2

BIOMEDICAL SCIENCE

SKILLS AND STRATEGIES

- Understanding Text Organization
- Using the Dictionary to Find Word Meaning
- Using Graphic Organizers

Understanding Text Organization

In most academic texts, writers use different forms of organization as they present supporting details for their ideas. They often use these different forms of organization for sections of text, paragraphs, or within individual sentences. They use formatting, specific words, or punctuation to signal these organizational structures. Becoming familiar with the most common forms of organization and their signals will help you understand academic texts.

Examples & Explanations

A New Post-Surgery **Remedy**

①After surgery, most patients just want to go home. ②Patients recover more quickly at home, so most doctors support the practice, but they face a **dilemma**. ③If they send patients home too soon after surgery, then they may develop complications. ④It is vital to watch these patients carefully until they are out of danger. ⑤The ideal **solution** would be remote monitoring. ⑥This option has recently become available in the form of small patches that can be attached to the skin. ⑦The patches contain sensors that send information to the patient's doctor. ⑧**Several** studies have demonstrated that allowing post-surgery patients to return home with a skin patch can **result in** lower medical costs. ⑨One study showed that the patch **led to** a 25 percent drop in the number of days a patient spent in the hospital, with **similar** health outcomes to those who remained in hospital care.

The overall organization of this passage is problem-solution. However, several other forms of text organization are found within this structure.

Headings often give a clue to organization. This heading includes a word, *remedy*, which suggests a solution.

In sentence 1, the writer introduces the topic: the claim that patients do not want to remain in the hospital after they have had surgery.

In sentence 2, the writer uses the word *dilemma* to announce that the claim presents a problem.

The problem is clearly identified in sentence 3 with an *if–then* expression, which indicates cause and effect. Sentence 4 provides details.

In sentence 5, the word *solution* signals a possible resolution. Sentences 6 and 7 provide details about this resolution.

In sentence 8, the writer does several things.

a. He continues to discuss the solution, but as part of the solution, he begins a section that has cause-and-effect organization, with the signal *result in*.

b. He also makes a claim – a skin patch can result in lower health costs – leading the reader to expect some evidence for the claim.

Sentence 9 offers the first piece of evidence to support the claim. It uses both cause-and-effect organization, with the signal *led to*, and comparison organization, with the signal *similar*.

⑩Another study showed significant **savings** by utilizing the skin patch. ⑪The skin patch, which required no in-house or in-hospital care, cost one hospital about $1,600 per patient per year. ⑫**In comparison**, in-home care cost the hospital $13,000 per patient per year, and in-hospital care was over twice that at almost $78,000 per patient per year.

Sentence 10 provides the second piece of evidence for the claim.

Sentences 11 and 12 provide details for the second piece of evidence. They show a compare/contrast organization, using the signal *in comparison*.

The Language of Text Organization

The charts below show the signals of organization that writers often use in academic texts.

CAUSE AND EFFECT			
Nouns		**Verbs / Verb Phrases**	
benefit	*influence*	*to affect*	*to contribute to*
cause	*origin*	*to attribute to*	*to have a role in*
consequence	*outcome*	*to be a factor in*	*to lead to*
effect	*purpose*	*to be associated with*	*to play a part in*
factor	*reason*	*to be responsible for*	*to produce*
impact	*result*	*to benefit from*	*to promote*
		to blame	*to result from*
		to cause	*to trigger*
To Introduce a Phrase		**To Connect Clauses**	**To Connect Sentences**
as a result of [+ cause]		*as* [+ cause]	*As a result,* [+ effect]
because of [+ cause]		*because* [+ cause]	*Consequently,* [+ effect]
due to [+ cause]		*if* [+ cause] (*then*) [+ effect]	*For this reason,* [+ effect]
thanks to [+ cause]		*since* [+ cause]	*In an effort to* [+ effect]
		so that [+ effect]	*So,* [+ effect]
			Therefore, [+ effect]

COMPARISON		CONTRAST	
To Introduce a Phrase	**To Connect Sentences**	**To Introduce a Phrase**	**To Connect Sentences**
in comparison with / to	*in comparison,*	*despite*	*although*
like	*likewise,*	*in contrast to*	*even though*
similar to	*similarly,*	*in spite of*	*however,*
		instead of	*in contrast,*
		unlike	*nevertheless,*
			whereas
			while
			yet

DEFINITION
Verbs / Phrases
is / are
is / are called
is / are defined as
is / are known as
is / are referred to as
in other words
mean(s)
that is

CLASSIFICATION			
Verbs	**Nouns**		**Other**
to be based on	*category*	*part*	*based on*
to categorize	*class*	*section*	*depending on*
to classify	*component*	*set*	*including*
to consist of	*form*	*sort*	
to divide (into)	*group*	*type*	
to group	*kind*		
to include			

PROBLEMS			SOLUTIONS	
Nouns		**Verbs**	**Nouns**	**Verbs**
barrier	*failure*	*to damage*	*relief*	*to address*
challenge	*hardship*	*to endanger*	*remedy*	*to catch*
concern	*issue*	*to fail*	*resolution*	*to cope with*
conflict	*lack*	*to harm*	*response*	*to deal with*
crisis	*obstacle*	*to risk*	*solution*	*to ease*
damage	*problem*	*to threaten*		*to overcome*
danger	*risk*			*to relieve*
difficulty	*setback*			*to remedy*
dilemma	*shortage*			*to resolve*
dispute	*threat*			*to respond to*
error	*trouble*			*to solve*
				to tackle

In addition, writers may use formatting, such as headings, lists, and bullets, as well as punctuation, to signal text organization.

Strategies

These strategies will help you recognize and understand text organization.

- Look for signals of broader text organization, like section headings and bulleted lists while you preview or read an article.
- While you read, look for more local signals of text organization, such as words, phrases, and punctuation.
- After identifying a text organization signal, scan ahead to find information that is linked to this type of organization. For example, if the signal indicates a list, look for items in the list. If a signal indicates a problem, identify the problem and then look for a solution.
- Expect several types of text organization within a single reading. Some will structure larger portions of the reading; others will only give structure to short sections.
- Writers do not always provide explicit signals to indicate text organization. In these cases, you will need to infer how the text is organized.

Skill Practice 1

Read the following sentences. Highlight the text organization signals and check (✓) the type of organization they signal. A signal may be a single word or a phrase, and there may be more than one signal in an item. The first one has been done for you.

1 The fatal misdiagnosis of their daughter in 1993 led a British couple to develop an app to help doctors arrive at more accurate diagnoses.

a ____ compare/contrast b ✓ cause/effect c ____ definition

2 The app has several components. One section provides all possible diagnoses. A second section helps the user rule out irrelevant ones and narrow down likely possibilities.

a ____ classification b ____ definition c ____ problem/solution

3 Errors in diagnosis are the most serious patient safety issue. Hospitals are starting to develop systems to catch these errors before patients get hurt.

a ____ problem/solution b ____ cause/effect c ____ definition

4 Many hospitals have difficulty maintaining a sterile environment.

a ____ cause/effect b ____ comparison/contrast c ____ problem/solution

5 Periodic outbreaks of infections in hospitals are often blamed on bacteria and fungi that grow on walls, floors, and bedding.

a ____ problem/solution b ____ cause/effect c ____ definition

6 For years, scientists have been trying to find a way to minimize the risk that these microorganisms pose to patients' health and safety.

a _____ cause/effect b _____ problem/solution c _____ classification

7 Covering surfaces with an antimicrobial film has resolved the problem to some degree.

a _____ comparison/contrast b _____ classification c _____ problem/solution

8 However, the film cannot be spread uniformly across soft and irregular surfaces. High cost is also an obstacle to its widespread use.

a _____ cause/effect b _____ classification c _____ problem/solution

9 A new product has just come on the market, which, unlike its predecessor, works effectively on soft surfaces like bedding and curtains.

a _____ definition b _____ comparison/contrast c _____ problem/solution

10 It consists of titanium oxide and copper.

a _____ classification b _____ comparison/contrast c _____ cause/effect

Skill Practice 2

Read the following passages. Determine what type of text organization is used in each passage and write it on the line. Highlight the signal(s) that indicates the type of text organization. The first one has been done for you.

1 The Quantified Self (QS), a program that uses technology to analyze all aspects of our daily lives, is growing in popularity.

Definition

2 Declining costs of analysis have enabled ordinary people to participate in this kind of self-tracking. In addition, there have been improvements in two types of technology that are essential to the QS program:

- Sensors, monitors, computer programs, and phone apps make it simple to track every possible metric.
- Powerful computing tools have made it equally easy for anyone to break down the results to see patterns in their own behavior.

3 When these apps first emerged, it was not possible to track blood sugar levels or examine the microbes in intestines at a reasonable price. In contrast, the cost to perform such functions today is relatively inexpensive.

4 There are many types of QS apps, but three categories are the most popular: The most frequently downloaded apps are related to diet and fitness. Diet apps maintain a record of the calories ingested as well as the carbohydrates, fats, and proteins consumed. Fitness apps are also popular. They monitor how users move, how far they walk, and the number of calories they burn. Finally, many QS enthusiasts have downloaded sleep apps, which monitor their sleep activity.

5 One other major type of QS app is the mood monitor. Unlike the wellness and sleep apps, mood monitor apps are more subjective. Instead of facts and data, they require opinions and emotions as data.

6 Most users adopt QS for self-improvement. Enthusiastic supporters report that their experience using the QS app has been positive. One person wanted to lose weight. She tracked her food consumption and activity. She believes this record contributed to her weight loss – 25 pounds (11 kilos). Another person with lung disease improved his lung capacity by 30 percent. He attributes these results to the detailed record of his breathing that he kept with the QS app.

7 Thanks to the growing popularity of QS, there has been a steady increase in business opportunities for app developers and marketers. There are numerous businesses that are ready and eager to sell the public the tools they need to track, analyze, and share just about any possible metric.

Connecting to the Topic

Discuss the following questions with a partner.

1 The terms *health* and *wellness* have similar meanings, but they are not exactly the same. How do you think they differ?

2 Do you or members of your family rely on technology to manage your health?

3 Do you or members of your family use any technology to keep track of what you eat, how much you exercise, or what medicine you take?

4 How do you communicate with your doctor? In person? Phone? Text? Email?

Previewing and Predicting

You will understand a reading more easily if you form an idea about its organization and content before you start reading. One way is to read the first sentence in each paragraph. This method can help you predict what the reading will be about.

A Read the title and first sentence of paragraphs 2–8 in Reading 1. Then read the following topics. Write the number of the paragraph next to the topic where you think it will be discussed.

PARAGRAPH	TOPIC
	Controlling the spread of disease with mHealth devices
	Attitudes of health-care professionals to mHealth
	mHealth for healthy people
	Providing health care in locations far from hospitals
	Details of how mHealth devices operate
	The role of mHealth devices in managing health-care problems
	Improving communication with patients with mHealth devices

B Compare your answers with a partner's.

While You Read

As you read, stop at the end of each sentence that contains words in bold. Then follow the instructions in the box in the margin.

READING 1

Health and Wellness on the Go

1 Marie Jesperson is 92 and is beginning to have significant health problems that require a variety of medications, but occasionally she forgets to take them, or she confuses the days or dosage[1]. Caroline Silva is pregnant for the second time and has serious health concerns. She lost her first baby, so her pregnancy is considered high risk, requiring weekly visits to a clinic for check-ups. Her doctor has informed her that she will need to spend the final weeks of her pregnancy in the hospital connected to a fetal[2] heart monitor that can detect whether her baby is in distress. Zhang Bao has cardiovascular disease; his heart is weak, and many of his arteries are **blocked**. This condition requires medication, as well as frequent blood tests and electrocardiograms[3] to monitor his cardiovascular health. Unfortunately, there is no hospital near his home, so he has to take time off from work to go to a hospital in another town. If the tests indicate there is a problem, Zhang must make a second trip to consult with a doctor and adjust his medication. For all of these patients, the current medical care is both inconvenient and expensive, and in some cases, not as safe as their doctors would like. In the coming years, however, this situation is likely to change for the better.

2 This transformation is coming in the form of mobile health care, or mHealth, which is defined as all forms of health care that take advantage of mobile devices. The development of mHealth solutions is possible because of a combination of technological advances: smaller, more powerful sensors; increased, cloud-based[4] computing power and storage; and wireless data transfer capabilities. All of this technology has become available within a single device – the mobile phone, or, in some cases, a device that works in conjunction with a mobile phone. These powerful devices are capable of providing and transmitting health information on the go. In the past, this could be done only in doctors' offices and hospitals. As of 2013, there were nearly 100,000 health-related apps for mobile phones. Patients can download an app, and the phone transforms into a health-care **device**.

WHILE YOU READ 1

Look back at this sentence and find context clues that help you guess what *cardiovascular* means. Underline these two words.

WHILE YOU READ 2

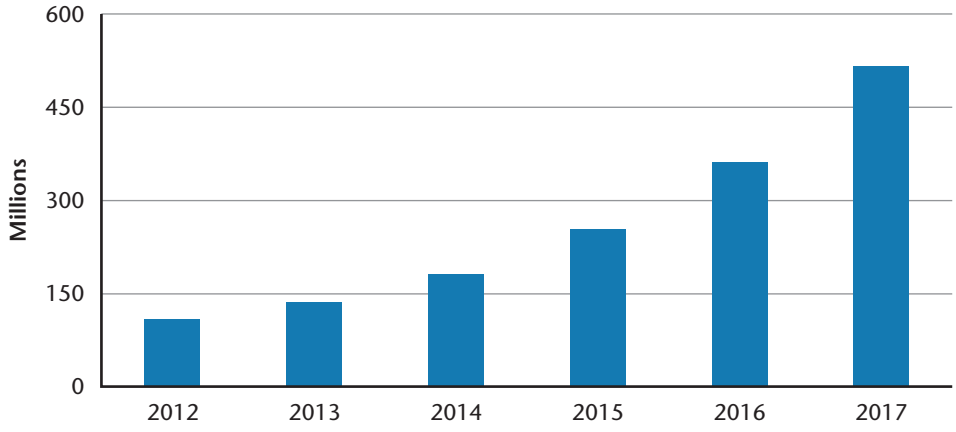
Look back at paragraph 2. Highlight a signal of definition in the paragraph and underline the definition.

I. Developments in mHealth for Patients and Practitioners

3 Although there are many new and prospective roles for mHealth, it is currently most widely used in the monitoring and management of health

[1] *dosage:* a measured amount of medicine
[2] *fetal:* related to an unborn baby
[3] *electrocardiogram:* a record of the electrical activity of the heart
[4] *cloud-based:* related to computer use and storage delivered from a remote location rather than a desktop

Figure 2.1 Global Mobile Sensing Health and Fitness Sensor Shipments (2012–2017)



problems, particularly those associated with chronic disease. Monitoring comes in two primary forms and operates in two **directions**. In one form, patients wear sensors on their bodies, for example, on a watch or skin patch. These devices can measure and record a wide range of physiological functions, such as body temperature, respiration, and blood pressure, or, for pregnant women, fetal heart rate. This information is transmitted continuously and wirelessly to a laboratory or health-care provider, so at the first sign of trouble, often before patients themselves are aware that anything is wrong, the provider can take action. This action could be anything from adjusting medication to admitting a patient to a hospital. Such continuous monitoring minimizes the need for patients to come in for frequent tests and, more importantly, can avert a major health crisis by providing an early warning. The sale of these mobile sensors is growing dramatically. (See Figure 2.1.)

WHILE YOU READ 3

Highlight two words in this sentence that indicate classification into categories. Scan paragraphs 3 and 4 and highlight the two noun phrases that introduce these two forms of monitoring.

4 Mobile sensors worn on the body go in one direction, transmitting vital information from patients to health providers, whereas a second form of monitoring – a lower-tech mHealth solution – works in the other direction, from doctors to patients. When doctors prescribe medication, it can be difficult to ensure that patients comply accurately or completely with the doctor's instructions. The second form of monitoring is ideal for addressing this problem. Automated SMS text messages can be sent by health-care providers to patients, reminding them of which medications to take and when to the take them.

5 Patient compliance is also crucial with communicable diseases, such as tuberculosis[5], which are difficult to treat because of the complex and extended therapy they require. In order to cure patients' tuberculosis and,

[5] *tuberculosis:* a dangerous lung disease

equally important, to ensure that the disease does not spread, compliance is essential. However, because the therapy takes many months and involves multiple medications, many patients begin treatment but never finish it, or they skip doses. This kind of noncompliant behavior can promote drug-resistant strains[6] of communicable diseases, which can then quickly spread. mHealth programs that utilize automated reminders can increase the effectiveness of treatment considerably. They can also lead to huge savings in health-care costs. One estimate suggests that advances in mHealth could save almost 200 billion dollars over the next 25 years in the United States **alone**.

6 Advances in mHealth devices are also allowing health-care workers to provide services to patients who do not have easy access to a doctor's office or hospital. In China, there is increasing concern about cardiovascular disease, which kills three million people a year. Many of these deaths could be prevented with adequate monitoring, a practice that is difficult to sustain, particularly for patients who live outside of urban centers. Today nurses and local health-care workers in China are responding to this public health challenge by using a handheld device to collect patient data. It records thirty seconds of cardiac data and transmits it to a central facility in Beijing. There, doctors and technicians analyze the data and can then provide an immediate diagnosis and recommend a treatment plan. The program is already having a major impact on the annual heart attack rate in China. One analyst estimates that if the incidence of heart disease declined by just 1 percent over the next 30 years, China could save more than $10 trillion in health-care **costs**.

WHILE YOU READ 4

In paragraph 5, the author makes the claim that patient compliance is crucial. What evidence does the author provide to support that claim? Highlight the sentence(s) of support.

WHILE YOU READ 5

Look back at paragraph 6. Highlight the signals of problems and solution.

II. Personal Wellness

7 The growth of mHealth is not limited to the sick and elderly; healthy people are also using a wide range of mobile devices and apps to monitor and maintain their health. In general, the goal of these wellness mHealth devices and apps is to promote self-awareness and self-improvement. Mobile apps allow individuals to track a variety of physiological metrics, such as heart rate and body temperature, which in the past, could only be monitored by a health-care professional. People can also track their activities: how far they walk, how many calories they burn, how many hours and how deeply they sleep. These metrics are recorded by wearable sensors, while other apps require input from users; for example, users can enter what they eat, and the app tells them how many calories or how much fat they have eaten. The recorded data can be stored, analyzed, and even shared through social media.

8 In general, health-care professionals have accepted these health and wellness apps. Other mHealth apps that provide self-diagnosis, in contrast,

[6] *drug-resistant strain:* a type of bacteria that does not respond to medication

have received a more cautious reception from doctors. **Melanoma**, a dangerous and often deadly form of skin cancer, can start as small lesions[7] on the skin. Dermatologists[8] can evaluate these lesions to determine if they are cancerous. The skin cancer diagnosis app allows people to do this themselves by taking photographs of their skin lesions. The photographs are then compared to a library of images stored in the app. The results suggest whether a person's lesion may be cancerous. Health-care professionals remain skeptical of such apps. They worry that these apps may not be accurate enough to lead to early detection and are concerned that they might become an unwise substitute for consulting a doctor. Because these self-diagnosis apps are relatively recent, this question remains open.

WHILE YOU READ 6

Use punctuation clues to find the definition of *melanoma*. Underline the definition.

9 It is likely that the role of mobile devices in promoting individual and community health will continue to expand throughout the twenty-first century. Annual expenditures on mHealth and wellness apps alone are expected to exceed 25 billion dollars in just a few years. At the same time, mHealth is expected to save billions of dollars and improve the lives of thousands of patients, like Marie Jesperson, Caroline Silva, and Zhang Bao.

[7] *lesion:* a sore or an injury to a part of the body
[8] *dermatologist:* a doctor who treats diseases of the skin

Main Idea Check

Match the main ideas below to five of the paragraphs in Reading 1. Write the number of the paragraph on the blank line.

_____ **A** mHealth devices send patient information to health-care providers.
_____ **B** mHealth devices can help stop communicable diseases from spreading.
_____ **C** The value of some mHealth apps has not yet been decided.
_____ **D** Advances in technology have enabled the growth of mHealth.
_____ **E** mHealth can extend the geographic reach of patient care.

A Closer Look

Look back at Reading 1 to answer the following questions.

1 What do the three patients in Reading 1 have in common?
- **a** They all need more intensive health-care solutions.
- **b** They have all benefited from developments in mHealth.
- **c** Their health care could be improved through mHealth.
- **d** They will all have better health care in the future.

2 What development(s) in technology have allowed mHealth to grow so rapidly? Choose all that apply.
- **a** Apps for mobile phones are now widely available.
- **b** It has become easier to send information wirelessly.
- **c** The cost of mobile health care has dropped dramatically.
- **d** Computers are much smaller than in the past.

3 In what ways are mHealth applications ideally suited for the management of chronic disease? Choose all that apply.
- **a** They are cheaper than visits to a doctor's office.
- **b** They can measure several different body functions.
- **c** They are more convenient for the patients' doctors.
- **d** They can provide constant monitoring.

4 Monitoring devices remain limited because they can only send information in one direction. **True or False?**

5 How can automated SMS messages improve health care? Choose all that apply.
- **a** They can improve individual health care by increasing patient compliance.
- **b** They can improve community health care by increasing compliance of patients with dangerous diseases.
- **c** They can remind patients about important health-care information.
- **d** They can increase the compliance of health-care practitioners with new laws for mHealth.

6 mHealth devices allow doctors to visit patients who live in remote locations. **True or False?**

7 How can mobile wellness apps help users? Choose all that apply.

a They allow users to keep a record of their behavior.
b They make users aware of their own behavior.
c They indicate what medication that users need.
d They notify the users' doctors about their behavior.

8 Why are some doctors hesitant to accept health care apps?

a They are afraid that some of their patients will stop coming to their offices.
b They are concerned that patients will be frightened by what they learn.
c They believe that patients should not have this kind of information.
d They are afraid that they will lead to a misdiagnosis.

Skill Review

In Skills and Strategies 4, you learned that writers usually use a variety of text types within a single piece of writing. They often, though not always, signal the type of text organization with formatting, nouns, verbs, and connectors.

A Reread the following paragraph from Reading 1. Then answer the questions.

Marie Jesperson is 92 and is beginning to have significant health problems that require a variety of medications, but occasionally she forgets to take them, or she confuses the days or dosage. Caroline Silva is pregnant for the second time and has serious health concerns. She lost her first baby, so her pregnancy is considered high risk, requiring weekly visits to a clinic for check-ups. Her doctor has informed her that she will need to spend the final weeks of her pregnancy in the hospital connected to a fetal heart monitor that can detect whether her baby is in distress. Zhang Bao has cardiovascular disease; his heart is weak, and many of his arteries are blocked. This condition requires medication, as well as frequent blood tests and electrocardiograms to monitor his cardiovascular health. Unfortunately, there is no hospital near his home, so he has to take time off from work to go to a hospital in another town. If the tests indicate there is a problem, Zhang must make a second trip to consult with a doctor and adjust his medication. For all of these patients, the current medical care is both inconvenient and expensive, and in some cases, not as safe as their doctors would like. In the coming years, however, this situation is likely to change for the better.

1 What type of text organization is used in this paragraph?

_____

2 Highlight the words or features in the paragraph above that signal this type of organization.

B The primary text organization of Reading 1 is cause and effect. Read the following sentences from paragraph 5 of this reading. In each sentence, highlight the signal(s) of cause and effect, and then underline the phrases that show either cause or effect. Write *C* before phrases that are causes and *E* before those that are effects. The first one has been done for you.

1 E Patient compliance is also crucial with communicable diseases, such as tuberculosis, which are difficult to treat because of C the complex and extended therapy they require.

2 However, because the therapy takes many months and involves multiple medications, many patients begin treatment but never finish it, or they skip doses.

3 This kind of noncompliant behavior can promote drug-resistant strains of communicable diseases, which can then quickly spread.

4 mHealth programs that utilize automated reminders can increase the effectiveness of treatment considerably. They can also lead to huge savings in health-care costs.

Definitions

Find the words in Reading 1 that are similar to the definitions below.

1 to get information from an expert (*v*) Par. 1
2 ability; capacity (*n*) Par. 2
3 working together with (*prep*) Par. 2
4 continuing for a long time, especially for diseases (*adj*) Par. 3
5 to reduce to the lowest level (*v*) Par. 3
6 to obey an order or request (*v*) Par. 4
7 to record behavior or development over time (*v*) Par. 7
8 the discovery and identification of a problem – usually of a medical problem (*n*) Par. 8
9 the way that someone reacts to information (*n*) Par. 8
10 to go beyond; to be more than (*v*) Par. 9

Synonyms

Complete the sentences with words from Reading 1 in the box below. These words replace the words or phrases in parentheses, which are similar in meaning.

avert	distress	monitor	prospective	transformation
detect	incidence	promote	sustain	transmit

1 There is a new product that (encourages) _____ hair growth in men who are bald.
2 If the business does not begin to make a profit soon, we will not be able to (continue) _____ our operations.
3 As part of an economic (change) _____ after the war, thousands of people moved from farms to cities.
4 The government will (check) _____ the impact of the new tax law to see if it has a negative effect.
5 We need to act immediately if we want to (avoid) _____ a disaster.
6 Dogs can (sense) _____ a wider range of sounds and odors than humans.
7 I am sure that this beautiful home will appeal to many (potential) _____ buyers.
8 Mobile phones (send) _____ signals to towers in the network whenever you make a call.
9 From the expression on her face, it was clear that she was in extreme (trouble) _____.
10 The (occurrence) _____ of crime is usually higher in cities than in the countryside.

Thinking

EXPLORING OPINIONS

Critical readers form their own opinions about important topics in a text.

Reading 1 discusses the potential of mHealth to transform health care and personal wellness. It presents a generally positive outlook.

A Read the following list of mHealth functions you have learned about in Reading 1. If necessary, review the text. Then with a partner, discuss whether these mHealth responses to health-care problems may have any negative outcomes.

1 Patient compliance
   a To maintain individual health
   b To prevent the spread of communicable diseases

2 Home monitoring for chronic disease and high-risk pregnancy

3 Mobile diagnostics outside of a health-care facility

4 Personal health and wellness apps
   a Sensors that automatically collect data
   b Apps that require users to input data

B As a class, discuss whether the usefulness of these mHealth applications outweighs any potential negative outcomes.

Research

You have read about the growing popularity of personal health and wellness apps. Research this topic and choose an app that you think would be useful for you. Find answers to the following questions.

- What is the purpose of this app?
- How does it work?
- How is this app useful?
- How could this app improve users' health or change their behavior?
- Would you recommend it for others?

Writing

Write a short report on your research. Write two paragraphs about the app you have chosen. The first paragraph will describe the app and how it works. The second paragraph will describe in detail why you have chosen this app out of the many apps available, as well as the impact you think it could have on your health and wellness.

Connecting to the Topic

Discuss the following questions with a partner.

1 What do you think the world's most serious health problems are?
2 Where do you think the most serious health problems exist?
3 What are some of the obstacles to solving these problems?
4 Could technology be a solution to any of them? Explain your answer.

Previewing and Predicting

Writers can indicate text organization by the using special formatting, such as numbered or bulleted lists. They may use other treatments for this purpose as well. For example, certain sections of a reading may be separated from the rest of the text by the use of headings, subheadings, or phrases in italics.

A Read the title of Reading 2, the sentences that are introduced by numbers or bullets (•), and the words that are in *italics*. Then put a check (✓) next to the topics you think will be included in the reading.

_____ A How mHealth can help people who live far from cities
_____ B How overpopulation affects global health
_____ C Solving today's most serious global health problems
_____ D Recommendations for mHealth projects
_____ E The role of mHealth in education
_____ F Profits from mHealth devices
_____ G Health problems that affect mothers and young children

B Compare your answers with a partner's.

While You Read

As you read, stop at the end of each sentence that contains words in bold. Then follow the instructions in the box in the margin.

READING 2

Funding Global mHealth Projects

Executive Summary

1 As the cost of mobile technology drops and mobile phone networks expand, philanthropic[1] and non-governmental organizations (NGOs) have rushed in to fund mobile health (mHealth) projects in the developing world. Of particular interest to many NGOs are those mHealth projects designed to meet the health-related United Nations Millennium Development Goals (MDGs):

- Reduce child mortality[2]
- Reduce maternal mortality and improve maternal health
- Combat HIV/AIDS, malaria, and other **infectious diseases**

This report provides a context for funding opportunities in mHealth, including profiles of some currently funded mHealth projects in the developing world. It also explores some of the challenges and limitations that other NGOs have encountered in the implementation of these projects. Finally, it makes preliminary recommendations for funding future mHealth projects based, in part, on lessons learned.

WHILE YOU READ 1

Try to guess the meaning of *infectious diseases* from the examples the author gives. Underline the examples and write a definition: _____

I. Putting the Health Problems in Context

2 There are numerous challenges in global health, but the following concerns are among the most significant.

1 Children born in developing countries are 33 times more likely to die before the age of five than children born in industrialized countries. Often the cause of death is a preventable and/or treatable disease.

2 One woman dies every minute as the result of the complications of pregnancy or childbirth. Every year, nearly 10 million more suffer a serious pregnancy-related injury or infection.

3 Approximately 2.3 million people became infected with HIV in 2012. The same year, more than eight million people contracted tuberculosis and about 200 million contracted malaria.

II. The Promise of mHealth Projects

3 mHealth programs have been heralded as transformative, with the potential to bring basic health care to geographically or socially isolated populations that often have minimal educational and financial resources. It is these populations that are the target of the MGDs and that are likely

[1] *philanthropic:* charitable
[2] *mortality:* death

to derive the greatest benefit from mHealth initiatives. Studies show that in the developing world, mobile phones are far more prevalent than televisions, radios, or computers, thus facilitating their use as the primary form of communication and vehicle for the delivery of services in public health **initiatives**.

WHILE YOU READ 2

Highlight the signal phrase that the author uses to present evidence for this claim.

III. Current mHealth Projects

4 Currently funded mHealth projects have a broad set of goals:

Building health awareness and providing health information

In some projects, patients and their families initiate communication with health-care providers. The predominant example of this is the call center. For a small fee, or in some cases, for no fee, members of the public can call and obtain answers to questions on a range of health issues, including **prenatal** care, immunizations[3], and disease prevention. Other mHealth initiatives operate in the other direction, with messages that are disseminated widely to the public, as in campaigns to promote immunization. In others, such as a program for pregnant mothers in Bangladesh, messages are more targeted. In this project, trained health-care workers visit expectant mothers and register them for regular health reminders by voice or text during and after their pregnancy. (See Figure 2.2.)

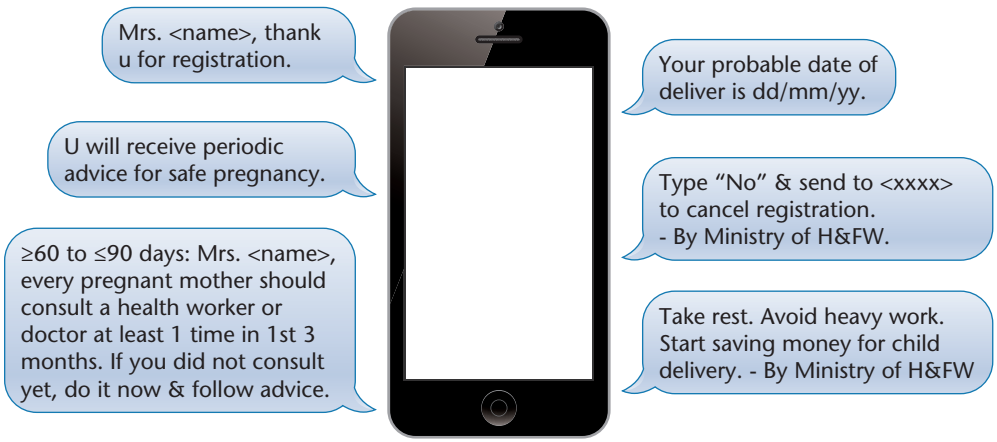
WHILE YOU READ 3

Use your knowledge of word roots and parts of words to guess the meaning of *prenatal*. Does it mean (a) before marriage, (b) women's health, or (c) before birth?

5 *Collecting information on public health and tracking the spread of disease*

One of the most important mHealth functions is the tracking of infectious diseases. It is difficult for officials to respond to a public health crisis if they don't know where it is. A program in Cambodia is tackling

Figure 2.2 Sample Text Messages Between Health-care Workers and Expectant Mothers



Source: World Health Organization

[3] *immunizations:* protection against future disease, often by injection

this problem by using SMS messages to track and report twelve diseases, including cholera, measles, and dengue fever. If local health workers become aware of outbreaks of these diseases, they send a text message to a central office, which compiles similar information from all over the country. When the number of cases of any of these diseases exceeds an established threshold, this triggers an emergency response, and a team of health professionals is sent to the area.

6 *Monitoring patient health and compliance*

This function is particularly important for managing chronic **disease**. Programs in Thailand and the Philippines have been using SMS messaging to remind tuberculosis patients to take their medication. A much more efficient and cost-effective[4] approach than home visits, these programs have achieved 90 percent patient compliance.

WHILE YOU READ 4

What evidence does the author provide for this claim? Underline the evidence.

7 *Providing diagnosis and treatment in geographically remote areas*

Mobile phones can extend the reach of health care by empowering local health-care workers with the tools to diagnose and treat patients. In many remote areas, community health workers, not doctors, are the primary care providers. They can treat routine cases; however, they may lack the expertise for more complex cases. With mobile technology, they can rely on diagnostic and treatment guides available on their phones, eliminating the need to contact a doctor. Australian researchers are working on a project for health workers in Mozambique, creating reference materials and analytical tools that are stored on their phones.

IV. Challenges and Limitations in mHealth

8 Although the potential benefits of mHealth in the developing world are enormous, there are also significant challenges that funders[5] should not overlook.

Evaluation: Many mHealth projects never progress beyond the pilot stage[6]. Most of these have been evaluated in terms of feasibility, rather than their impact on health.

Scale: Even projects that pass the feasibility test often fail when they attempt to operate on a larger scale. What is effective in a small corner of the country may not work on a regional or national scale.

Integration: If an mHealth project fails to take into account systems that are already in place, it can be difficult to integrate the mHealth project into the existing systems. Sometimes the obstacles to success are obvious but not easy to overcome. Projects that rely on SMS messages will not work if the target population is not literate[7], if the messages are in a language that the target population does not understand, or if the patients do not trust the messenger.

---

[4] *cost-effective:* producing good value for the amount of money
[5] *funders:* people or organizations who provide money for a specific purpose or cause
[6] *pilot stage:* the beginning phase of a project during which ideas are tested
[7] *literate:* able to read and write

Strategic planning: The most basic problem of all is reaching the target population. A project aimed at promoting maternal and fetal health, for example, will be most effective if the mobile phones are in the hands of women. If men control phone use, a different strategy is required.

Economic barriers: Finally, even if initiatives are considered low cost by funders, local users may not share this perspective. A subscription to an SMS health message service may cost users only a few cents, but this money may be needed for food or other essentials. Most projects that do not move beyond the pilot stage fail because these local concerns are not considered fully as part of the planning **process**.

WHILE YOU READ 5

Reread section IV and highlight the signals used to indicate problems.

V. Recommendations

9 Based on a review of past and current mHealth initiatives, we offer the following general recommendations:

1. Employ the simplest possible technology. Seventy-five percent of people in developing countries have access to basic mobile phones. Although the capabilities of smart phones make them more powerful, at this time, it is not advisable to base any project on their availability.
2. Plan a project that has the broadest possible impact. Although there are many worthy projects, those aimed at maternal-fetal health may have the greatest and most immediate potential to save lives and improve health. Providing prenatal and postnatal care need not be expensive or complicated but can make a huge difference in health outcomes.
3. Take local context and stakeholders[8] into account during the planning stage. First, funders must understand the existing public health structure and determine if and how their proposal can be integrated into it. If it cannot be, the chances for the long-term success of the project are remote. Second, it is crucial to understand the local culture. Who will patients trust for health advice and treatment? Pregnant women may prefer to hear advice from a woman, but it must also be someone they respect as knowledgeable about health issues. What language should be used in health messages? Would written or oral messages be more effective for the target population?
4. Keep costs low, both for the infrastructure and for users. To ensure the long-term success of the project, it must be possible for either the government or organizations in the host country to assume responsibility for the cost of the project once the pilot stage is over. Equally important, users must be able to participate in the program at either no cost or at a very low cost.

[8] *stakeholder:* a person who has an interest in the success of a program

Main Idea Check

Here are the main ideas of five of the paragraphs in Reading 2. Match each paragraph to its main idea. Write the number of the paragraph on the blank line.

_____ **A** mHealth programs can bring health care to people in remote areas.

_____ **B** Organizations are interested in mHealth projects for their potential to meet the UN Millennium Development Goals for health care.

_____ **C** Successful mHealth programs must understand and integrate local concerns.

_____ **D** A rapid increase in access to mobile phones has increased the potential of mHealth initiatives.

_____ **E** mHealth projects can help monitor and prevent the spread of disease.

A Closer Look

Look back at Reading 2 to answer the following questions.

1 Reading 2 is an executive summary. What purposes does it serve? Choose all that apply.

a It provides background information on global mHealth projects.
b It explains reasons for the health problems of the developing world.
c It makes funding recommendations for mHealth programs.
d It compares health problems in the industrialized and developing world.
e It explains the United Nations MDGs.

2 What makes mHealth particularly well suited to address global health problems?

a mHealth solutions are particularly appropriate when primary care providers are not doctors.
b The UN Millennium Development Goals are targeted at health problems in the developing world.
c The wide availability of mobile phones makes the delivery of services cost-effective.
d The Internet is giving people access to a wider range of health-care options.

3 At the core of many mHealth programs is communication and the exchange of information. In the chart below, for each program, write a check (✓) to indicate the direction in which information goes.

	PATIENTS TO PROVIDERS	PROVIDERS TO PATIENTS
Call centers		
Immunization campaigns		
Prenatal health for expectant mothers in Bangladesh		
Patient compliance programs		

4 How can mHealth programs slow the spread of infectious diseases? Indicate the order of the events. Write the correct letter in each box.

A Community health workers send information about the number of cases to a central office.
B An outbreak of disease occurs.
C When a predetermined level of infection is reached, health workers are sent to assist the community experiencing the outbreak.
D A central office tracks the number and seriousness of the outbreaks.

5 How can mHealth improve health care for communities in remote areas?

a Mobile phones make it easier for local health-care workers to communicate with medical experts.
b New technology allows experts in central locations to access the medical histories of patients in remote areas.
c Access to technology has meant that fewer people need to leave their communities to seek health care.
d Materials available through mobile technology can upgrade the skills and knowledge of community health workers.

6 Global mHealth projects often fail because of inappropriate evaluation. **True or False?**

7 Why should stakeholders be consulted during the planning stages of any mHealth initiative according to the Executive Summary?

a They have the most knowledge of what will work in their community.
b They can tell funders how much money mHealth projects are likely to cost.
c They can continue the project even if the funders stop their support.
d Other people trust them.

Skill Review

In Skills and Strategies 4, you learned that writers usually use a variety of text types within a single piece of writing. They often, though not always, signal the type of text organization with formatting, nouns, verbs, and connectors. You also learned that a text may have one overall type of organization but that sections within the text may contain signals of other types of organization.

A **Review Reading 2. Then answer the questions below.**

1 What is the organization of the text as a whole?

_____

2 What type of text organization is used in the section **Current mHealth Projects**?

_____

B **Reread paragraph 5 below. Then answer the questions that follow.**

Collecting information on public health and tracking the spread of disease

One of the most important mHealth functions is the tracking of infectious diseases. It is difficult for officials to respond to a public health crisis if they don't know where it is. A program in Cambodia is tackling this problem by using SMS messages to track and report twelve diseases, including cholera, measles, and dengue fever. If local health workers become aware of outbreaks of these diseases, they send a text message to a central office, which compiles similar information from all over the country. When the number of cases of any of these diseases exceeds an established threshold, this triggers an emergency response, and a team of health professionals is sent to the area.

1 This paragraph includes two different forms of text organization, one in the first half and another in the second half. What are they?

a first half _____

b second half _____

2 What signals does the author use to indicate the text organization?

	LIST OF SIGNALS
First half	
Second half	

Definitions

Find the words in Reading 2 that are similar to the definitions below.

1 the process of putting a plan into action (*n*) Par. 1
2 to say that something new is good and important (*v*) Par. 3
3 to get; obtain (*v*) Par. 3
4 common or happening frequently (*adj*) Par. 3
5 to make something easier (*v*) Par. 3
6 something used as a way of achieving something (*n*) Par. 3
7 to cause something to begin (*v*) Par. 4
8 most noticeable; largest or most common (*adj*) Par. 4
9 to give out; spread (*v*) Par. 4
10 the point at which something starts (*n*) Par. 5
11 to cause a series of events to begin, often suddenly (*v*) Par. 5
12 to not notice or not recognize the importance of something (*v*) Par. 8
13 likelihood that something will be successful (*n*) Par. 8
14 to combine two or more things to make them more effective (*v*) Par. 8
15 the basic structures that an organization, country, etc., needs for its operation (*n*) Par. 9

Words in Context

Complete the passages with words from Reading 2 in the box below.

assume	eliminated	isolated	outbreaks	preliminary
compiling	fund	obstacle	outcome	routine

1 Although the final report will not be issued until next week, a _____ (a) report of Global Health Watch indicates that many people in _____ (b) communities lack access to _____ (c) health care. This situation can lead to periodic _____ (d) of more serious diseases and is a major _____ (e) in the pursuit of global health-care goals.

2 Our office is _____ (f) information on the number of people in the country with the Ebola virus. Because there are so few local health workers who are trained to deal with this deadly disease, our organization will _____ (g) responsibility for staffing hospitals in the areas. We believe that we have _____ (h) most of the sources of infection in the local health-care facilities. We are confident that this operation will have a positive _____ (i). To help _____ (j) this project, please make a donation on our website.

Academic Word List

The following are Academic Word List words from Readings 1 and 2 of this unit. Use these words to complete the sentences. (For more on the Academic Word List, see page 299.)

compiled (*v*)	eliminate (*v*)	implementation (*n*)	outcome (*n*)	promote (*v*)
consult (*v*)	exceed (*v*)	minimize (*v*)	preliminary (*adj*)	transmit (*v*)

1 If everyone wears protective clothing, we can _____ the risk of infection.

2 Travelers who have suitcases that _____ the weight limit for this aircraft will have to pay extra.

3 The _____ of this project will have to be delayed until we receive additional funding.

4 A / An _____ evaluation indicates that a program has been very successful, but the final report will have more complete information.

5 The government has _____ and published a list of hospitals that provide emergency health care.

6 You should _____ a doctor before you begin this diet.

7 The _____ of the election will have important consequences for the nation.

8 GPS satellites _____ information in the form of radio waves.

9 The new medication will _____ the need for surgery for many patients.

10 A warm, moist environment will _____ the growth of bacteria.

Critical Thinking

Readings 1 and 2 present information about advances in mHealth and how they may improve health and wellness. Reading 2 emphasizes the positive impact these applications could have on global health and makes several recommendations about where mHealth funding and efforts should be concentrated.

SYNTHESIZING

Critical thinking includes connecting new information to information you learned in previous readings.

A Work with a partner. Consider the three health-related United Nations Millennium Development Goals (MDGs):

B Based on what you read in this unit and your own knowledge, answer the questions below. Review the readings if necessary.

1 Do you agree with the funding recommendations in Reading 2? Explain why or why not.

2 For which MDG do you think mHealth solutions will be the most useful?

3 In what situation(s) would you personally find an mHealth application useful or helpful?

4 Do you think that the application you chose in number 3 could be extended to meet any of the health-related MDGs?

5 In Reading 1, you read that mHealth solutions have been made possible by three developments: (1) more powerful sensors, (2) cloud-based computing storage, and (3) wireless data transfer. Which of these will be most important for meeting health-related MDGs and why?

Research

As you have read, many NGOs and philanthropic organizations are eager to embrace mHealth applications as a means of solving global health problems. Choose one of the MDGs and research a health problem that is not discussed in the readings. You may want to begin with the United Nations MDG website.

Choose one that you think could be improved with an mHealth application. Take notes on the problem and how an mHealth application could contribute to a solution. You do not need any technical knowledge. Assume only that the mHealth

app will be a mobile phone with the capabilities listed in question 5 of the Critical Thinking activity.

- You can research a real mobile phone app.
- Or, you can use your imagination in describing an mHealth app that you think would be useful. It does not have to be one that already exists, but it should be consistent with the level of technology that you have read about in the readings.

Writing

Your assignment is to make funding recommendations for mHealth similar to the ones in Reading 2.

A Preparing to Write

1 Look over your notes from your research.

2 Review Readings 1 and 2. Highlight any information you think you would like to include in your report.

3 Organize your notes into an outline for the report. It should include the following sections:

- A description of the health problem – what makes this problem particularly challenging?
- A description of the mHealth app
- An explanation of how the app can contribute to solving the health problem

B Writing

1 Write your report. Write one paragraph for each of the points in your outline.

2 Begin each paragraph with a general sentence that tells your reader what the paragraph will be about.

3 Conclude your report with a short recommendation for your app.

4 When you have finished your report, check it for grammar and spelling errors.

Improving Your Reading Speed

Good readers read quickly and still understand most of what they read.

A Read the instructions and strategies for Improving Your Reading Speed in Appendix 3 on page 316.

B Choose one of the readings in this unit. Read it without stopping. Time how long it takes you to finish the text in minutes and seconds. Enter the time in the chart on page 317. Then calculate your reading speed in number of words per minute.

Using the Dictionary to Find Word Meaning

In Skills and Strategies 2, you learned that good readers decide what strategy to use when they encounter unfamiliar words. In some cases, they can use context clues to figure out the meaning of these words while they are reading. However, sometimes there is not enough information in the context to figure out the exact meaning of a word.

When you come across a word you don't know and you can't determine the meaning from the context, you will need to use a dictionary. Many words have more than one entry in a dictionary, so you will have to choose among two or more meanings. You can use your own knowledge and clues in the text to narrow down your choice. Be careful to read all the meanings of the word and choose the one that best fits the context.

Examples & Explanations

1. *His years in prison* ***exacted*** *a heavy toll on his health.*

exact – *v* (obtain) to demand and obtain something, sometimes using threats or force: *The girl's family will surely exact revenge for this crime.*
exact – *adj* (correct) in perfect detail; complete and correct: *The exact distance is 3.4 miles.*

Some words look and sound alike, but they have completely different meanings and are often different parts of speech. They will appear as separate entries in the dictionary. Use grammatical clues such as articles for nouns and tense endings for verbs to decide on the correct part of speech. Then choose the meaning. In sentence 1, the *-ed* ending clearly indicates that *exact* is a verb.

2. *The public needs to* ***recognize*** *the challenges we face in terms of the increasing cost of health care.*

recognize – *v* (know) to know someone or something because you have seen or experienced that person or thing before: *I recognized my old high school teacher from the photograph.*
recognize – *v* (accept as true) to accept that something is true or important: *We recognize the problems you have faced.*

Some words have multiple meanings but are the same part of speech. The meanings may be very different, or they may be related and the differences are more subtle. Dictionaries have different ways of dealing with this situation. In learner dictionaries, different meanings may appear in separate entries with a general category of meaning in parentheses. Or, they may appear as a separate, numbered definition within the same entry. In sentence 2, substitute the general meaning in parentheses into the original sentence. Although the two meanings are close, the meaning *accept as true* is a better fit than *know.*

3. *The government needs to provide more* ***oversight*** *of hospitals.*

oversight – *n* (management) management of an operation or process: *The army provided technical expertise and general oversight to the investigation.*
oversight – *n* (mistake) a mistake caused by a failure to notice or do something: *Because of a bank oversight, the money had not been sent to my account.*

Context clues in the original sentence and example sentences in the definition can help you choose the correct meaning. The example sentences in the definition often use other words that commonly occur with it. In sentence 3, the word *provide* is a common collocation with the first meaning of *oversight.*

4. *He has enough money to* ***weather*** *this period of unemployment.*

weather – *n* Weather is what it is like outside at a specific time, for example, it is raining or snowing.
weather – *v* If you weather a difficult situation, you get through it even though it was hard.

Some dictionaries provide contextual definitions; that is, instead of a formal definition, they show how the word is used. These can be helpful especially when the word is familiar but is used in a very unfamiliar way. This kind of definition can help you decide which sentence is more like the use of the word in your sentence. In sentence 4, the *period of unemployment* is similar to "a difficult situation."

Strategies

These strategies will help you use the dictionary effectively.

- When you read an unfamiliar word, use what you learned in Skills and Strategies 2 to decide which strategy to use.
- If you think a word is important but you cannot guess its meaning, finish reading and then consult a dictionary.
- If there are entries in the dictionary for more than one part of speech, go back to the reading and look for clues such as verb endings or noun forms that will help you choose the correct one.
- If the dictionary provides more than one meaning for a word, go back to the reading to look for clues in the context, such as collocations.
- Substitute each meaning for the word in the original sentences. Decide which one makes more sense.
- Check the examples in the dictionary entry. See if one of the examples uses any of the same words as the original sentence. If the sentences include the same collocation, this may indicate that the original sentence and the dictionary example are related in meaning.

Skill Practice 1

The following sentences contain a word in bold that has more than one meaning. Read the sentences and the dictionary entries that follow. Look for clues that help you decide which definition best fits the meaning of the bold word. Highlight the clues. Then choose the correct definition.

1 The first page of the document gives a general description of the disease, and the following pages offer a **breakdown** of the symptoms and treatment options.

a *n* (division): a division of information into parts that belong together
We need a breakdown of the statistics into age groups.

b *n* (failure): a mechanical failure or a failure in a system or relationship
A breakdown in communication led to an inaccurate report.

2 After the accident, the driver was taken to a hospital, but the hospital **denied** him treatment.

a *v* (claim not true): to say that something is not true
She denied all of the charges that the government has brought against her.

b *v* (refuse): to refuse something or refuse to allow someone to do something
I asked for a little more time to complete the task, but my request was denied.

3 In his speech, the president **appealed** directly to the voters for their support.

a *v* (attract): to be interesting or attractive
This music will appeal to both younger and older listeners.

b *v* (request): to make a serious and formal request
After the earthquake the Red Cross appealed to the public for blood donations.

4 The committee quickly **dismissed** the plan as expensive and impractical.

a *v* (not consider): to decide that something is not important and not worth considering
Let's not dismiss this idea without discussing it first.

b *v* (send away): to formally ask to leave
The teacher dismissed the class early for the holiday weekend.

5 I'll finish painting the bedroom when I have some **spare** time.

a *v* (avoid): to avoid or save something
If you follow the directions carefully, it will spare you a lot of trouble.

b *adj* (extra): not being used, more than is usually available
I keep my spare keys in my desk.

6 My uncle is in the hospital with a heart **condition**.

a *n* (state): the state that someone or something is in
I bought the car because it was in good condition.

b *n* (state): a state that is bad or not working
She was born with a life-threatening condition.

c *n* (limitation): something that must exist or occur before something else can happen
He agreed to the arrangement, but he had several conditions.

Skill Practice 2

The following sentences contain a word in bold that has more than one meaning. The dictionary definitions that follow are in a contextual format. Based on these contextual definitions, decide which definition matches the word in the sentence.

1 I hate it when doctors **patronize** their patients.

a When you patronize people, you appear to be friendly, but you really think you are better than they are.

b If you patronize a store, you shop there and give the store your business.

2 All of the newspaper stories on the election seem **slanted**.

a If something is slanted, it is points at an angle, not horizontally or vertically.

b If information or a report is slanted, it deliberately favors a particular group or point of view.

3 Going to college was the **realization** of all her hopes and dreams.

a A realization of a situation is an awareness and understanding of it.

b The realization of a goal or a plan is the achievement of it.

4 As soon as it was light, we **scrambled** down the hill.

a When you scramble across the ground, you move quickly often using your hands to help you.

b If you scramble something, you mix it up.

5 The first item that the committee will discuss **concerns** the latest development in educational research.

a When an issue or story concerns something, it tells something about it or involves it.

b If something concerns you, it troubles you or causes you anxiety.

Skill Practice 3

The following sentences contain a word in bold that has more than one meaning. Use a dictionary to figure out the meaning of the words as they are used in the sentence. Use the strategies you have just learned to decide which meaning is correct. Write the definition on the blank lines. Check your answers with a partner.

1 He failed to **grasp** the reasons for this decision.

_____

2 The president **issued** a statement about the economy.

_____

3 This seems like a very **rash** decision.

_____

4 Don't **bother** reading the rest of the story.

5 I am going to **defer** to you on this matter.

6 The new **measure** is intended to decrease crime.

7 We need **tougher** rules.

8 The children were not able to **contain** themselves.

9 This recipe needs another **dash** of vinegar.

10 I don't like the **tone** of his message.

Connecting to the Topic

Read the definitions of *genetics* and *genomics*, and then discuss the following questions with a partner.

Genetics refers to the study of individual genes, which are specific sequences of DNA, and their role in inheritance.

Genomics is the study of an organism's entire set of genetic information as well the ways in which it can be regulated.

1 What is the relationship between genes and health?

2 How do you think genetics and genomics might be useful in treating disease?

3 How many genes do you think are in a human genome?

- a about 2,000
- b about 20,000
- c about 2 million

Previewing and Predicting

Reading the section headings and the first sentence in each paragraph can help you predict what a reading will be about.

A Read the section headings and the first sentence of each paragraph in Reading 3. Then read each question in the chart below, and write the number of the section (*I–IV*) where you expect to find the answer. The first one has been done for you.

SECTION	QUESTION
II	Why is it important to understand the structure of the human genome?
	What role does genomics have in preventing disease?
	How will genomics change the treatment of disease?
	What are some of the biggest problems in medicine today?
	How exact is the treatment of disease?
	How might genomics change medicine in the future?
	How can knowledge of the human genome help doctors decide on the right medicine?

B Compare your answers with a partner's.

While You Read

As you read, stop at the end of each sentence that contains words in bold. Then follow the instructions in the box in the margin.

READING 3

Genomics

I. Current Models of Medicine

1 The focus of modern medicine has been primarily to diagnose and cure disease. Doctors perform diagnostic tests to determine the cause of their patients' symptoms, and based on the resulting diagnosis, they suggest medication, behavioral changes, or perhaps even surgery. For serious diseases, such as many cancers, this **intervention** may occur when the disease is fairly advanced because it is only at this stage that patients begin to have the symptoms that motivate them to see their doctors.

2 This model of medical care is imprecise; it involves considerable guesswork. Based on an initial examination, doctors generally consider a range of possible causes of the patient's illness before making any decisions. First, the doctor may order imaging[1] or lab tests, the results of which often rule out some of these possibilities. Using this often lengthy process of elimination, doctors arrive at the most likely diagnosis. The next step is treatment, which can be similarly imprecise. Treatment practices are based largely on statistical data rather than on the facts of individual cases: For example, if fifty percent of patients with a particular disease have responded positively to a specific drug, doctors will begin by treating all patients with that drug.

3 There are obvious problems with this model of health care. Its imprecision is both expensive and labor-intensive. In addition, since each human being is unique, errors in both the diagnosis and treatment inevitably occur. If only fifty percent of patients with the same disease respond positively to a drug, then obviously, fifty percent do not. Some will undoubtedly receive ineffective treatment; indeed, in some cases, the treatment may even be harmful. What if we could change the focus of health care to one based on the characteristics of individual human beings, rather than on statistical probabilities? What if we could concentrate our efforts on prediction and prevention, rather than simply on diagnosis and treatment? Current medical research is taking promising steps in these directions, propelled by the research findings of a new area of biomedical science called ***genomics***.

WHILE YOU READ 1

Can you guess the general meaning of *intervention* from context? Highlight the examples that provide clues.

WHILE YOU READ 2

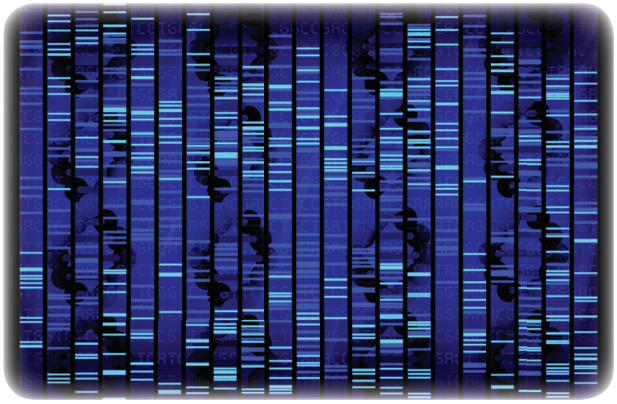
The author makes the claim that the current model of health poses problems. What evidence does the author provide to support that claim. Highlight the sentence(s) of support.

II. The Human Genome

4 Humans have 23 chromosomes[2], each of which contains hundreds of thousands of genes. These genes contain DNA, made up of approximately 3 billion pairs of chemical molecules (labeled A and T; C and G), called base pairs. Together, these base pairs make up the human genome, which contains a complete set of "genetic instructions needed to develop and direct

[1] *imaging:* medical tests that use computers to produce pictures of the inside of the body
[2] *chromosome:* a structure that carries the genetic code for life

the activities of every organism" (genome .gov). In 1998, scientists set out to sequence the entire human genome, in a project that spanned 13 years and cost close to U.S. $3 billion. It determined the sequence of base pairs in a healthy human being, which established a baseline[3] reference for subsequent research. Every human genome is slightly different. Many genes have mutations, or variations, most of which are inconsequential. Other mutations, however, result in life-threatening conditions, such as cystic fibrosis, developmental disorders, and various types of cancer. Analysis of individual genomes, and the mutations they contain, has led to a deeper understanding of these genetic diseases. Genomics researchers have even higher aspirations for this work: that it can lead to individualized forms of disease prevention and treatment. In other words, a person's genome will, in part, determine the course of his or her health care.



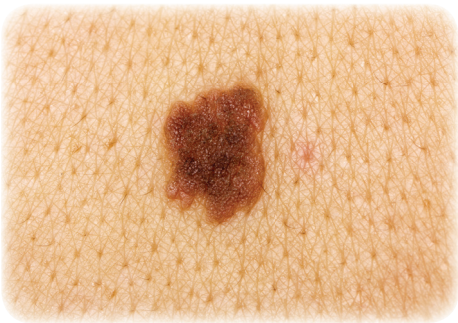
The human genome

WHILE YOU READ 3

After you read about BRAF, use cause-and-effect markers to put the sequence in the correct order: (a) binding of drug to tumor protein; (b) uncontrollable cell division; (c) mutation of the gene; (d) shrinking of the tumor; (e) creation of a defective protein. Not all of the steps in the sequence are introduced by a signal.

III. Genomics in Treatment

5 Genomic research has already resulted in some successes in treatment, even on diseases at an advanced stage. One example is melanoma, the most dangerous form of skin cancer. If not detected at an early stage, it can metastasize[4], causing tumors[5] in other parts of the body, and resulting in almost certain death. However, melanoma is a complex disease, and its trajectory may differ from one patient to another. As might be expected, not all melanoma patients have an identical response to treatment. To be effective, cancer therapy requires a detailed understanding of how specific cancers develop. The only way to discover a cancer's precise structure is to sequence its genome. Sequencing the genomes of different melanomas has revealed that certain types of melanoma have specific mutations of a gene on chromosome 7, called **BRAF**. This mutation results in a defective protein that causes uncontrollable cell division, in other words, cancer. In clinical trials, researchers have been testing a drug that binds to this specific protein, shrinking the tumors, at least temporarily. This treatment is far less toxic than traditional chemotherapy[6], which kills healthy cells along with the cancer cells. The new



Melanoma

[3] *baseline:* the usual condition against which other conditions can be compared
[4] *metastasize:* spread (refers specifically to cancer cells)
[5] *tumor:* a mass of fast-growing cells that can cause illness
[6] *chemotherapy:* the treatment of disease with chemicals (refers specifically to cancer)

treatment is therefore preferable, provided that its long-term effectiveness can be demonstrated.

6 Genomic sequencing can also be a valuable tool in determining drug sensitivity and even dosage levels. In order to prevent strokes[7] or other problems associated with blood clots[8], many doctors prescribe blood thinners for their patients. One popular blood thinner, *warfarin*, has been prescribed for more than 50 years. However, doctors must be cautious when they prescribe it because its therapeutic **range** is quite narrow. If the dose is too low, the drug will be ineffective in preventing dangerous clots; if, on the other hand, the dose is too high, the patient may experience internal bleeding. Early clinical trials provided statistical information about effective dosage levels; however, subsequent trials have shown that genetics plays a major role in sensitivity to warfarin, specifically, that mutations of several genes are responsible for some of the variable sensitivity to the drug. Findings like these will allow doctors to personalize the dosage levels based on patients' genetic profiles.

WHILE YOU READ 4

Which definition of *range* matches the meaning in this sentence? (a) The period of time or space in which something is possible (b) A set of related things

IV. Genomics in Screening

7 **The promise of genomics extends beyond treatment to prevention of disease**. Scientists have already identified a number of genetic mutations responsible for certain cancers, some types of heart attacks, cystic fibrosis, and Huntington's disease. Based on this knowledge, they have developed screening procedures that can predict the likelihood that a person will develop the disease long before any symptoms are evident. In a few cases, the presence of the mutation makes it almost certain that the person will develop the disease, but in most cases, the test can only show that the odds are higher or lower than average. Further complicating the situation are the consequences of discovering this information. For some diseases, it is possible to decrease the likelihood that a person will get sick, and, if he or she does develop the disease, some form of treatment is available. For example, if patients' genomic sequence indicates that their odds of developing diabetes[9] are higher than average, they have several options that may delay or prevent the onset of the disease, including weight loss or a change in diet. In some unfortunate situations, however, no treatment is currently available, and the knowledge that the disease may develop is the only outcome of the screening procedure. However, since some of these mutations can be inherited, this knowledge could be useful in a patient's decision to start a family.

WHILE YOU READ 5

After you read the paragraph, look back at the bolded sentence. In this sentence, the author makes a claim. Highlight one sentence that provides support.

[7] *stroke:* a sudden change in blood flow that can lead to a loss of physical and mental ability
[8] *clot:* a lump of thick blood
[9] *diabetes:* a disease in which the body cannot control the level of sugar in the blood

8 This kind of information is a powerful tool, and it is likely that in the near future, it will be used to prevent and treat disease in thousands of patients. However, it also presents an ethical dilemma. How much information do people want about their future health, especially when this information only represents the probability that they will develop the disease? Consider the example of the gene APOE. People who have one copy of a particular variant of this gene are three times more likely to develop Alzheimer's, a devastating form of dementia[10]. However, for the two percent of the population that has two copies of the variant – one from each parent, the risk of Alzheimer's is 10 to 30 times higher than for those without the variant. This is not the kind of information that everyone wants. Dr. James Watson, one of the two scientists who discovered the structure of DNA, and winner of the Nobel Prize, was one of the first people to have his genome sequenced. He made this genetic information publicly available for research purposes, with one exception: He asked not to be informed of the status of his APOE gene. As the field of genomics advances, the scientific community, together with the public, will have to grapple with ethical as well as medical challenges.

A DNA strand

[10] *dementia:* the gradual loss of mental abilities, especially with age

Main Idea Check

Here are the main ideas for five of the paragraphs in Reading 3. Match each paragraph to its main idea. Write the number of the paragraph on the blank line.

_____ **A** Sequencing a person's genome can help predict future health problems.

_____ **B** Sequencing the genomes of tumors holds promise for treatment of cancer and other diseases.

_____ **C** Diagnosis and treatment can be a guessing game.

_____ **D** Predicting disease presents ethical challenges.

_____ **E** Most health care today is based on the characteristics of groups, not individuals.

A Closer Look

Look back at Reading 3 to answer the following questions.

1 Why does the author characterize current practices in diagnosis and treatment as "imprecise"? Choose all that apply.

- **a** Doctors often need to do research before they can offer a diagnosis or recommend treatment.
- **b** Doctors often have to make diagnoses by methodically eliminating possible causes of illness.
- **c** Decisions about medication and dosage are based on large populations, not on the patient's experience.
- **d** Doctors usually understand only about 50 percent of the cases that they treat.

2 All genetic mutations are dangerous. **True or False?**

3 Why does the author include the example of the treatment of melanoma?

- **a** It illustrates the importance of sequencing not just a person's genome, but the genome of tumor cells.
- **b** It demonstrates how genomics can lead to treatments that are more effective for a longer time.
- **c** It shows that genomic sequencing is not always successful.
- **d** It demonstrates a technique that can prevent cancer tumors from metastasizing.

4 Why do drugs often vary in their effectiveness?

- **a** Sensitivity to drugs is different at different points in the day.
- **b** Doctors prescribe different dosage levels for different patients.
- **c** Genomic sequencing is sensitive to dosage levels.
- **d** There is a genetic component to drug sensitivity.

5 Why might patients choose to have genetic screening? Choose all that apply.

- **a** The result might affect their decision to have children.
- **b** The result might motivate them to seek treatment even before they get sick.
- **c** The result might motivate them to make changes in their lives.
- **d** The result might cause them to decide to change their genetic profile.

6 Dr. James Watson had his genome sequenced to find out whether he was likely to get Alzheimer's. **True or False?**

7 How might genomics change the way doctors practice medicine?

a They will not have to order as many tests as they do now.
b They will base their decisions on statistical evidence.
c They will be able to provide more individualized care.
d They will spend more time on treatment than on diagnosis.

Skill Review

In Skills and Strategies 5, you learned that you sometimes need to use a dictionary to choose the correct meaning for words with multiple meanings.

A The following sentences are from Reading 3. Each of the words in bold has more than one meaning. Read the two definitions and then substitute each of them into the original sentence. Choose the definition that matches the meaning of the word in bold.

1 What if we could **concentrate** our efforts on prediction and prevention, rather than simply on diagnosis and treatment?

a (give attention): to give a lot of attention to one thing
b (come together): bring together in a large amount in one area

2 Current medical research is taking **promising** steps in these directions, propelled by the research findings of a new area of biomedical science called *genomics*.

a (state certainly): saying with certainty that you will do something
b (likely success): showing signs of future success

3 Other mutations, however, result in life-threatening conditions, such as cystic fibrosis, developmental **disorders**, and various types of cancer.

a (confusion): a lack of organization
b (illness): an illness of the body or mind

4 In other words, a person's genome will, in part, determine the **course** of his or her health care.

a (direction): the path in which something goes, particularly a river or ship
b (development): the gradual development of something, the way something happens
c (class): a class at school

B The words below appear in Reading 3. They all have more than one meaning. Use your dictionary to find the meaning of each word as it is used in the reading. Write the definition, including the part of speech, on the blank lines.

1 span (Par. 4) _____

2 trial (Pars. 5, 6) _____

3 screen (Par. 7) _____

Definitions

Find the words in Reading 3 that are similar to the definitions below.

1 the act of becoming involved in a difficult situation (*n*) Par. 1
2 to make someone want to do something (*v*) Par. 1
3 happening with certainty (*adv*) Par. 3
4 to establish the order of elements in something (*v*) Par. 4
5 later (*adj*) Par. 4
6 not important (*adj*) Par. 4
7 an illness (*n*) Par. 4
8 to stick to (*v*) Par. 5
9 having a healthy, healing effect (*adj*) Par. 6
10 related to the principles of right and wrong (*adj*) Par. 8

Words in Context

Complete the sentences with words from Reading 3 in the box below.

aspirations	devastating	odds	rules out	status
defective	inherits	onset	screen	trajectory

1 His use of steroids _____ the possibility of his participation in the Olympics.
2 There are specific symptoms that signal the _____ of the disease.
3 She called the admissions office to check on the _____ of her application.
4 Everyone at the company was surprised at the remarkable _____ of his career in just five years.
5 Since she was ten years old, she has had _____ to serve in the military.
6 He bought a new car last week, but the brakes were _____, so he decided to return it.
7 He is always late to every event, so the _____ are that he will not be on time for this one.
8 The officials at the airport _____ all luggage to make sure it is not dangerous.
9 The effect of the terrible news was _____ for all of us.
10 Every child _____ genetic material from both parents.

Critical Thinking

Reading 3 discusses the promise of genomics for screening and treating genetic diseases. It also discusses the possibility of health care that is tailored to individuals, based on their genomes.

EXPLORING OPINIONS

Critical readers form their own opinions about important topics in a text.

A In a small group, discuss the dangers and problems that might arise as a result of genomic sequencing:

1. Finding out about life-threatening conditions could have a devastating emotional impact.
2. Automatic genomic screening of newborn babies takes away their right *not* to know about their genetic condition.
3. Genomic sequencing could lead to discrimination against people with genetic conditions:
   - In the workplace
   - In getting insurance
   - In communities or specific social groups
4. With inexpensive sequencing, could someone steal and then use another person's DNA identity?

B With the rest of the class, try to work out solutions to some of these problems.

Research

You have read about the enormous potential of genomics for improving health, and you have discussed some of the possible problems associated with this new technology. Do some research on either the positive or possible negative outcomes of advances in genomics. In some cases, there may be both negative and positive aspects of a topic. Choose one topic for your research.

- DNA theft
- Screening for genetic disorders at birth
- Screening for Huntington's disease
- Screening for a BRCA mutation for breast cancer
- Accidental disclosure of genetic information
- Sequencing of tumor cell genomes
- Your choice of a genomics topic

Writing

Write a short report on your research. Write two paragraphs about your topic. The first paragraph should explain the topic. The second paragraph should explore its consequences for individuals or society.

Connecting to the Topic

Discuss the following questions with a partner.

1 What were the prospects for cancer patients in the twentieth century and before?
2 What do you know about advances in cancer treatment in the last 20 years?
3 Have you read or do you know of any stories of cancer survivors? Describe one of them briefly to your partner.
4 Do you think that the stories of cancer survivors can inspire patients who are suffering from cancer? Explain your answer.

Previewing and Predicting

Knowing what *type* of reading (for example, a textbook, a newspaper article, a story) you are about to read can help you decide what to expect when you begin to read. Reading the title and the first sentence of each paragraph, and looking at photographs can help you predict what kind of reading it will be.

A Read the title and the first sentence of each paragraph in Reading 4. Look at the graph. Then put a check (✓) next to kind of reading you think it will be.

_____ A A scientific study, that is, a report on research
_____ B A narrative, that is, a story about something that happened
_____ C An article about a recent event in the news
_____ D A section of a medical textbook
_____ E A business report about medical news

B Based on what you have read, do you think the outcome of the reading will be positive or negative?

C Compare your answers with a partner's.

While You Read

As you read, stop at the end of each sentence that contains words in bold. Then follow the instructions in the box in the margin.

READING 4

A Case Study in Genomics

1 As a schoolboy, all Lucas Wartman ever wanted was to become a veterinarian[1] like his grandfather, but all that changed the summer he spent working in a hospital. There he witnessed firsthand the suffering caused by cancer. That experience left a deep impression on Wartman, eventually leading him to opt for a career in medicine that would allow him to devote himself to the study and treatment of cancer. Some ten years after that fateful summer, he enrolled in medical school, where he spent part of his time doing clinical research in oncology[2], focusing specifically on leukemia – a form of cancer that affects blood cells.

2 On the morning that Wartman was scheduled to interview for a residency[3] at Stanford University in California, he got a shock that changed his life forever. "I could not get out of bed for an interview that was the most important of my life," Wartman says, recalling that terrible day. Somehow he rallied and managed to complete the interview, but he still felt so tired that every step was an enormous effort. Puzzled and then alarmed when his health did not improve after his return to school, he went for tests to determine the cause for his fatigue. The tests revealed he was suffering from acute lymphoblastic leukemia, ironically, the very disease he had been investigating in his research.

3 Following the diagnosis, Dr. Wartman went through traditional chemotherapy, which sent his cancer into remission[4], stirring his hope that the cancer was gone for good. Secretly, Wartman was also scared, and with good reason, because the outlook for patients with the disease was overwhelmingly **negative**. For those patients who relapsed after remission, there was only a four to five percent survival rate for this particular form of leukemia. Five years went by without any recurrence of the cancer, fueling Wartman's confidence that his recovery would be permanent. He and his doctors believed he had conquered the disease, but then, sadly, one day the symptoms recurred; the cancer had come back. Wartman searched for information on the survival rate for those who survived a second relapse, but to no avail. There was no record of survivors of a second relapse; patients simply did not survive. Nevertheless, Wartman didn't give up; he and his doctors decided to try again with a different treatment. He underwent a more aggressive chemotherapy program and received a bone-marrow transplant[5] from his brother, once again, sending the cancer into remission. Wartman and his team of doctors crossed their fingers, hoping that they had defeated the cancer this time, that there would be no

WHILE YOU READ 1

Look back at this sentence. The author claims that Wartman had a good reason to be scared. What evidence does the author provide to support this claim? Highlight it.

[1] *veterinarian:* a professional who is trained in the medical treatment of animals
[2] *oncology:* the medical specialty that focuses on cancer
[3] *residency:* the final stage in doctors' training when they begin to work in their own special area
[4] *remission:* a period when an illness improves and is less severe
[5] *bone-marrow transplant:* an operation in which cells from the inside of one person's bones is transferred to another person

second relapse. Again, they were wrong, and three years later, the symptoms returned.

4 Wartman began still another treatment program, but his condition was deteriorating rapidly. He knew that he was running out of time, but just as Wartman and his team were beginning to think there were no more options, Timothy Ley, Associate Director of the Genome Institute at Washington University, where Wartman worked, offered a radical suggestion in response to this crisis. Three years earlier, Ley had used a supercomputer to sequence the genome of another form of cancer; based on this experience, he thought he could sequence and analyze the genome of Wartman's tumor cells. Ley believed that genomic sequencing might provide information about which mutations were causing the **leukemia**.

WHILE YOU READ 2

Look back at paragraph 4. Highlight the signals of problem and solution.

5 At that time, genomic sequencing was being heralded as a life-saving medical **breakthrough**, but sequencing the genome of Wartman's tumor would be just the first step in a long journey. Once the genome of the tumor was mapped, this vast store of data would have to be analyzed, a process that could take months. Next, after researchers identified specific mutations in the genome, they would have to ascertain whether these mutations were important and if so, whether they were related to the disease. Many of the variations across the genome could turn out to be inconsequential or irrelevant. And finally, if they were successful in all of these efforts, the research team would need to match the mutation they had identified to a drug that could potentially counteract its effects.

WHILE YOU READ 3

Use your knowledge of vocabulary to guess the meaning of *breakthrough*. Does it mean (a) a type of therapy, or (b) a discovery that comes after a long period of effort?

6 In record time, Ley and his team sequenced and compared Wartman's normal and tumor genomes, as well as his RNA, a molecule closely related to DNA. The genome analysis yielded no clues, but the analysis of his RNA revealed that a single gene, called FLT3, was being overexpressed; that is, it was about 800 times more active than it normally should be, thus promoting the growth of the cancer cells. Members of the team were elated; they were confident that the FLT3 mutation was the cause of Wartman's leukemia.

7 Next came the hunt for appropriate treatment, a step that involved searching the drug-gene interaction database[6] to find a drug that might be effective against the overactive FLT3 gene. Their search revealed that one drug had been successful in blocking similar FLT3 activity in advanced kidney cancer. It had never been tried on a leukemia patient; Wartman would be the first. This drug, in conjunction with other treatments, caused Wartman's cancer to go into remission once again.

8 Wartman is cautious about saying this remission is permanent, but today, he is practicing medicine and living a full life. He and his doctors are certain that without this intervention, he would not have survived the second relapse. This story has a happy ending, but the implications of this pioneering treatment go far beyond Wartman's case. The research that led

[6] *drug-gene interaction database:* a computerized library of information that explains how specific genes respond to specific drugs

to his treatment suggests that cancers – leukemia, breast cancer, colon cancer, etc. – cannot be treated uniformly because each case may be different. Each cancer is as different from another cancer as one human being is different from another human being.

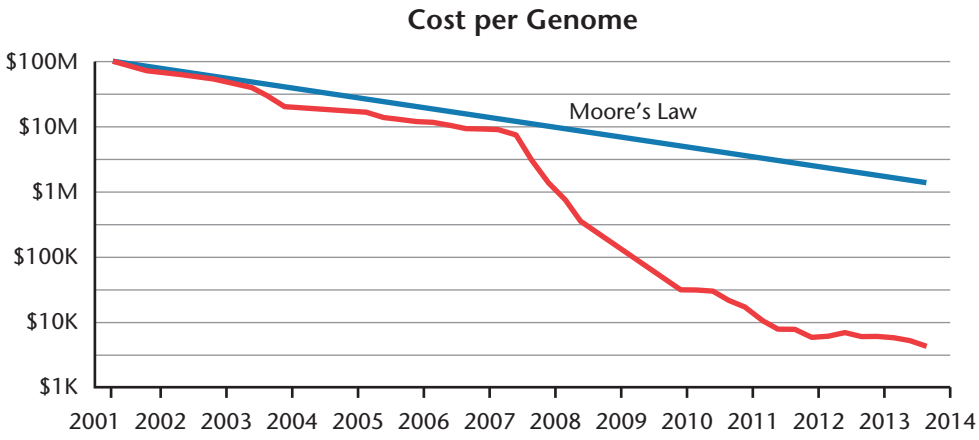
9 Dr. Wartman was lucky because he was working at a university where relevant research was being **conducted** and he had colleagues who were able and willing to assist him. This kind of procedure is both expensive and time-consuming, and therefore, not an option for everyone. However, this situation is gradually changing, with a dramatic drop in the cost of sequencing since the completion of the Human Genome Project. (See Figure 2.3.) Researchers predict it may soon be available for as little as U.S. $1,000. It is also getting quicker. In 2014, in a new and experimental procedure, doctors at the Laboratory of Genetics at the University of Wisconsin used DNA sequencing to quickly identify the bacteria that were causing a young patient's brain to swell up with fluid. This was the first time that researchers had sequenced not just a patient's DNA, but all the small pieces of other DNA found in the patient's body, including DNA from invasive bacteria. This analysis helped the Wisconsin research team identify the bacteria that were causing the patient's infection. In this case, speed was of the utmost importance because without this rapid analysis and subsequent diagnosis, the patient would almost certainly have died.

10 Of course, the procedures that helped Wartman and the Wisconsin patient were experimental and are still not available for most patients, but the hope is that soon this type of analysis will lead to diagnosis and treatment in the majority of cancer cases. Dr. Malachi Griffith, one of the Washington University scientists who worked on Wartman's case, believes that this will eventually become routine treatment. He says, hopefully, "We want to be able to take the tumor of every patient that comes into the clinic, sequence their genome, and produce a clinical report just like when a physician orders a blood test."

WHILE YOU READ 4

Which definition of *conducted* matches the meaning in this sentence?
(a) Carry out, organize
(b) Behave in a certain way

Figure 2.3 Cost of Sequencing a Genome



Source: *National Institutes of Health*

Main Idea Check

Here are the main ideas for five of the paragraphs in Reading 4. Match each paragraph to its main idea. Write the number of the paragraph on the blank line.

_____ **A** Genomic sequencing offered Wartman an alternative treatment.

_____ **B** A recent case demonstrates that sequencing can be a relatively quick process.

_____ **C** Sequencing the genome of Wartman's tumor would be the beginning of his long way to recovery.

_____ **D** The search for a potentially effective drug was successful.

_____ **E** Wartman tried several rounds of traditional cancer treatments.

A Closer Look

Look back at Reading 4 to answer the following questions.

1 What was the primary reason for Wartman's career choice?

a He worked at a hospital, where he saw the devastating effects of cancer.
b He admired his grandfather, who was a veterinarian.
c He wanted to devote himself to medical school.
d He was not sure what he wanted to do until he began to study oncology.

2 Why does the author describe Wartman's diagnosis as "ironic"?

a Wartman got sick at the exact moment when he had a very important interview.
b It is ironic that the news changed Wartman's life.
c It took an unusually long period of time to establish Wartman's diagnosis.
d Wartman never expected to get the disease that he was studying.

3 Only about five percent of those who survived a second relapse of this type of leukemia survived. **True or False?**

4 Indicate the correct order of the steps in Wartman's treatment. Write the correct number in each box.

A Researchers identified an overactive gene.
B Researchers identified a drug that might work against the effects of the mutation.
C Researchers sequenced Wartman's genome.
D Researchers compared Wartman's genome to the tumor genome.

5 Most kinds of cancer require the same treatment. **True or False?**

6 How does Wartman's case illustrate the fundamental insight of genomics?

a It demonstrates that we will need to build vast databases of genes and drugs in order to find effective treatments.
b It suggests that the effectiveness of medical treatment may depend on a patient's genetic profile.
c It shows that if doctors keep trying, they will eventually arrive at an effective treatment.
d It suggests that we need to find a way to sequence cancer genomes more quickly and at a lower cost.

7 In 2014, the cost of genomic sequencing had dropped to about one percent of its original cost. **True or False?**

8 In what ways was the Wisconsin case an advance over Wartman's? Choose all that apply.

a The sequencing was done more quickly.
b The sequencing was done at a lower cost to the patient.
c The sequencing included DNA that did not belong to the patient.
d The procedure was experimental.

Skill Review

In Skills and Strategies 5, you learned that you sometimes need to use a dictionary to choose the correct meaning for words that have more than one meaning.

A The following sentences are from Reading 4. Each of the words in bold has more than one meaning. Look up each word in a dictionary or online. Read each definition and then substitute each one into the original sentence. Choose the definition that matches the meaning of the word in bold and write it on the line below.

1 That experience left a deep **impression** on Wartman, eventually leading him to opt for a career in medicine that would allow him to devote himself to the study and treatment of cancer.

_____

2 Following the diagnosis, Dr. Wartman went through traditional chemotherapy, which sent his cancer into remission, **stirring** his hope that the cancer was gone for good.

_____

3 Once the genome of the tumor was mapped, this vast **store** of data would have to be analyzed, a process that could take months.

_____

4 Wartman is cautious about saying this remission is permanent, but today, he is **practicing** medicine and living a full life.

_____

B Some words have more than two meanings. Read the following two sentences from Reading 4. They contain the same word, but with a different meaning. Look up each word in a dictionary or online. Read each definition and then substitute each one into the original sentence. Choose the definition that matches the meaning of the word in bold and write it on the line below.

1 There was no **record** of survivors of a second relapse; patients simply did not survive.

_____

2 In **record** time, Ley and his team sequenced and compared Wartman's normal and tumor genomes, as well as his RNA, a molecule closely related to DNA.

_____

Definitions

Find the words in Reading 4 that are similar to the definitions below.

1 related to medical treatment (*adj*) Par. 1
2 state of being extremely tired; exhaustion (*n*) Par. 2
3 in a way that is the opposite of what is expected (*adv*) Par. 2
4 permanently (*adv*) Par. 3
5 for the greatest part, overpoweringly (*adv*) Par. 3
6 the return of an illness or condition (*n*) Par. 3
7 unsuccessfully (*idiom*) Par. 3
8 to experience something unpleasant or difficult (*v*) Par. 3
9 characterized by strong, forceful methods (*adj*) Par. 3
10 to hope for the best (*idiom*) Par. 3
11 to reduce the effect of something by having the opposite effect (*v*) Par. 5
12 being the first to do something in a particular way (*adj*) Par. 8
13 always in the same way (*adv*) Par. 8
14 tending to spread in an uncontrollable way (*adj*) Par. 9
15 greatest or most (*adj*) Par. 9

Synonyms

Complete the sentences with words from Reading 4 in the box below. These words replace the words or phrases in parentheses, which are similar in meaning.

alarmed	deteriorate	implications	rallied	recurrence
ascertained	elated	opted for	radical	yield

1 After careful consideration, he (chose) _____ surgery instead of chemotherapy.
2 The new policy should ensure that the country sees no (return) _____ of the economic problems of the last decade.
3 He was (frightened) _____ by how thin his mother had become since he last saw her.
4 This decision will have serious (consequences) _____ for the future, so you should consider it very carefully.
5 Researchers hope that the study will (provide) _____ evidence that supports their theory.
6 After a few moments of rest, the team (recovered) _____ and went on to win the game.

7 These ideas are too (extreme) _____. We need to move more slowly.

8 Health officials (discovered) _____ that the outbreak of the infection began in a fast-food restaurant.

9 They were (overjoyed) _____ when they heard the news about the new baby.

10 Unfortunately, the patient's condition continued to (worsen) _____ during the night.

Academic Word List

The following are Academic Word List words from Readings 3 and 4 of this unit. Use these words to complete the sentences. (For more on the Academic Word List, see page 299.)

ethical (*adj*)	inevitably (*adv*)	motivate (*v*)	status (*n*)	undergo (*v*)
implications (*n*)	intervention (*n*)	radical (*adj*)	subsequent (*adj*)	uniformly (*adv*)

1 Although the thieves tried to run away, they _____ will be caught eventually.

2 They hope to visit the Winter Palace on a _____ trip to Beijing. They did not have time when they went to China last year.

3 His doctor informed him that he would have to _____ surgery in order to repair the damage to his heart.

4 Early _____ by teachers and professionals can help troubled teenagers avoid criminal behavior.

5 Political candidates often give powerful speeches in an effort to _____ people to vote for them.

6 The use of animals in scientific experiments raises _____ questions for many people.

7 Her ideas are too new and _____. People are not ready to accept them.

8 The members of the committee were _____ opposed to the proposal.

9 The broader _____ of climate change are only now becoming apparent.

10 One of the responsibilities of this office is to check the immigration _____ of all incoming students.

Critical Thinking

SYNTHESIZING

Critical thinking includes connecting new information to information you learned in previous readings.

In Readings 3 and 4 you learned about advances in genomics and read a narrative about its personal impact on one patient.

A Work with a partner to discuss how genomics might have an effect on you personally or someone you know.

B Based on what you read in this unit and your own knowledge, answer the questions below with a partner. Review the readings if necessary.

1 Under what circumstances would you want your own genome sequenced?
2 Would you feel differently about genomic sequencing to find a cure and sequencing to screen for possible future diseases if you were sick?
3 If a family member found out about a dangerous genetic defect in his or her profile, would this encourage or discourage you from getting your own genome sequenced?
4 Would you agree to genomic screening for your baby at birth?
5 Would you recommend it for a sick family member or friend?
6 How expensive do you think genomic sequencing should be? Consider whether there could be negative consequences if it becomes very inexpensive.
7 What are your hopes for the future of genomics?

Research

Continue your discussion of these questions as a whole class. Take notes on what your classmates are saying. Record how many people hold a particular view. You will use this information in your writing assignment. Consider the following questions as you listen to the discussion:

- What are the circumstances in which they are most likely to want or agree to the sequencing of their genome? What are their reasons?
- Do they feel differently about treatment versus screening?
- What worries them most about genomic sequencing? Why?
- What is the most divisive aspect of this issue? Why do you think this is the case?
- Did women respond differently than men? Are there any other clear differences in the responses across groups?

Follow up with individual classmates if you want more information about their views before writing.

Writing

Your assignment is to analyze and report the views of your classmates on the topic of genomics and genomic sequencing.

A Preparing to Write

1 Look over your notes from your class discussion.

2 Review Readings 3 and 4. Highlight any information to include in your report.

3 Organize your notes into an outline. I include the following sections:

- The circumstances under which your classmates were most likely to accept or even welcome sequencing for themselves or for members of their families. What were their reasons?
- The circumstances under which your classmates were most likely to reject sequencing for themselves or for members of their families. What were their reasons?
- The circumstances and issues that were the most divisive among your classmates on the subject of genomic sequencing
- Their general outlook for the future of this aspect or field of biomedical science

4 Consider any differences across groups: men vs. women, married vs. single people, etc.

B Writing

1 Write your report. Write one paragraph for each of the first three points in your outline.

2 Begin each paragraph with a general sentence that tells your reader what the paragraph will be about.

3 Include information about different groups to each paragraph if this is relevant.

4 You do not need to provide specific numbers, but try to give a profile of the class (e.g., *most students in the class. . .*, *all the women. . .*, etc.).

5 When you have finished, check your report for grammar and spelling errors.

Improving Your Reading Speed

Good readers read quickly and still understand most of what they read.

A Read the instructions and strategies for Improving Your Reading Speed in Appendix 3 on page 316.

B Choose one of the readings in this unit. Read it without stopping. Time how long it takes you to finish the text in minutes and seconds. Enter the time in the chart on page 317. Then calculate your reading speed in number of words per minute.

Using Graphic Organizers

In order to better understand and remember information in a text, it is important to take notes. You can make annotations in the text or mark it up by highlighting, underlining, or using your own system to emphasize important sections and key terms. Visual or graphic organizers are other tools you can use to comprehend and remember information. They allow you to actually see the text structure (see Skills and Strategies 4) and how the information is organized.

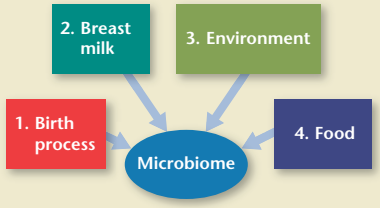
Examples & Explanations

Recent research has shown that humans carry millions of microorganisms and viruses in and on their bodies. Scientists refer to them as the human microbiome. In fact, the cells of the human body are outnumbered ten to one by the cells in the microbiome. The discovery of this massive microscopic community has prompted questions – as well as a robust research program – into the origins and functions of these microorganisms.

The first paragraph is an introduction. The last sentence tells the reader that the rest of the text will focus on the sources and functions of the microbiome.

Research into the microbiome is in its infancy, but preliminary research suggests that a baby's microbiome has several sources beginning at birth. ①During birth, the baby becomes covered with the microbes that live in the mother's body, a process that plants a sort of microbial garden in and on the newborn baby. ②Breast milk transfers more of the inhabitants of the mother's microbiome to the child, which is one reason that babies' microbiomes appear much like their mothers'. ③As children grow, their microbiomes expand and become more diverse as they are exposed to other microorganisms in the environment. These microorganisms are everywhere – on their toys, in their beds, and on the family dog. ④Children may also ingest microbes in the food that they eat. These preliminary ideas about the source of the human microbial population do not answer the even more pressing question: Why? What are all of those microorganisms doing all over our bodies?

The second paragraph focuses on the sources of microbes in the microbiome. You can illustrate this relationship using a graphic organizer. This same type of organizer can be used to display causes or reasons in a cause-and-effect text.



For decades, most people have considered microbes as pathogens, that is, causes of disease. ⑤Although it is true that many do cause disease, emerging research on the human microbiome has caused a 180-degree shift in this thinking ⑥as studies have begun to show that many microbes are beneficial, or even essential, for human health. The functions of microorganisms suggested by such studies fall into the following categories: (a) the training of immune cells, (b) defense against pathogens, and (c) the regulation of metabolism. Scientists suspect that when the microbiome, especially the part of it found in the human gut, falls out of balance, humans can become seriously ill. Researchers have even begun to trace the cause of some diseases of the modern era to disturbances in our microbiome.

The third paragraph discusses what these microorganisms do in the body. We learn that they can cause disease, but they also perform many beneficial functions that fall into three categories. You can use a graphic organizer to visualize this relationship.

Functions of Microbes	
cause disease	*train immune system*
	defend against infection
	regulate metabolism

Strategies

These strategies will help you create graphic organizers that represent important concepts in the text as you take notes.

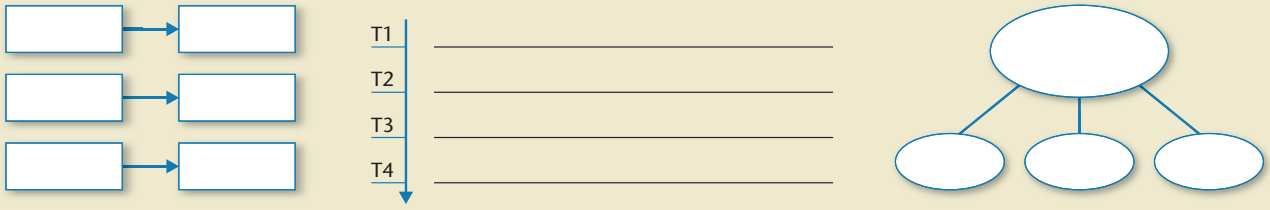
- As you read, highlight or annotate main ideas and supporting details.
- Consider how the text is organized. Is it one of the text types described in Skills and Strategies 4? If so, consider using one of the organizers in this section in your notes.
- If it is a different text type, try to use or adapt one of these organizers for your specific purpose.
- Add important information, such as key words, to your graphic organizer. This makes important information, and how it is organized, more obvious.
- Use size or numbers to show the difference between more important and less important details.
- Keep your graphic organizer simple. If you include too much information, you will not be able to visualize the information as clearly.

Skill Practice 1

Read the following texts. As you read, notice that the student has highlighted the main idea and other important details. Check (✓) the graphic organizer that best represents the information in the text. Write in important details.

1 Modern pharmaceuticals have many origins. Some are created in laboratories; some have come from natural substances found in the environment, such as molds, plants, or even naturally occurring bacteria. The search for the newest drugs is taking place in an unlikely place – our own bodies. Recent research has revealed that some of the microorganisms in our microbiome are tiny drug producers.

A scientist at the University of California, Dr. Michael Fischbach, has identified genes that make 3,000 different molecules that may be useful as medicine. Several genes work together to cause the proteins to create tiny amounts of these products. These genes are generally located together in a cluster. Fischbach and his colleagues wrote a computer program to identify these clusters in the human microbiome. Then they identified over 3,000 common gene clusters and chose one for development. Finally, they grew them in huge numbers in order to amass enough of their product to test. They discovered that this product has a structure that is very similar to the structure of an antibiotic, the type of drug taken to cure bacterial infections. Fischbach is now testing the effectiveness of this microbial "antibiotic."



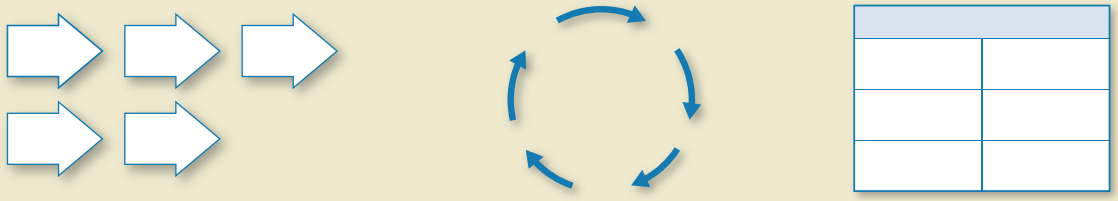
a _____ b _____ c _____

2 Recent research has convinced many of us of the value of our microbial communities. We understand that they are important for maintaining good health. However, the microbiome story turns out to be more complex. Our microbial companions are not selfless heroes acting on our behalf; instead, they are acting very much in their own interests.

It seems that in order to advance their interests, these microbes can make us engage in behavior that may ultimately harm us, for example, by making poor food choices. These tiny organisms may be the ones that are really in control, especially when it comes to food. In cancer researcher Carlo Maley's words, these microbes have "the means, motives, and opportunity" to manipulate their hosts, in other words, us.

Bacteria in the human gut manufacture tiny amounts of substances that can actually change the biochemistry of the human brain. It is possible that these changes encourage cravings for certain foods, such as a desire for sweet foods or chocolate. Scientists studying this phenomenon have hypothesized that this is because specific microbes thrive on these substances.

Neuroscientist John Cryan suggests another way in which microbes may influence our behavior and explains the reason for this microbial manipulation. It is still just a hypothesis, but he believes that microbes manufacture chemicals that may influence humans to be more social. His research has demonstrated that compared to mice with normal gut bacteria, lab mice without an active microbiome tend to avoid contact with other mice. That is not a favorable situation for bacteria. They thrive when their hosts are near one another in social groups since this allows them to move from one host to another. Therefore, it is in their interest for their human hosts to spend more time with one another. It seems that our microbiome may even make us friendlier! And, unlike their role in our food choices, that is probably a good thing.



a _____ b _____ c _____

Skill Practice 2

Read the following texts. Then choose or modify a graphic organizer from this section that illustrates the important information, or create your own graphic organizer. Use it to take notes.

1 Many people say they believe the well-known saying, "An ounce of prevention is worth a pound of cure," but as a society, do we really follow this advice? Among health-care providers and policy makers, there is an ongoing debate about the relative value of the prevention and treatment of disease. Where should we spend the limited resources available for health care for our own citizens as well as the global population?

Whatever, we say we believe, it is clear that more money is currently being spent on treatment than prevention. In the United States, as in many other developed countries, spending on treatment is almost twenty times higher than spending on prevention programs. Many health-care professionals argue that prevention programs are much cheaper in the long run. They keep people healthy, which reduces overall health-care costs and also increases economic productivity. It is more expensive to care for people after they become seriously ill. An additional drawback of focusing primarily on treatment is that it may encourage the development of drug-resistant bacteria. Prevention, in contrast, generally does not require drugs and so does not entail this risk.

In spite of the clear benefits of prevention, the emphasis on treatment programs remains widespread. Several explanations have been advanced for this disparity. Perhaps most important is the distress factor. Patients who are in pain or even dying demand our immediate attention, whereas prevention programs seem comparatively less urgent. They lack the drama that attends treatment. It also harder to demonstrate success, that is, to show that positive outcomes are the result of prevention measures, at least to do so in ways that are persuasive to the public. Most evidence of their effectiveness is statistical in nature, in contrast to the concrete certainty of a cure. Finally, prevention programs are for healthy people, who may not always be willing to accept this kind of interference. Patients who need treatment have little choice in the matter.

2. In 2014, the world was confronted with a major health-care crisis: a massive outbreak of the Ebola virus in West Africa. Ebola, a disease that originated in animals, particularly bats and monkeys, is often fatal in humans. The virus spreads through the population by human-to-human transmission. The 2014 epidemic was the worst in history, in part because the health-care systems in the affected countries were already fragile before the epidemic took hold. There was also a critical shortage of trained medical personnel and supplies. Many health-care workers are hesitant to work with Ebola patients because of the risk it poses to their own health.

   At present, there is neither a cure nor a preventive vaccine for Ebola. However, there are measures that can be taken to deal with the situation to reduce the threat of infection. These include reducing the risk of animal-human transmission that can come from contact with infected bats or monkeys, reducing the risk of the person-to-person transmission by using gloves and other protective clothing, and separating the sick from the healthy.

   The scientific community has also responded to this challenge by working as quickly as possible to find ways to treat the virus effectively. One remedy, which is based on the tobacco plant, was tested on two American patients, who did make complete recoveries. However, it is not clear whether the remedy or simply supportive care was the primary factor in their recovery. Other scientists are working on the possibility of a therapy that uses the blood plasma of patients who have recovered from the disease. Finally, some researchers are tackling the problem from the perspective of prevention; they are hoping to develop a vaccine. It is crucial to work on all fronts in order to prevent a recurrence of this type of epidemic in the future.

Connecting to the Topic

Discuss the following questions with a partner.

1 What are the origins of most of the drugs that we use to treat and cure diseases?
2 Do you know the background of a specific drug and how it was invented or discovered? Explain your answer.
3 Which do you think is more common in the creation of new drugs – the discovery of something that already exists, or invention, that is, the creation of something new? Explain your answer.
4 Who pays for the development of new drugs?

Previewing and Predicting

Reading the title, section headings, and the first sentence of each section can help you predict what the reading will be about.

A Look at the illustration, read the section headings and the first sentence of each sentence in Reading 5, and think about the title of the reading. Then read the following topics. Write the number of the section (*I–III*) where you think that topic will be discussed.

SECTION	TOPIC
	Modern methods of drug discovery research
	A general description of the drug discovery process
	Drug design methods
	The steps in the discovery pipeline
	What happens after compounds are identified
	Drug discovery prior to the twenty-first century

B Compare your answers with a partner's.

While You Read

As you read, stop at the end of each sentence that contains words in bold. Then follow the instructions in the box in the margin.

READING 5

Drug Discovery in the Twenty-First Century

by Dr. Brian Kay

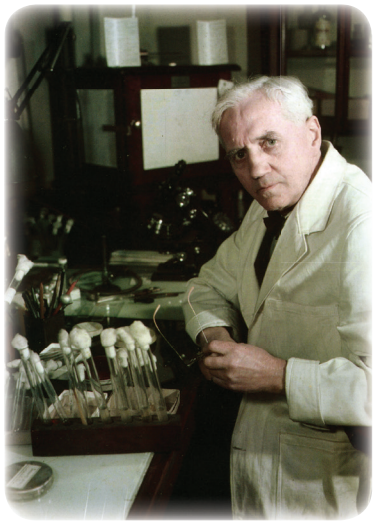
I. What Is Drug Discovery?

1 Drugs improve the quality of life for millions of people. They enable patients to fight off bacterial and viral infections, they help diabetic patients respond to dangerous elevated glucose[1] levels, and they represent the first line of defense in treating cancer. It is difficult to imagine modern life without them. What most people don't appreciate, however, is that for every successful drug on the market, there are hundreds of failures. Many potential drugs never make it to the local pharmacy or hospital. This can happen for a variety of reasons: because they don't work in the way that researchers anticipated, they only work for some patients and not others, they turn out to be too toxic, or they have other serious side effects. The path to drug discovery is perilous, unpredictable, and extremely **expensive**.

WHILE YOU READ 1

Look back at paragraph 1. This paragraph includes both problem/solution and cause/effect text organization. Underline the noun that signals problem/solution and the noun that signals cause/effect text organization.

2 A review of the history of drug discovery reveals the important role of chance. The story of the Scottish scientist Alexander Fleming may be a familiar one. In 1928, Fleming observed that a type of fungus, which had accidently contaminated a sample of bacteria, inhibited its growth. This casual observation, in the hands of a thoughtful, curious scientist, eventually led to the identification of penicillin, an immensely important antibiotic[2] that has had a profound and positive impact on society. Perhaps less familiar is the story of the Wisconsin farmer who, in 1933, noticed that his herd of cows experienced internal bleeding whenever they ate a specific type of sweet clover. This observation attracted the interests of biochemists at the University of Wisconsin, who analyzed the chemical compounds in the clover, ultimately leading to the identification of the anticoagulant[3], warfarin. Although warfarin was initially sold as a rat poison, medical researchers later found that it was very effective in preventing the formation of blood clots[4] in blood vessels, thereby preventing strokes. Today, warfarin is widely prescribed for the prevention of blood clots.



Alexander Fleming

II. The Twenty-First Century: Current Practices

3 Although serendipity can have a profound impact on developments in medicine, it is a rather haphazard and unsatisfying way to conduct

[1] *glucose:* a simple sugar
[2] *antibiotic:* a chemical that destroys harmful bacteria
[3] *anticoagulant:* a chemical that prevents blood from thickening and creating a clot
[4] *clot:* a thick lump of blood

research. So, instead of hoping to be lucky, the pharmaceutical industry takes a more direct, focused approach to discovering new drugs. Generally, it starts by identifying a vulnerable point within a pathogen's or cancer cell's development. This identification process, that is, the discovery of a gene and its protein product that plays a crucial role in growth or life of the cell or virus, generally involves the analysis of mutations. To discover the role of key genes in human cancer cells, scientists often analyze mutations in model organisms, such as yeast, fruit flies, worms, or mice, and then later demonstrate that the equivalent gene in human cancer cells has the same critical function.

4 Once experiments have demonstrated that a particular protein might be a worthwhile target, the next goal of such research is to identify a chemical that might inhibit the activity of that protein. This can **block** the growth of the virus, bacterial cell, or cancer cell. Teams of biologists and chemists are dedicated to drug discovery efforts at pharmaceutical companies. They work together to build a "drug discovery pipeline" to find and test a new drug. The first part of the pipeline generally consists of four different approaches: high-throughput screening of small molecule libraries; structure-based drug design; fragment-based lead discovery; and cell-based **screening**.

High-throughput screening of small molecule libraries

5 At pharmaceutical companies, there is a standard workflow for discovering small chemicals that inhibit targets. First, the protein for the target is produced in large amounts, and its function – whether to make a chemical reaction go faster or bind other molecules – is then measured by an appropriate assay. An assay is defined as a procedure for evaluating the presence or biochemical activity of a chemical. Then a chemical compound is added to the assay to determine if it will inhibit the protein's activity, and depending on the assay format, the intensity of color or emitted light will decrease.

6 Once a research team has established a reliable, reproducible assay, the next step is to screen "libraries" of chemical compounds to determine which compounds display the desired inhibitory activity. Pharmaceutical companies have libraries of approximately two million small chemicals, and every member of a library can be individually tested in an assay with the help of robots that fill tiny wells in small plastic trays. In a typical high-throughput screen, the percentage of wells with inhibitory activity is less than one percent.

Structure-based drug design

7 Another popular approach to discovery is to take a target protein and determine its three-dimensional structure. Once chemists and structural biologists know the shape of the protein, they look for an active site in the protein. These are pockets where proteins naturally bind small molecules, or peptides. Researchers then design small chemicals that will bind at these active sites, thereby interfering with the protein's activity. An analogy for this process would be using a magnifying glass to see inside a door lock,

WHILE YOU READ 2

Which definition of *block* matches the meaning in this sentence? (a) A solid hard piece of something (b) Prevent

WHILE YOU READ 3

Read the last sentence of paragraph 4. What text organization do you think will follow? _____
Underline the signal(s).

and then guessing the shape of a key in order to create a similar shape, which, when inserted into the lock, prevents the door from unlocking. The process of determining the appropriate shape of a chemical inhibitor, which in the past was based on intuition and experience, is now aided by powerful computer programs that are capable of searching large databases of compound structures and predicting those that might bind to the target's active site. Typically, chemists sift through the top 1,000 compounds, which, based on past experience, are judged to have attractive attributes, and then retest them in **follow-up** assays.

WHILE YOU READ 4

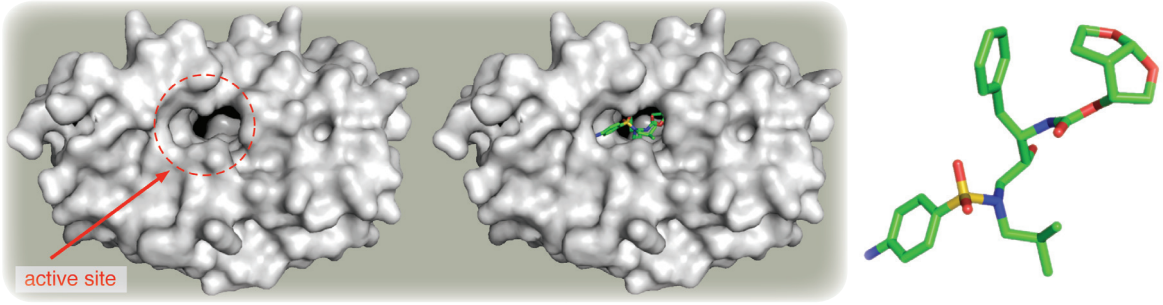
Use context and your knowledge of word parts to guess the meaning of *follow-up*. Does it mean (a) more important, (b) later, or (c) more demanding?

8 One of the most heralded successes of structure-based drug discovery occurred in 1995, with the announcement of inhibitors of the Human Immunodeficiency Virus (HIV) protease. This enzyme[5] is essential for the virus to copy itself and infect new cells. Once the DNA sequence of the virus was known, the gene for HIV protease could be isolated, the protein could be produced in large quantities, and the three-dimensional structure of the protein was determined. Scientists reasoned that if they could develop a small molecule that fit in the active site (Figure 2.4, left panel), it would inhibit the enzyme's activity. With several pharmaceutical companies working toward the same goal, several powerful drugs have been developed. The drug, Prezista, fits tightly into the active site of HIV protease (Figure 2.4, right panel), where it acts as a very effective inhibitor of the enzyme. Thus, Prezista blocks the production of the virus and allows the body to fight HIV more effectively. This important development has allowed many of those infected with AIDs to survive and lead productive lives.

Fragment-based lead discovery

9 A third approach, which is a variant of the structure-based design, is called fragment-based lead discovery. In the structure-based design approach, it can be very challenging to find a compound that fits exactly into the active site. In part, this is because the compounds in the library

Figure 2.4 Model representing the three-dimensional structure of HIV protease (left panel) alone, and with the inhibitor, Prezista, in the protease's active site (right panel)



[5] *enzyme:* a substance produced by living cells to cause a chemical reaction

are large compared to the size of the site. In response to this challenge, fragment-based design starts with a library of smaller chemical fragments, which are tested to determine if any bind near or at the active site. Once one of these fragments has been identified as capable of binding to part of the site, the process is repeated with another set of chemical fragments, this time to find a second compound that can bind to a different site. If the two binding sites are near each other, chemists can synthesize a structural bridge between the two fragments. This new, larger compound binds better than either fragment alone and can block activity of the **target**.

WHILE YOU READ 5

Look back at the second sentence of paragraph 9. What text organization do you think will follow? _____ Underline the signal(s) that indicate this type of organization.

10 A significant number of targets had eluded drug researchers because no compounds could be found to bind their active sites using traditional drug discovery approaches. Yet, fragment-based design has succeeded. The repeated screening process in this approach allows researchers to build their own compounds, ones that uniquely bind to active sites. Because of these successes, every major pharmaceutical company has now implemented this research strategy in their drug discovery pipeline.

Cell-based screening

11 The fourth method commonly used by pharmaceutical companies employs human cells*. In a sense, the living cell becomes a "test tube" in which the chemical compound's activity is assessed through changes in the visual appearance of cells, such as shape, size, or number. Alternatively, one can monitor changes in protein expression in cells, as visualized by expression of green fluorescent[6] proteins or binding of fluorescent antibodies. In this manner, the impact of chemical compounds on complex biological processes can be evaluated in a novel fashion.

12 Although cell-based assays are generally not high-throughput, that is, they cannot be done on as large of a scale as high-throughput screening methods, thousands to hundreds of thousands of compounds can still be tested on cells. In some cases, the assessment of a compound's activity is **captured** with a system that digitally photographs populations of cells incubated[7] with the compound, followed by automated image analysis. While cell-based screening requires more resources than high-throughput screening, the cell-based screening approach has several advantages. First, compounds can be tested in the context of a living cell, instead of proteins in a well, which is more representative of how a drug works in a person. Second, the use of human cells in this method readily identifies and eliminates compounds that are toxic and kill cells, before they move further into the pipeline. Third, to succeed in this phase of the testing process, compounds must be able to cross the cell membrane, a required attribute of most drugs. Thus, active compounds that have undergone cell-based screening have already cleared three major hurdles.

WHILE YOU READ 6

Which definition of *captured* matches the meaning in this sentence?
(a) Recorded
(b) Taken as a prisoner

* These cells are taken from established cell lines that are grown in the laboratory, not from human beings.

[6] *fluorescent:* giving off light

[7] *incubate:* to keep something warm to allow it to grow

III. The Pipeline

13 Once promising chemical compounds are discovered through any of the above four methods, they are called *hits*. Chemists evaluate the chemical structures of the collection of hits according to several criteria, including novelty, similarity to known toxic compounds, and ease of synthesis. In follow-up analyses, chemists synthesize a set of related compounds, differing in very subtle ways, and then pick the best ones to pass onto biologists for testing. These prioritized compounds are called *drug leads*. In turn, biologists assess how long the compounds last in the body after administration, how quickly they are excreted or broken down, and what types of toxicity might occur in animal testing. Generally, all drugs are first tested in small animals, mice or rats, before they are tested in human volunteers. Many drug leads fail in one or more of these tests, but those that pass are then labeled as *drug candidates*. Before moving further down the pipeline, pharmacists determine a formula for the compound that remains stable in solution or pill form as well as the appropriate dosing regimen[8].

14 But this is not the end of the pipeline process. In the United States, for a drug candidate to transition into an actual drug used by the public, it must pass three rounds of patient testing, also known as clinical trials. Phase I tests a drug candidate in a small group of volunteers and determines a safe dosage, as well as identifies any side effects. Phase II then tests it on a larger group of people to see if it is effective in treating a particular illness. Finally, Phase III tests it on a large population of patients to confirm its effectiveness, monitors side effects, and compares it to commonly used treatments. Data are collected during Phase III in a double-blind manner, meaning that neither doctors nor patients know whether the drug or a placebo[9] is being administered. After thousands of patients have received treatment, a government agency carefully examines the resulting data. Only when a drug is demonstrated in clinical trials to be effective and safe does the government grant permission to a pharmaceutical company to sell it to the general public.

15 In many respects, the drug discovery process is a gamble for pharmaceutical companies. The chemical compounds must progress through many steps, in transitioning from hit to candidate to drug, and at any point, failure is a very real possibility. It has been estimated that for every successful drug, there were 1,000 compounds that failed to progress through the pipeline. Thus, there is considerable incentive to improve the drug discovery and evaluation process. If pharmaceutical companies can find a way to do this, the expectation is that the number of newly approved drugs will increase and will lead to an improvement in human **health**.

WHILE YOU READ 7

Look back at paragraph 15. Highlight the word that signals a cause.

[8] *regimen:* a set of rules, especially for health

[9] *placebo:* a substance that is not medicine, but is given to patients as medicine in order to test the effectiveness of a drug during a trial

Main Idea Check

For sections I–III of Reading 5, match the main ideas to the paragraphs in each section. Write the number of the paragraph on the blank line.

SECTION I: What Is Drug Discovery?

_____ **A** New drugs are often discovered by chance.

_____ **B** The drug discovery process is long and often unsuccessful.

SECTION II: The Twenty-First Century: Current Practices

_____ **A** In one approach, scientists try to determine the shape and structure of one compound that will fit into an active site.

_____ **B** In one approach, researchers use human cells to test the effectiveness of the compound.

_____ **C** After researchers determine a target, they need to identify a compound that can inhibit its activity.

SECTION III: The Pipeline

_____ **A** Chemists and biologists test and adjust promising compounds before the compounds enter the trial phase.

_____ **B** Before a drug can be sold, it must go through a series of trials on humans.

A Closer Look

Look back at Reading 5 to answer the following questions.

1 Why do so many potential drugs fail to make it to the market? Choose all that apply.
- **a** They turn out to do more harm than good.
- **b** Their cost is too high.
- **c** They are not found to be sufficiently effective.
- **d** Pharmaceutical companies decide not to pursue them.

2 Why was warfarin first used as a rat poison?
- **a** It was not yet proven safe to use on humans.
- **b** It caused internal bleeding in rats, leading to their death.
- **c** Scientists wanted to try it out on rats first.
- **d** Scientists were not sure what kinds of side effects it might cause.

3 Why does the author include the example of warfarin? Choose all that apply.
- **a** To show that drug discovery is a long and difficult process.
- **b** To show the role that chance plays in drug discovery.
- **c** To show that drugs do more than just benefit human health.
- **d** To show that a drug developed for one purpose may be later used for another.

4 Which of the following is a step in the first phase of the drug discovery process?

a Scientists create mutations in organisms such as fruit flies, worms, or mice.
b Scientists look for a chemical or compound that will increase a protein's activity.
c Scientists identify a weak point in the development of a disease-causing cell.

5 High-throughput screening is an approach that allows scientists to test large numbers of compounds. **True or False?**

6 What developments have fueled the growth of structure-based drug design? Choose all that apply.

a New assay formats
b Knowledge of the three-dimensional structure of molecules
c Computer programs that can handle large data sets
d Massive libraries of chemicals and chemical compounds

7 What advantage does cell-based screening have over other drug discovery practices?

a It reveals how the drug would work on humans.
b It uses fewer resources than other types of screening.
c It is not toxic.
d It can be captured with digital photography.

8 What is the best way to describe the difference between a *drug lead* and a *drug candidate*?

a Drug candidates, but not leads, have been tested on humans.
b Drug leads, but not candidates, have been through the animal test phase.
c Drug candidates, but not leads, have undergone toxicity tests.

9 Why do clinical trials use double-blind methods?

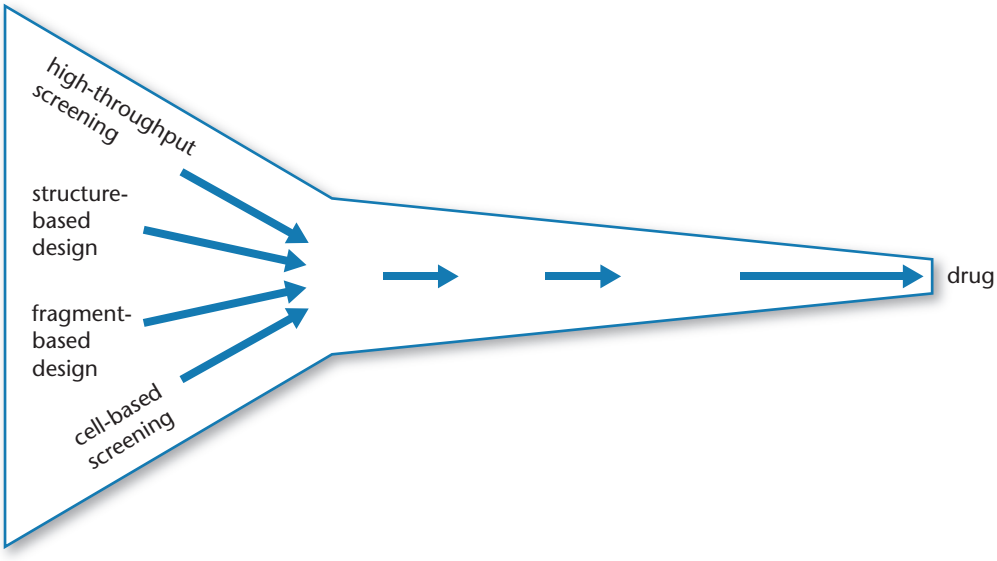
a They do not rely on the use of placebos.
b The government requires proof of safety and effectiveness.
c They prevent participants from influencing the outcome.
d They increase the incentive for pharmaceutical companies.

Skill Review

In Skills and Strategies 6, you learned that graphic organizers can help you comprehend and remember information. They can also help you visualize the organization of a text.

A **1 Study the figure below. What text organization does it illustrate?**

a Cause and effect
b Steps in a process
c Problem-solution



2 Fill in the blanks in the figure.

B **Review Section II of Reading 5 and look over any notes you have taken. Then answer the question.**

What is the text organization of this section?

_____

C **Now choose or modify the appropriate graphic organizer from this unit that illustrates the important information, or create your own graphic organizer. Use it to organize your notes.**

Definitions

Find the words in Reading 5 that are similar to the definitions below.

1 to be aware that something is valuable or important (*v*) Par. 1
2 poisonous (*adj*) Par. 1
3 dangerous (*adj*) Par. 1
4 to make something less pure (*v*) Par. 2
5 great; deep (*adj*) Par. 2
6 the fact of finding something interesting by accident (*n*) Par. 3
7 unplanned, lacking order (*adj*) Par. 3
8 equal to or having the same effect (*adj*) Par. 3
9 the ability to understand without using reason (*n*) Par. 7
10 as another option (*adv*) Par. 11
11 difficulty; obstacle (*n*) Par. 12
12 standards by which something can be evaluated (*n pl*) Par. 13
13 to combine two or more things to create something new (*v*) Par. 13
14 not likely to change; fixed (*adj*) Par. 13
15 something that encourages a person to do something (*n*) Par. 15

Words in Context

Complete the sentences with words from Reading 5 in the box below.

analogy	formula	immensely	prioritize	sift
compound	gamble	phase	side effects	ultimately

1 When he bought this company, most people considered it a / an _____, but it has turned out to be very successful.
2 A / An _____ can be a useful way to explain how something works; for example, a camera works like an eye.
3 Many products, such as Coca-Cola, have a secret _____.
4 The _____ of the new drug include headaches and weight gain.
5 This television program has become _____ popular in a short period of time.
6 The team of scientists began to _____ through the data to find a pattern.
7 Chemists discovered that this _____ is found in many plants and can cause a painful reaction.

8 It is important to _____ your tasks so that you work on the most important ones first.

9 The next _____ of the project will begin next year.

10 _____, the decision is yours, and you will have to decide what is best.

Same or Different

The following pairs of sentences contain vocabulary from all the readings of this unit. Write *S* on the blank lines if the two sentences have the same meaning. Write *D* if the meanings are different.

_____ 1 Although the new treatment appears **promising**, there are still many **hurdles** to clear before we can be certain of its effectiveness.

There are still many **obstacles** that must be **overcome** before we can **ascertain** that this treatment is **therapeutic**, but all the signs are positive.

_____ 2 In order to **eliminate** the threat of communicable diseases **for good**, we will need to invest in more **infrastructure**.

Recent **breakthroughs** in the treatment of communicable diseases indicate that the **outlook** for the future is very good.

_____ 3 Government workers were very concerned when they heard about an **outbreak** of cholera in a **remote** village in the mountains.

Officials were **alarmed** to hear that several people had **contracted** cholera in an **isolated** village in the mountains.

_____ 4 We have the **capability** to **detect** an epidemic in its earliest stages and to **minimize** its impact.

We know how to **facilitate** rapid **diagnosis** during the **onset** of an epidemic as well as design appropriate **interventions**.

_____ 5 The **trajectory** of the disease is quite predictable. It begins with **fatigue**, and then the patient's condition gradually worsens.

The **course** of the disease is similar in most patients. They begin to feel very tired, and then their condition slowly **deteriorates**.

_____ 6 **Ironically**, the **side effects** of the **aggressive** treatment were worse than the disease.

The **preliminary** results suggested that the **toxic** effects of the **radical** treatment were **inevitable**.

_____ 7 Chemists are able to **synthesize compounds** in the laboratory that remain **stable** in extreme conditions.

Scientists have **derived** a **formula** that **is compliant** with all of the required regulations.

_____ 8 The government works **in conjunction with** pharmaceutical companies to **track** how well new drugs are working.

Drug companies work with the government to **monitor** the effectiveness of their new products.

Disciplinary Vocabulary

The following words are from all the readings of this unit. Research shows that they frequently appear in academic texts related to biomedical science. Complete the sentences with these words.

chronic (*adj*)	concentrate (*v*)	disorders (*n*)	phase (*n*)	synthesize (*v*)
clinical (*adj*)	derive (*v*)	isolated (*adj*)	promote (*v*)	therapeutic (*adj*)
compound (*n*)	detect (*v*)	outcome (*n*)	sequence (*v*)	toxic (*adj*)

1 Is it possible to _____ DNA yet?

2 Some mushrooms contain _____ chemicals that can make people very sick.

3 We are just in the planning _____ of this project; building will begin late next year.

4 Many people buy products that they hope will _____ weight loss, but most of these products are not effective.

5 Dogs have a very powerful sense of smell, so they can _____ even very small amounts of chemical substances.

6 The government has approved a new drug that will help people who suffer from _____ pain.

7 The hospital has a new building that is for patients with heart and lung _____.

8 Water is a / an _____ made of oxygen and hydrogen.

9 Until we know the _____ of the election, it will be difficult to make a decision about what to do next.

10 Emergency services had difficulty reaching several _____ villages after the earthquake.

11 Many medical professionals believe that exercise has a _____ effect, especially for reducing stress.

12 Many scientists make discoveries that later have unexpected _____ applications.

13 In 2000, scientists were able to _____ the entire human genome for the first time.

14 The people who will _____ the greatest benefit from the new program are families with young children.

15 If you _____ your energy on solving the problem, you'll find a solution.

Critical Thinking

EXPLORING OPINIONS

Critical readers form their own opinions about important topics in a text.

In Reading 5, you learned about the long and complex process that leads to the development of new drugs. You learned about the many places along this pipeline where the process may end in disappointment.

A Based on what you have read in this unit and your own knowledge, read the two statements below.

1 Pharmaceutical companies spend vast sums of money in the pursuit of new and effective drugs. Successful drugs can be very profitable. Most of the time, however, the search stops at a dead end, often only after the company has made a significant investment. Some policy makers maintain it is important for these companies to be able to recover their investment and make a profit.

2 Other policy makers have argued that many drugs should be on the list of things that are considered *public goods*. Public goods are provided without profit to all members of a society, usually by the government, but also by other organizations. Clean air and water, education, and national security are often considered examples of public goods.

B In a small group, answer the questions that follow. Review the reading if necessary.

1 Are pharmaceutical companies entitled to recover their investment in all of their research by charging high prices on their successful products?

2 What if, for example, a patient with cancer, or a community that is experiencing an epidemic, such as AIDS or Ebola, cannot afford to pay these prices?

3 What do you think would happen if the prices of drugs were lowered to make them more affordable to more people?

4 In general, who should pay the price of drug discovery?

5 Which statement do you agree with, 1 or 2?

Research

You have discussed the costs of drug discovery and the need for public access to drugs with your classmates. Now find out what experts are saying on the subject of the cost of new drugs. Research this issue to gather information about the perspective of (1) the pharmaceutical industry and (2) patients or doctors who say the cost of new drugs is too high.

Writing

Write two paragraphs. In the first paragraph, explain the perspective of the pharmaceutical industry. In the second paragraph, present the viewpoint of opponents who say the high cost of new drugs is unnecessary and unfair.

Exercise 1

Writers connect ideas between sentences in many different ways. The second sentence may:

a contain a correction to a view that is reported in the first sentence

b describe a cause of what is reported in the first sentence

c provide a contrast to what is described in the first sentence

d add a detail or details to support the more general information in the first sentence

How does the second sentence in each pair of sentences below connect to the first sentence? Write *a*, *b*, *c*, or *d* on the line depending on whether it is a correction, a cause, a contrast, or a detail.

_____ **1** "23 and me" is a company which, until recently, provided customers with tools and information to explore the secrets locked in their DNA. Customers provide the company with a saliva sample, and based on that sample, "23 and me" provides the customers with information about their ancestry as well as a complete genetic profile.

_____ **2** Since it was founded in 2006, the company had consistently argued that results of the DNA tests provide general information, a service that is not regulated by the government. Given that the information the company provides has clear health and medical implications, this claim seems unfounded at best.

_____ **3** In 2012, the company reversed itself, claiming that they provided a medical service that was worthy of patent protection. Undoubtedly, part of their motivation for this move was the possibility of the protection of their profits that a patent would confer.

_____ **4** In 2013, the government ordered "23 and me" to stop providing health information to customers based on their DNA profiles, so customers no longer have access to their "23 and me" medical files. However, the company is still permitted to provide its customers with detailed information on their ancestry, including what parts of the world their ancestors might come from and where their distant relatives might be found.

_____ **5** Although the company denies it, some reporters and industry experts maintain that the company's long-term goal is to amass a huge – and in all likelihood, very profitable – database of DNA profiles. The company could use the information in this database to sell customers health and medical products based on their DNA profiles.

Exercise 2

Make a clear paragraph by putting sentences A, B, and C into the best order after the numbered sentence. Write the letters in the correct order on the blank lines.

1 In the race to sequence the first human genome, the public and private sectors took different approaches. ___ ___ ___

A	B	C
These short sequences – between 100 and 1000 base pairs, could be then be reassembled as the complete sequence.	In contrast, Craig Ventner, who headed the private venture, was convinced that sequencing short sections of the genome would be a faster and more effective method.	Those in the private sector project, The Human Genome Project, wanted to methodically map every piece of the genome.

2 Once the projects were complete and the race was over, the first individuals had an opportunity to have their genomes sequenced. ___ ___ ___

A	B	C
His genomic profile revealed that he was at risk for heart disease and had a higher than average chance of developing Alzheimer's later in life.	One of the first in line for this opportunity was Craig Ventner.	The profile also revealed that his body is able to process the caffeine in drinks like coffee and tea more quickly than most people.

3 People decide to have their genomes sequenced for a variety of reasons. ___ ___ ___

A	B	C
Steve Jobs, the founder of Apple computer, suffered from pancreatic cancer, finally succumbing to the disease in 2011.	This last-ditch effort was an attempt to guide his doctors in choosing a drug that could stop the spread of the disease that was ravaging his body.	He had tried many different treatments, but before he died, he tried one final option – sequencing the genome of his cancer cells.

4 Harvard Professor Henry Louis Gates had an entirely different agenda when he chose to have his genome sequenced. ___ ___ ___

A	B	C
The genomic profile was much more helpful, revealing that some of his ancestors lived in Africa, while others had descended from Irish royalty.	He had always wondered who they were and where they came from, but written records had not been able tell him everything that he wanted to know.	His motivation for deciding to do so was rooted in a search, not for medical answers, but for answers about his ancestors.

5 Seong-Jin Kim was the first Korean to have his entire genome sequenced. ___ ___ ___

A	B	C
At the same time, he decided to have the genomes of other members of his family sequenced as well.	He decided to include all of their genomes because he wanted to investigate a possible genetic component of gastric cancer in Korean families.	He published the results of his investigations in hopes of convincing more Korean families to follow his example.