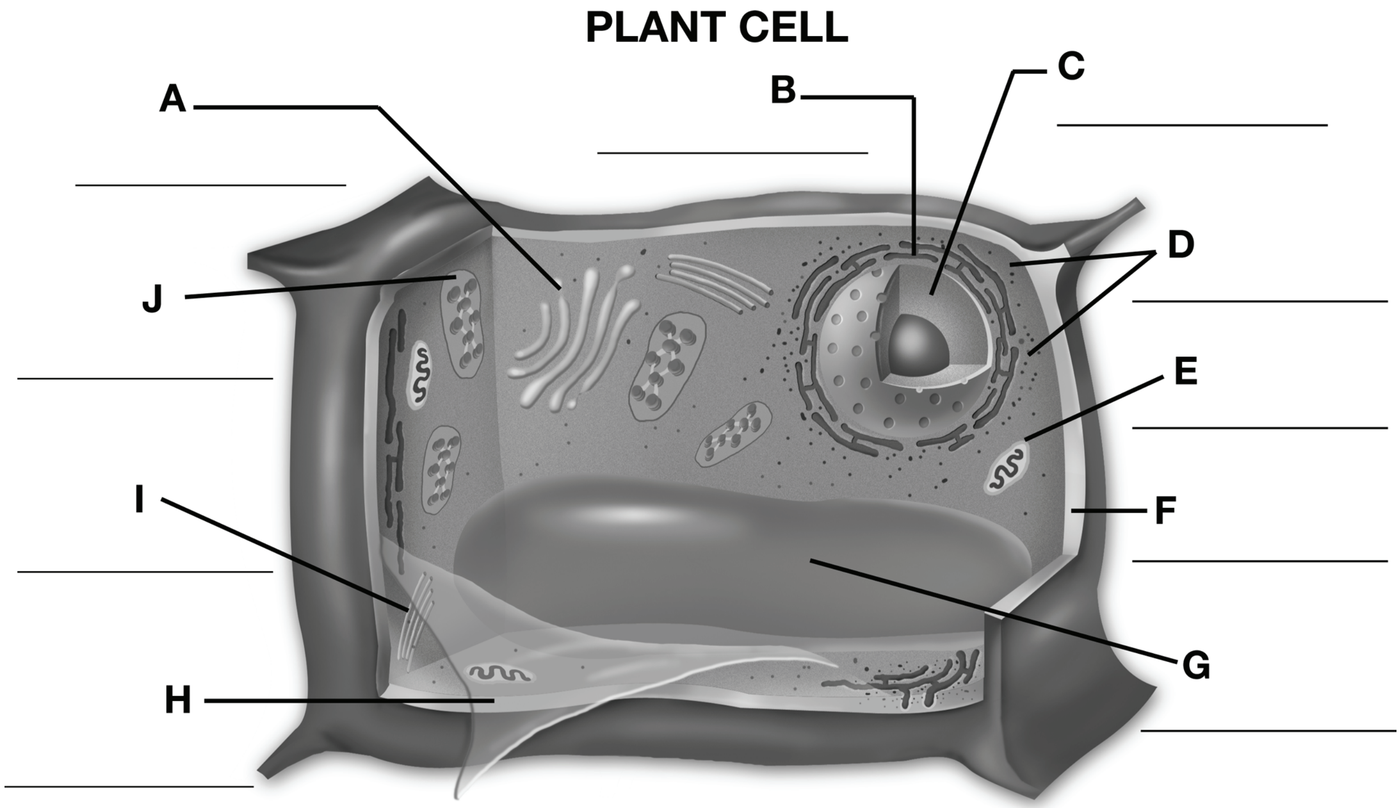
j. ______________________________

Name: ______________________ Date: ______________

SKILL and PRACTICE 7.2

Plant Cell Parts

Write the name of the part that corresponds to each letter in the diagram. Then, write the function of each part in the space below the diagram.



a. ______________________

b. ______________________

c. ______________________

d. ______________________

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f. ______________________

g. ______________________

h. ______________________

i. ______________________

j. ______________________

Name: ______________________ Date: ____________

SKILL and PRACTICE 8.1

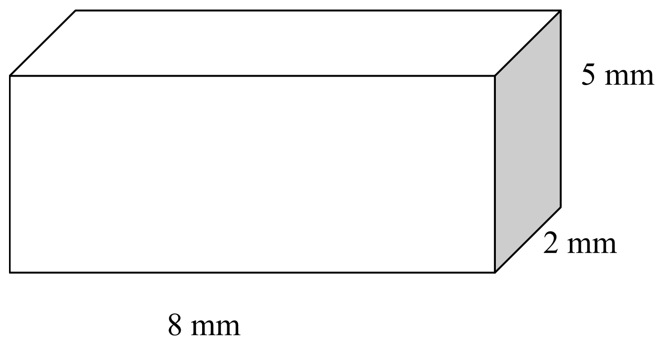
Calculating Surface Area

READ

How much wrapping paper will it take to wrap the present you're giving your best friend? How much leather does it take to cover a softball? Both of these questions are answered by finding the surface area of the objects. In this life science class, you need to be able to calculate the surface areas of cubes and rectangular solids (boxes), so that's what we will practice here.

EXAMPLE

Find the surface area of this box:



Answer/Solution: Find the area of each of the 6 faces of the solid then add to get the total surface area. Each face is a rectangle, so use the formula: (Area = length × width) to get the area of each face. Think of the faces in three categories (with 2 rectangles in each category), then find the area of each.

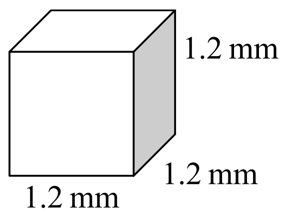
Front/Back:	Top/Bottom:	Sides:
8 mm × 5 mm	8 mm × 2 mm	2 mm × 5 mm
$A = l \times w$	$A = l \times w$	$A = l \times w$
$A = 8 \times 5$	$A = 8 \times 2$	$A = 2 \times 5$
$A = 40\ \text{mm}^2$	$A = 16\ \text{mm}^2$	$A = 10\ \text{mm}^2$
× 2 of these rectangles = 80 mm^2	× 2 of these rectangles = 32 mm^2	× 2 of these rectangles = 20 mm^2

Now, add all areas (80 mm^2 + 32 mm^2 + 20 mm^2) to find the total surface area, 132 mm^2.

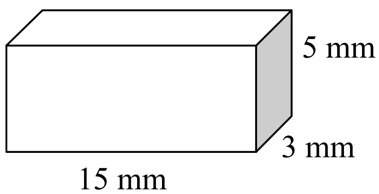
PRACTICE

Find the surface area of each solid:

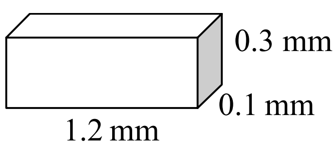
1.



2.



3.



4. A cube whose edge is 0.04 cm

5. A rectangular solid whose square base is 1.3 m by 1.3 m, and whose height is 2.8 m.

Name: ______________________ Date: ______________

SKILL and PRACTICE 8.1

Working with Ratios

READ

For comparison purposes in science (and in many other fields), it is often useful to simplify a numerical result into a ratio. Most people find that whole number ratios are the easiest to interpret. For example, the ratio **5:4** is quicker to read, write, and understand than the ratio **2.5:2**, even though these ratios are equivalent:

$$\frac{5}{4} = \frac{2.5}{2}$$

EXAMPLE

One Friday night, Jerod went out to dinner and a movie with his family. His parents ended up spending $82.40 for dinner, and it cost $45 for everyone to see the movie. What is the ratio of the money spent for the movie to the money spent on food? Please give the answer as a whole-number ratio.

1. Write the given information as a ratio. Here we want $ movie: $ food; $45: $82.40
2. Write the ratio as a fraction: $\frac{\$45}{\$82.40}$
3. Divide top and bottom by the smallest number: $\frac{\$45 \div \$45}{\$82.40 \div \$45} = \frac{1}{1.831}$
4. Round the decimal (when there is one) to the nearest whole number: 1.831 ≈ 2. The fraction from step #3 is rewritten as $^1/_2$.
5. Write as a ratio: 1:2.

   The whole number ratio of the money that Jerod's family spent on the movie to the money they spent on food is 1:2.

PRACTICE 1

Part A: Rewrite each as a simple whole-number ratio.

1. 67 **:** 128
2. 15.8 **:** 2.6
3. 15,007 **:** 33,045
4. 322.8 **:** 89
5. 203 **:** 1,088

Part B: Answer each with a simple whole number ratio.

6. Theresa's doll collection has only brunette and blonde dolls. Eight of the dolls are brunettes, while twenty-five of them have blonde hair. What is the ratio of blondes to brunettes in this doll collection?
7. In Herbert Hoover Middle School, there are 1,285 students. Eight hundred six of the students are girls, while 479 are boys. What is the ratio of girls to boys?

8. After it rained one Saturday, Gail and Terry decided to collect earthworms. They planned to sell them for fishing bait. Deciding that they could charge more money for the larger worms (those over 7 centimeters long) they began counting and sorting. Of the 356 worms they had collected, just 82 of them were over 7 centimeters long. What is the ratio of short worms to long worms?

EXAMPLE

In some situations, this method for writing whole-number ratios does not provide enough information. In the example of Jerod going out with his family for dinner and a movie, if only the estimated whole-number ratio (2:1) is given, we might believe that his family spent twice as much money on food as it did on the movie. Maybe this estimate is enough, if only a very general idea is needed. But if Jerod's parents would like a better idea of how they spent their money (maybe for budgeting purposes), they might use the following approach (note that the first three steps are the same as with the first method):

1. Write the given information as a ratio. Here we want \$ movie: \$ food; \$45: \$82.40.
2. Write the ratio as a fraction: $\frac{\$45}{\$82.40}$
3. Divide top and bottom by the smallest number: $\frac{\$45 \div \$45}{\$82.40 \div \$45} = \frac{1}{1.831}$
4. Round the decimal part of the fraction from (3) to the nearest tenth. $1.831 \approx 1.8$
5. Write the decimal from (4) as a mixed number, and reduce to lowest terms if possible. $1.8 = 1\,{}^{8}/_{10} = 1\,{}^{4}/_{5}$
6. Rewrite the mixed number from (5) as an improper fraction. $1\,{}^{4}/_{5} = {}^{9}/_{5}$
7. Replace the decimal part of the fraction in (3) with the fraction from (6). Here, that gives $\frac{1}{\frac{9}{5}}$, which means "the reciprocal of ${}^{9}/_{5}$"; in other words, ${}^{5}/_{9}$.

   NOTE: The result in this step will always be either ${}^{1}/_{\text{fraction}}$ (in which case the reciprocal is required), or ${}^{\text{fraction}}/_{1}$, in which case the fraction is being divided by 1, and the result is the fraction itself.

8. Write as a ratio: 5:9

   The whole number ratio of the money that Jerod's family spent on the movie to the money they spent on food is 5:9. This means that for about every \$5 the family spent on the movie, they spent about \$9 on food.

PRACTICE 2

Part A: Rewrite each as a simpler whole-number ratio, using the method of rounding to the nearest tenth as shown in the last example.

1. 167 **:** 108
2. 5.8 **:** 12.6
3. 3,450 **:** 5,007
4. 32.28 **:** 112.5
5. 2,043 **:** 888

SKILL and PRACTICE 8.1

Part B: Answer each with a simple whole-number ratio.

6. Sonya's troll collection has only red-headed and purple-headed trolls. Seventy-seven of the trolls have red hair, while just forty-six of them have purple hair. What is the ratio of red-headed trolls to purple-haired trolls in this collection?

7. In Everett Middle School, there are 508 students. Two hundred seventy-seven of the students are boys, while 231 are girls. What is the ratio of girls to boys?

8. Tim and Rocco were asked to clean out their little brother's toy box. While they were doing this, they found that many of their own markers were mixed in with their brother's. They sorted them into two piles, and to their surprise, only 17 of the 109 markers actually belonged to their brother. What is the ratio of Tim and Rocco's markers to their little brother's markers?

Name:____ Date: _________________

SKILL and PRACTICE 9.1

Francesco Redi

Francesco Redi was an Italian medical doctor who performed an experiment that proved that maggots in rotting meat came from flies that laid eggs, not from the meat itself. His experiment was one of the first to show that living things do not come from nonliving things. His experiment was a good one because he used experimental controls, a practice scientists continue to use today.

Medical doctor to Grand Dukes

Francesco Redi was born February 18, 1626, in Arezzo, Italy. His father, Gregorio Redi, was a medical doctor for the Medici family. The Medici's were wealthy, important merchants in Florence, Italy. Francesco eventually became head physician to the Medici family. In this position he treated two Grand Dukes of Tuscany: Ferdinand II and Cosimo III. To prepare for this job he studied medicine and philosophy at the University of Pisa. He graduated at age 21 and enrolled in the College of Medicine in Florence the next year.

Influenced by Renaissance

Francesco Redi was a doctor, a scientist, and a poet who was deeply influenced by the period of history called the *Renaissance*. The Renaissance, which lasted from the 1300s to the 1600s, began in Florence and introduced new ways of thinking and learning. Art, medicine, and literature flourished at this time. Ideas that had been held for centuries were being questioned and thought about in new ways. Many other famous people in Italy were affected by this new approach to medicine and science. Galileo Galilei (1564–1642) was a medical student who became a professor of mathematics and defended the view that the Earth revolved around the Sun. Leonardo Da Vinci (1452–1519) was one of the first artists to dissect bodies and draw detailed pictures of anatomy. English physician William Harvey (1578–1657) left England to study blood circulation in Padua, Italy, where surgery and anatomy were taught.

Designed a controlled experiment

Several of Harvey's writings, including "On the Circulation of the Blood" (1649) and "On the Generation of Living Creatures" (1651), may have influenced Redi's work. In 1668, in his most famous experiment, Redi set out to test Harvey's idea that tiny organisms that grew from no visible living plant or animal actually arose from seeds or eggs too small to be seen. Redi placed meat samples in eight jars. Four of the jars were sealed so nothing could get in and four were left open to the air. Flies landed on the meat in the open jars. Over time it became clear that the meat in the open containers was the only meat that grew maggots. He repeated the experiment a second time by covering half of the jars with gauze, and leaving half open. Again, all the meat in all the jars rotted, but only the uncovered meat had maggots.

Life from microscopic eggs

Redi's work was important for several reasons. His experiment was designed to show that the commonly held belief in biogenesis, i.e., that life spontaneously generates from nonliving matter, was mistaken. His results were strong evidence that life (maggots) came from microscopic eggs and not from rotting meat itself. In his experiment, he introduced an important part of scientific study, the use of experimental controls. The control flasks were the ones left open to the air. A scientist can predict in advance what will happen with the control variable because it has already been reliably observed. Controls are an important part of science experiments today.

Studied language, snakes, parasites

Redi is most well-known for his experiment with rotting meat, but he pursued other interests as well. He was the first to suggest that snake venom came from glands behind the snake's fangs. He described over 100 parasitic worms collected from animals, mollusks, and crustaceans. As a writer, he studied Italian dialects and helped to write a dictionary. He wrote a famous poem in 1685, *Bacchus in Tuscany*. Francesco Redi is a good example of how the Renaissance revived an interest in the study of science and language. He died March 1, 1697.

Reading reflection

1. What is Francesco Redi most well-known for?
2. List three people besides Redi who were influenced by the Renaissance and tell what each of them studied.
3. Identify the experimental and control variables in Redi's maggot experiment.
4. Why do you think Redi repeated his experiment a second time under slightly different conditions? What hypothesis was he trying to test?
5. List the topics Redi researched. Explain why a medical doctor would be interested in these subjects.
6. **Research:** Read another biography from the same time period (1600–1700). Compare and contrast the subjects that scientists were studying at the time. Identify any equipment they used to do their research. Explain how improvements in technology have helped to advance our understanding of science.

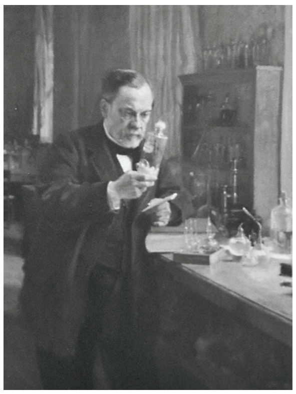
Name:____ Date: ________________

SKILL and PRACTICE 9.2

Louis Pasteur

Louis Pasteur was a French microbiologist and chemist whose research helped both the wine and silk industries of France. His later work on vaccines and disease prevention saved countless lives and was a major contribution to modern day medicine.

A tanner, an artist, and a scholar



Louis Pasteur was born in Dole, France, on December 27, 1822. For generations, his family worked in tanneries, where they turned cattle and sheep skin into leather. Little did young Pasteur know that much of the tanning process depended on microscopic organisms. Before too long, Pasteur's life work would become the basis of modern day microbiology and medicine.

As a teenager, Pasteur proved to be a talented painter. However, his teachers thought him only an average student. Yet his school headmaster saw promise in Pasteur and encouraged him to take more classes. In 1842, Pasteur graduated from Besancon College Royal de la Franche where he studied physics, mathematics, Latin, and drawing. He furthered his studies in physics and chemistry at Ecole Normale.

Early in his career as a chemist, Pasteur studied crystals. He learned that some crystals changed the path of light—a phenomenon called polarization. At age of 26, Pasteur discovered mirror-image molecules. His research later became the foundation of a new branch of chemistry—stereochemistry.

Fermentation and pasteurization

While Pasteur was a chemistry professor at the University of Lille, one of his students asked his teacher for help. The student's father, Monsieur Bigo, owned a large factory where alcohol was made from beet juice. However, the juice was souring and the factory was losing money.

Pasteur discovered that yeast cells give off alcohol and carbon dioxide as they grow. When Pasteur studied the soured juice, he saw millions of bacteria. The bacteria were producing lactic acid that soured the juice. At the time, Pasteur did not know how to kill off the bacteria, but he did teach Bigo how to identify contaminated vats.

Next, Pasteur proved that germs spread through the air and reproduced by cell division. He also discovered that some microorganisms could live and grow without air.

In 1864, Emperor Napoleon III asked Pasteur to work with French vineyard growers. Again, Pasteur found that the wine was infected with bacteria. He found a way to kill these germs using heat. This process was later named after him. It's called "pasteurization."

Helping France's silk industry

In 1865, Pasteur studied the silkworm disease that was ruining France's silk industry. He worked for many years to prove that a microorganism was attacking silkworm eggs. By ridding the disease-causing organism from silkworm nurseries, the silk industry was saved.

A life-saving scientist

Pasteur is probably best remembered for his work in treating and preventing animal and human diseases. He also revolutionized surgery and reduced infection by promoting sterilization. His motivation to save lives was most likely due to the death of three of his children from typhoid fever.

Pasteur's research on animal diseases led to the creation of several vaccines in the 1870s and 1880s. Pasteur found that when healthy chickens were infected with a weak form of cholera, they became immune to the stronger form of the disease. Pasteur also created a vaccine that combatted the deadly cattle disease anthrax.

After these successes, Pasteur worked to create a rabies vaccine. He guessed that an organism too small to see with a microscope caused rabies—a virus. In 1885, Pasteur successfully vaccinated a nine-year-old boy against the deadly disease.

In 1888, the Academy of Sciences opened the Pasteur Institute in Paris, France. Pasteur served as director of the Institute until his death on September 28, 1895. Today, the Institute continues to research the prevention of disease.

Reading reflection

1. What causes fermenting liquids such as wine to sour, and what did Pasteur develop to prevent the contamination?
2. How did Pasteur help save France's silk industry?
3. What did Pasteur discover when he infected healthy chickens with a weak form of cholera?
4. Describe Pasteur's work on developing a vaccine for rabies.
5. **Research:** The Pasteur Institute is home to many outstanding scientists who have made major contributions in the field of microbiology and disease prevention. Use the library or the Internet to research some of the past and recent discoveries made at the Institute.