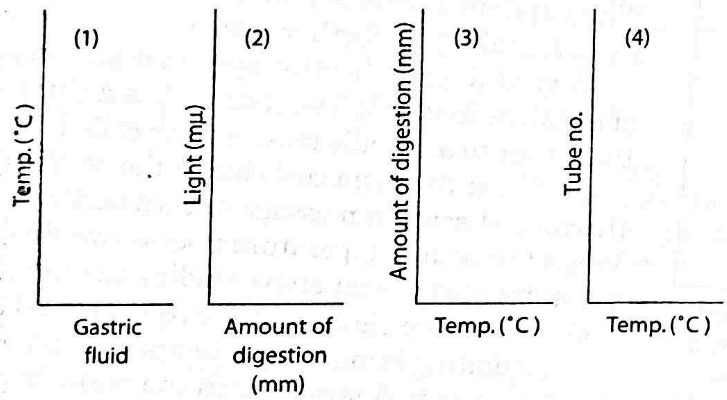
Data Table		
Tube	**Temperature (°C)**	**Amount of Digestion After 48 Hours**
1	4	0.0 mm
2	8	2.5 mm
3	21	4.0 mm
4	37	7.5 mm
5	100	0.0 mm

37. Which is the independent variable in this investigation? (1) gastric fluid (2) length of glass tubing (3) temperature (4) time

38. What amount of digestion might be expected after 48 hours in a test tube that is identical to the other five test tubes but at a temperature of 15°C? (1) less than 2.5 mm (2) between 2.5 and 4 mm (3) between 4.0 and 7.5 mm (4) more than 7.5 mm

39. The best graph of the results of this investigation would be made by plotting the data on which set of axes?



40. The student repeated this same experiment using a glass tube containing potato instead of egg white. After 48 hours, he found no evidence of any digestion. Explain why no digestion occurred.

41. During the winter, many fish eat very little. Some students thought this might be because less oxygen is dissolved in the cold winter water than in the same water during the warm summer months. The students tested the water and found that cold water holds more dissolved oxygen than warm water. They also discovered that the fish have nearly as much food available during the winter as in the summer. Explain why the fish eat very little during the winter.

Feedback and Homeostasis

Because an organism's external and internal environment is constantly changing, its homeostasis is constantly threatened. As a result, living things must monitor and respond to changes in the environment. Stability (homeostasis) results when the organism detects deviations (changes) in the environment and responds with an appropriate corrective action that returns the organism's systems to normal. If an organism's monitoring systems or control mechanisms fail, disease or even death can result.

For example, your body temperature may be readjusted, your heart and breathing rates slightly altered, and your blood flow increased or decreased just to keep you safe and alert as you go about your daily tasks. If your monitoring were to fail, these small adjustments would not be made. Soon, your body's homeostasis would begin to deteriorate. Under extreme conditions, you could become quite ill or even die. However, simple corrective actions usually take care of problems with your homeostasis and life goes on. Some examples of responses organisms have to changes they encounter are shown in Table 2-2.

Table 2-2. Responses to Environmental Changes

Organism	Change (stimulus)	Response
Species of bacterium	Temperature falls below a certain point.	Bacterium produces a chemical that acts as an antifreeze.
Many plants	Air is hot and dry.	Leaf pores close to conserve water.
Monarch butterflies	Seasons change.	Butterflies migrate.
Human	Person hears a loud noise.	The person becomes alert; heart rate increases in case "flight or fight" is necessary.

Dynamic Equilibrium

Organisms have a variety of mechanisms that maintain the physical and chemical aspects of the internal environment within the narrow limits that are favorable for cell activities. The stability that results from these responses is called homeostasis or a "steady state." To many biologists, the phrase *steady state* suggests an unchanging condition. They prefer to use the term **dynamic equilibrium** to describe the constant small corrections that normally keep the internal environment within the limits needed for survival. In Figure 2-9, notice that these small corrections include a normal range of variations. Certain microorganisms or diseases can interfere with dynamic equilibrium, and therefore with homeostasis. Organisms, including humans, have mechanisms to deal with such interference and restore the normal state. Homeostatic adjustments have their limits. They can operate only within certain set ranges.

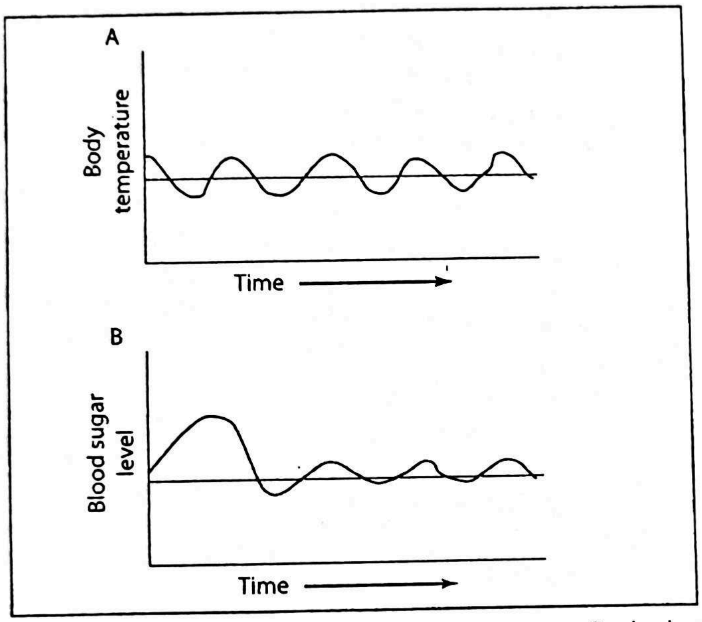


Figure 2-9. Dynamic equilibrium: (A) Temperature: Our body temperature shows a regular pattern of slight changes around a "normal" temperature of about 98.6°F (37°C). The graph represents the slight differences in temperature that are part of a daily cycle. Mechanisms such as shivering and sweating help maintain this range. (B) Blood sugar: Normal blood sugar levels show a rise in blood sugar after a meal, but blood sugar level is quickly restored to equilibrium as the hormone insulin prompts glucose to move from the blood to body cells.

Feedback Mechanisms

A **feedback mechanism** involves a cycle in which the output of a system "feeds back" to either modify or reinforce the action taken by the system. A variety of feedback mechanisms have evolved for helping organisms detect and respond to **stimuli** (changes in the environment). Multi-celled organisms detect and respond to change both at the cellular level and at the organism level. Their systems detect deviations from the normal state and take corrective actions to restore homeostasis.

Feedback responses can be simple or complex. A simple feedback response might involve a hormone that regulates a particular chemical process in a cell. A complex feedback response might be an elaborate learned behavior.

POSITIVE FEEDBACK Feedback mechanisms can also be either positive or negative. In positive feedback systems, a change prompts a response, which leads to a greater change and a greater response. An early stage of childbirth is a positive feedback system. The first contractions push the baby's head against the base of the uterus, which causes stronger contractions in the muscles surrounding the uterus, which increases the pressure of the baby's head against the base of the uterus, which causes stronger contractions and so on. Eventually the baby is born, and the feedback cycle ends.

NEGATIVE FEEDBACK Negative feedback systems are the most common. In this case, a change in the environment can prompt system 1 to send a message (often a hormone) to system 2, which responds by attempting to restore homeostasis. When system 1 detects that system 2 has acted, it stops signaling for further action.

A typical house heating system is an example of negative feedback. The furnace has a thermostat that is set to a specific temperature called the set point. When the room cools below the set point, the thermostat sends a message to turn on the furnace. When the room temperature rises above the set point, the thermostat stops sending the message, and the furnace shuts down. (See Figure 2-10.)

Regulating human body temperature uses a similar system. A structure in the brain detects that the temperature of the blood is too low. This brain structure then sends a signal to muscles, causing them to contract and relax in rapid cycles. The result is shivering, which generates body heat. When shivering has sufficiently warmed the body and blood, sensors in the brain detect the change, and the shiver signal stops.

Negative Feedback and Cell/Organ System Interaction

Maintaining dynamic equilibrium often involves interactions between cells and body organs or systems. For example, certain cells in the body monitor the level of glucose in the blood. When the glucose level is above normal limits, an endocrine organ called the **pancreas** secretes insulin. **Insulin** is a

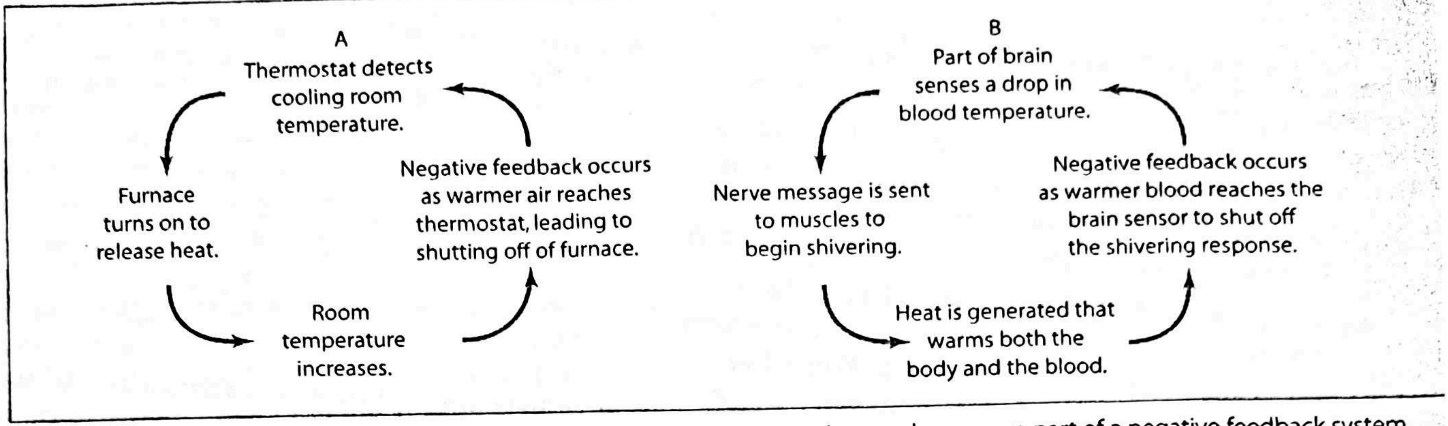


Figure 2-10. Negative feedback systems: (A) The furnace and thermostat in most houses are part of a negative feedback system. (B) Like the household heating system, the regulation of body temperature is a negative feedback system.

hormone that prompts glucose to move from the blood into body cells, resulting in a lower glucose level in the blood. Another hormone secreted by the pancreas works in the opposite way. When the glucose level in the blood is too low, this hormone prompts the release of glucose stored in the liver. The negative feedback process is shown in Figure 2-11.

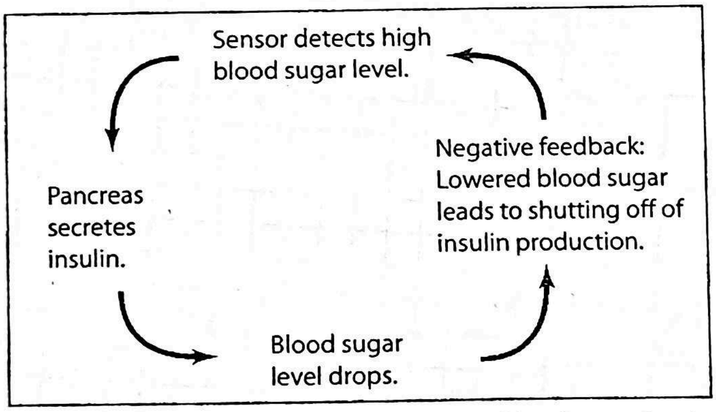


Figure 2-11. Negative feedback involving blood sugar level

Other examples of cell/organ feedback interactions include:

- Increased muscle activity is often accompanied by an increase in heart rate and breathing rate. If this did not occur, the muscles would not receive the increase in blood flow and oxygen they need to continue working.
- When leaves detect a water shortage (either due to a drought or just a very hot, dry day), **guard cells**—specialized cells that surround pores on the surface of the leaf—change shape to close the pores and reduce evaporation. The process is shown in Figure 2-12.

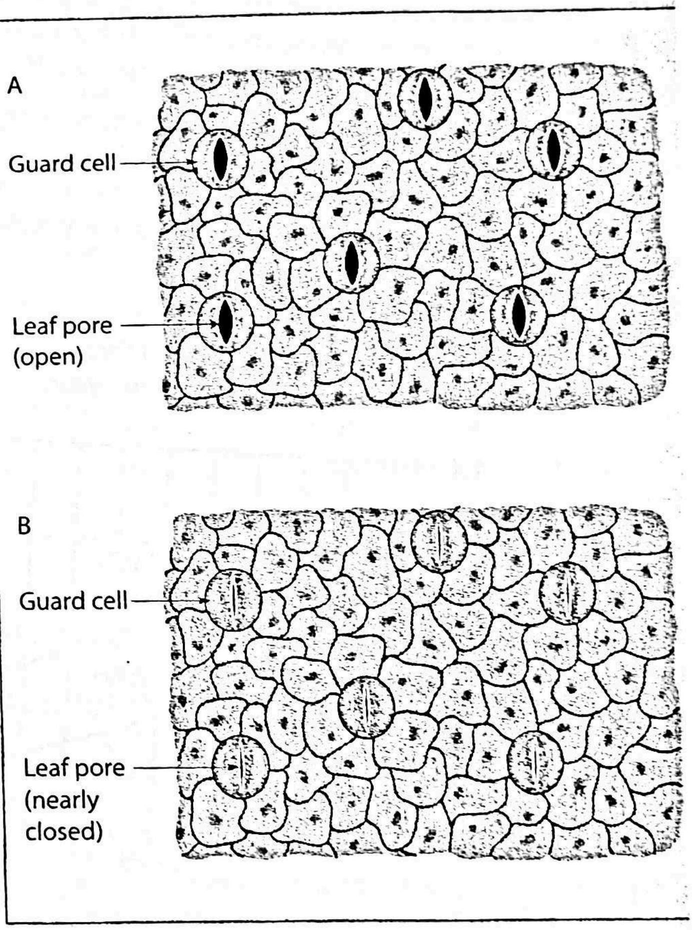


Figure 2-12. Guard cell activity on the surface of a leaf: (A) The guard cells have opened the pores in the leaf, allowing g exchange between the leaf and the environment. Water can exi from the leaf, and CO_2 can enter. This situation commonly exists when the sun is shining, the air is warm, and water is available i the soil. (B) The guard cells have nearly closed the pores in the leaf, thus protecting the leaf from drying out. Under these cond tions, gas exchange is limited, and photosynthesis slows down because little CO_2 is available. This situation commonly exists when the sun is shining, the air is hot and dry, and little water is available from the soil.

Review Questions

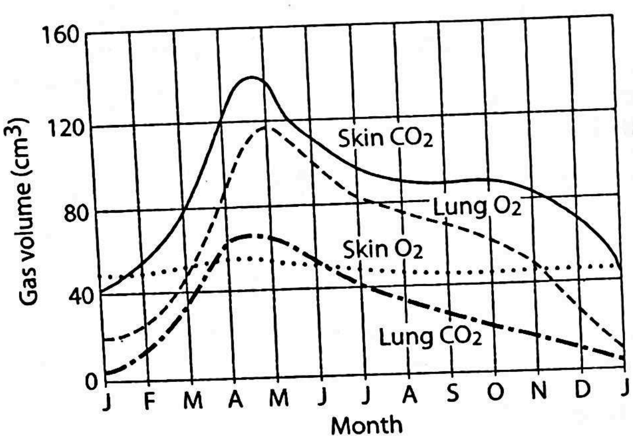
42. Some plants respond to light with a sudden enlargement of their leaf pores. This response is important because it enables the plant to increase its intake of (1) carbon dioxide (2) water (3) oxygen (4) nitrogen

43. An increase in the blood's level of a thyroid gland hormone decreases the release of thyroid-stimulating hormone. This mechanism illustrates (1) negative feedback (2) enzyme action (3) immune response (4) positive feedback

44. Maintenance of the pH of human blood within a certain range is an example of (1) chemical digestion (2) synthesis (3) respiration (4) dynamic equilibrium

45. Homeostasis is illustrated in the human body by the effects of insulin on the amount of (1) proteins digested (2) amino acids absorbed into the blood (3) oxygen transport to the lungs (4) glucose in the blood

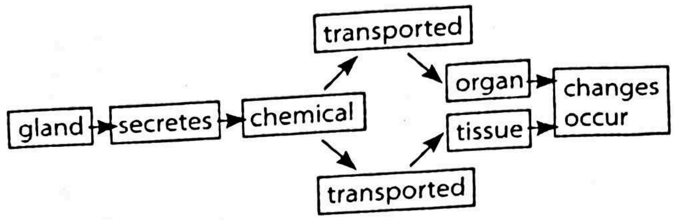
46. The following chart shows the amount of oxygen and carbon dioxide exchanged through the skin and lungs of a frog for a period of one year.



The lowest rate of gas exchange is most likely the result of (1) increased mating activity (2) elevated body temperature (3) environmental conditions (4) competition with other species

47. A student is frightened by a loud noise, which results in a hormone being released into the blood. The hormone causes the student's heart to beat rapidly. The two systems that work together to cause this reaction are the endocrine system that secretes the hormone and the (1) nervous system (2) reproductive system (3) excretory system (4) digestive system

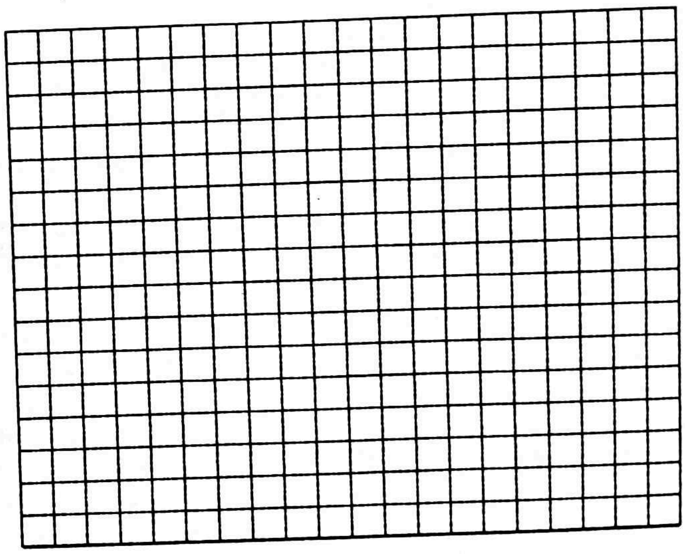
48. Which important human process is represented in the following diagram? (1) coordination (2) digestion (3) excretion (4) cell respiration



49. What normally happens to a person's blood sugar level soon after he or she eats a meal that contains carbohydrates?

50. How does insulin affect blood sugar levels?

51. Using the following graph grid, draw a line representing the relative blood sugar levels for two individuals (Person A and Person B) over a 5-hour period after a meal. Both people ate the same foods. Person A produces a normal amount of insulin, and Person B does not. Explain any differences in the lines representing Persons A and B.



52. During hot weather and vigorous exercise, people sweat. As the water on their skin evaporates, the water molecules absorb heat energy. Why is this process important to the individual?

53. Many different feedback mechanisms have evolved over time. These mechanisms allow an organism to respond to changes in both its internal and external environment. Select an organism from those you have learned about and, using one or more complete sentences, describe how a specific feedback process works within that organism. Include how the feedback specifically helps the organism maintain homeostasis.

Disease as a Failure of Homeostasis

Disease is any condition that prevents the body from working as it should. As a result, the body may fail to maintain homeostasis. Diseases in humans may result from foreign invader organisms, called **pathogens,** or from abnormal cells in the body that lead to cancer. Disease may also result from toxic substances, poor nutrition, organ malfunction, an inherited disorder, or risky personal behavior. All can lead to a disruption of the body's ability to function normally—that is, to maintain homeostasis. Sometimes the onset of a disease becomes apparent right away, as in the case of some birth defects or poisoning. Sometimes, however, the disease may not show up for many years, as is the case with lung cancer caused by exposure to tobacco smoke. Some examples of these kinds of diseases are noted in Table 2-3.

PATHOGENS There are many potentially dangerous disease-causing organisms in the air, water, and food we take in every day. A variety of pathogens—viruses, bacteria, fungi, and other parasites—can interfere with our normal functioning and make us seriously ill. Plants and other animals can also be infected by these and similar organisms. Some examples of pathogens and the diseases they cause are shown in Table 2-4.

CANCER Certain genetic mutations in a cell can result in uncontrolled cell division called cancer. Exposing cells to certain chemicals and radiation increases mutations and thus increases the chance of cancer. In this disease, genes that control and coordinate a cell's normal cycle of growth and division are altered by mutation. As a result, the cell begins to divide abnormally and uncontrollably. The result is a mass of abnormal cells referred to as a tumor.

Once they are identified, often by abnormal proteins on their surfaces, cancer cells may be attacked by the immune system and destroyed. If the immune system is unable to destroy the cancer cells, the disease may become life-threatening.

Table 2-3 Causes of Disease

Cause of Disease	Examples
Inherited disorders	Down syndrome, cystic fibrosis, sickle cell disease
Exposure to toxins	Lead poisoning, radiation poisoning
Poor nutrition	Scurvy (vitamin C deficiency), goiter (iodine deficiency)
Organ malfunction	Heart attack, diabetes
High-risk behaviors	Lung cancer, drug addiction, skin cancer

Table 2-4 Pathogens and Disease

Pathogen	Description of Pathogen	Examples of Disease
Virus	**Viruses** are particles composed of nucleic acid and protein. They reproduce when they invade living cells.	Viral diseases can spread quickly. Examples include the common cold, influenza, AIDS, and chicken pox.
Bacterium	**Bacteria** are one-celled organisms.	Bacterial illnesses include poisoning (from the toxins given off by some bacteria), strep throat, syphilis, and food poisoning. Antibiotics, such as penicillin, are used to treat many bacterial diseases.
Fungus	**Fungi** are organisms made of either one or many cells. They include yeasts and molds. They eat by absorbing organic substances.	Examples include athlete's foot and ringworm. Fungicides and antibiotics are used to fight fungal diseases.
Parasites	Some animals and one-celled organisms are **parasites** that survive by living and feeding on other organisms.	Parasites include leeches and tapeworms. Malaria (a disease caused by a one-celled organism and transmitted to humans by mosquitoes) and heartworm (a parasitic worm that lives in dogs and cats) are diseases caused by parasites.

The Immune System

Humans have many ways of protecting themselves from danger and disease. For example:

- Our eyes, ears, and sense of smell help us detect danger.
- We release hormones that stimulate emergency responses to danger.
- Our muscles allow us to fight off some threats and to flee from others.
- Our skin—when unbroken—keeps out many foreign organisms that could be harmful.
- Our tears, saliva, and other body secretions trap and/or destroy invaders that come into contact with them.
- Our nervous system provides rapid coordination of many of our responses to danger.

Once invaded, however, the body needs an effective way to combat invaders or body cells that malfunction. The **immune system** is the body's primary defense against disease-causing pathogens.

Pathogens, foreign substances, or cancer cells that threaten our homeostasis can usually be identified by molecules on their outer surfaces or membranes. These molecules, called **antigens,** trigger a response from the immune system. Toxins, the poisonous wastes of certain pathogens, can also act as antigens.

All cells have potential antigens on their surfaces, but the immune system can usually tell the difference between the molecules of "self" cells, which belong to the body, and "non-self" (foreign) cells, which come from outside the body. When cells of our immune system recognize foreign antigens, specialized white blood cells and antibodies attack them and the cells that display them.

WHITE BLOOD CELLS AND ANTIBODIES Some white blood cells are specialized to surround and engulf invading pathogens that are recognized as a threat. Others produce **antibodies**—proteins that either attack the invaders or mark them for killing. The marked invaders may then be killed by other white blood cells. In Figure 2-13, notice the Y-shaped antibodies that match the shape of antigens.

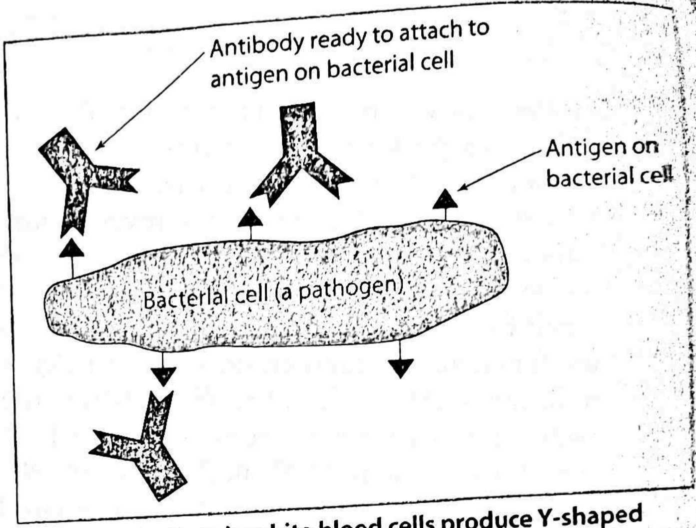


Figure 2-13. Certain white blood cells produce Y-shaped antibodies: The antibodies match the shape of certain antigens on pathogens or abnormal proteins on cancer cells. Note that the antibodies and antigens are not drawn to scale. They would be MUCH smaller than the pathogen cell.

Most of the antibodies and white blood cells that attack an invader break down soon after they have defended the body. However, some specialized white blood cells will remain. These cells are capable of quickly dividing and producing more antibodies of the same kind to fight off later invasions of the same **microbes** (microscopic organisms). Antibodies are effective even against microbes that appear years later.

MEMORY JOGGER

Remember germs? At one time *germ* was the word of choice for people who were talking about the tiny living things that cause disease. *Germ*, however, had two meanings in science, so the term *microbe* became the more accurate word choice. You still need to know that a microbe is any microscopic organism, but scientists now usually use the term *pathogen*. The reason is that the meaning of pathogen also includes viruses, those tiny "almost-organisms" that don't quite fit the description of a living thing.

VACCINATIONS Scientists have discovered that weakened microbes (pathogens) or even parts of microbes can stimulate the immune system to react. The antigens found on the live pathogens are usually present on the weakened or killed ones, too. As shown in Figure 2-14, **vaccines** are made using these weakened, killed, or parts of microbes (pathogens). When vaccines are injected into the body, the immune system responds just as if it had been invaded by a live pathogen. It produces antibodies. These antibodies can attack and destroy any of that pathogen that is still present in the body. After a vaccination, the immune system "remembers" specific pathogens by leaving behind white blood cells that protect the body for years. The vaccinated body reacts as if it has already defeated the specific pathogen and responds faster in the future than it did when attacked the first time. The second response is so rapid that in most cases the disease will not even have time to develop before the immune system wipes it out.

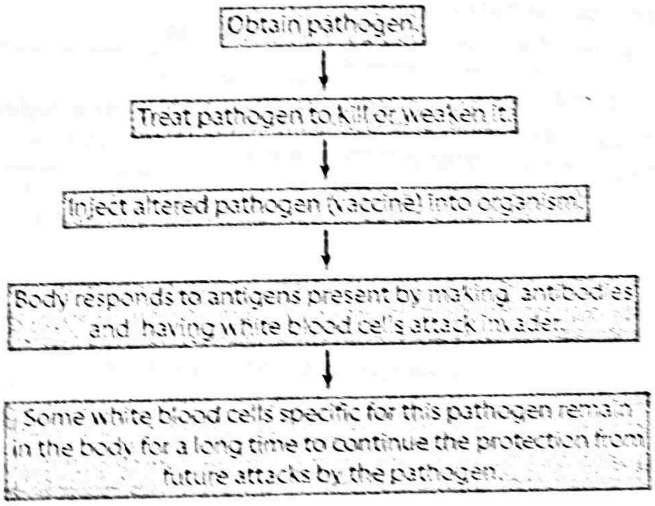


Figure 2-14. Preparation and use of a vaccine

DAMAGE TO THE IMMUNE SYSTEM A person's immune system may weaken with age or other factors. Stress and fatigue, for example, can lower our resistance and make us more vulnerable to disease. Some viral diseases, such as **AIDS,** result from an attack on the immune system. Damage from the disease may leave the person with AIDS unable to deal with infections and cancerous cells. Their weakened immune system is one reason people with AIDS often die of infections that a healthy immune system would easily destroy.

Problems Associated With the Immune Response Although our immune system is essential for our survival, it creates problems for some people. These people have an **allergy**—a rapid immune system reaction to environmental substances that are normally harmless. Examples of such substances include certain foods, pollen, and chemicals from insect bites. In people with allergies, the immune system reacts by releasing histamines. This leads to anything from a runny nose and sneezing to a rash and swelling. It is the swelling that makes some allergies dangerous: Occasionally, the throat swells, interfering with the victim's ability to breathe. People with allergies often use antihistamines to reduce the effects of the histamines and the symptoms they cause.

Sometimes the immune system fails to recognize the "self" molecules and attacks the body's own cells. For example, in some cases, the immune system attacks and destroys the pancreas cells that produce insulin. The result is one type of diabetes.

Since transplanted organs come from another person, they have foreign antigens on their cells. As a result, the immune system recognizes transplants as "invaders" and attacks them. To avoid "rejection" of their new organ, transplant patients receive injections of special drugs to reduce the effectiveness of their immune system. Of course, because the immune system's ability to protect the transplant patient from normal pathogens is reduced, the patient may become ill from a pathogen that normally would be no threat.

RESEARCH AND PROGRESS AGAINST DISEASE
Biological research of diseases and their causes has generated a vast amount of knowledge that is used to find ways of diagnosing, preventing, controlling, or curing diseases of plants and animals. Some examples of how medical knowledge has developed are shown in Table 2-5 on page 32.

Table 2-5. Biological Research of Diseases

Category of Research	Methods Developed
Diagnosing disease	• Culturing (growing) bacteria from the infected person to determine what specific pathogen is responsible for the illness • Using X-rays, CAT scans, ultrasound, blood pressure monitoring devices, and other methods to determine the cause or extent of the illness • Detecting genetic abnormalities that may be present in cells
Preventing and controlling disease	• Promoting improved sanitation measures, including frequent hand washing, safe garbage disposal, and sewage treatment • Sterilizing surgical instruments and treating wounds with antiseptics and other chemicals • Controlling populations of rats, flies, mosquitoes, and other disease-carrying organisms with pesticides or sanitation measures • Treating water, milk, and other foods to reduce the presence of pathogens • Vaccinating to promote the body's immune response to pathogens • Identifying the dangers of risky behaviors such as tobacco use
Treating and curing disease	• Developing antibiotics and other drugs to kill pathogens • Developing medical procedures, including surgical operations and laser techniques, to remove damaged or diseased tissue from the body

Review Questions

54. When a person is suffering from an infection, such as strep throat or chicken pox, his blood usually shows a significant increase in the number of (1) enzymes (2) antibodies (3) hormones (4) sugars

55. When microscope slides are stained to show blood cells, the small red blood cells that appear on the slides are much more numerous than the large white blood cells. This supports the concept that (1) the body's need for white blood cells is less than its need for red blood cells (2) red cells are more numerous because they are smaller than white blood cells (3) the nuclei of the white blood cells help them work more efficiently than the red blood cells, which lack nuclei (4) each kind of cell is present in the numbers best suited to meet the needs of the body

56. Which response usually occurs after an individual receives a vaccination for the influenza virus? (1) Hormones in the blood stop reproduction of the virus. (2) Pathogens from the vaccine deactivate the virus. (3) Enzymes released from platelets digest the virus. (4) Antibodies against the virus are found in the blood.

57. A patient has just received an organ transplant. Which treatment would be most effective in preventing the patient's body from rejecting the organ? (1) Treat the patient with medications that decrease the immune system's response. (2) Treat the patient with antibiotics to fight off a possible viral infection. (3) Restrict the patient's salt intake. (4) Give the patient blood transfusions.

58. The body makes chemicals that can help to destroy harmful viruses and bacteria. These chemicals are called (1) antibodies (2) vaccines (3) hormones (4) antibiotics

59. A vaccine can protect you against a disease becaus it (1) destroys toxic substances from bacteria befor they can make you sick (2) stimulates your immun system against the pathogen (3) kills any pathoge ic bacteria in your body (4) changes pathogenic bacteria into harmless bacteria

60. The body is protected against harmful flu viruses b (1) red blood cells and hormones (2) white blood cells and antibodies (3) white blood cells and enzymes (4) red blood cells and antibodies

61. A scientist wishes to determine how effective a vaccine is in protecting rats against a contagious disease. Which experimental procedure should the scientist use to determine the vaccine's effectiveness? (1) Expose 100 rats to the disease and then vaccinate them all. (2) Give vaccinations to 50 of the 100 rats and then expose all 100 to the disease. (3) Give vaccinations to 100 of the rats and expose them all to the disease. (4) Vaccinate 50 of the 100 rats and then expose only the 50 vaccinated rats to the disease.

62. Parasitic strains of *E. coli* may produce poisonous chemicals that attack living tissue and cause disease in humans. These chemicals are called (1) antibodies (2) toxins (3) viruses (4) antibiotics

63. Uncontrolled cell division is known as (1) meiosis (2) cancer (3) antibody production (4) sexual reproduction

64. The resistance of the body to a pathogen is called (1) immunity (2) antigen (3) cancer (4) infection

65. Diseases can be caused by inherited disorders, exposure to toxic substances, organ malfunction and certain personal behaviors. Choose TWO of the above causes and FOR EACH ONE give a specific example of an associated disease.

66. Our immune system normally helps us resist infection and disease. Sometimes, however, it may actually work against us by attacking certain tissues or organs in the body. Give an example of such a situation and tell how we try to counteract the problem.

67. Describe the steps you would follow to prepare a vaccine to immunize people against a newly discovered virus.

68. Biological research has generated much knowledge about diagnosing and preventing disease. Give one specific example of how research has helped us DIAGNOSE a disease and one specific example of how research has helped us PREVENT a disease.

69. Various types of pathogens, such as viruses, bacteria, fungi, and other parasites, can make us ill and interfere with normal body functioning. Choose ONE OF EACH of the above pathogen types, and for each type, name a specific organism (or its associated disease) that can make us ill or negatively affect body functioning.

Questions for Regents Practice

Part A

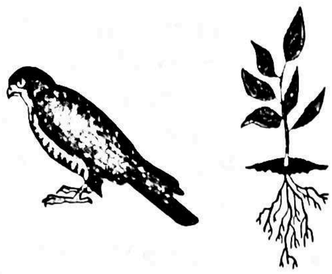
1. Most of the oxygen in our atmosphere comes from processes carried out
   (1) in the soil
   (2) by animals
   (3) in factories
   (4) by plants

2. Which organism releases oxygen into the atmosphere?
   (1) mold
   (2) bird
   (3) fish
   (4) tree

3. Plants provide food for animals through the process of
   (1) respiration
   (2) digestion
   (3) photosynthesis
   (4) excretion

4. Which word equation represents the process of photosynthesis?
   (1) starch → many glucose molecules
   (2) glucose + oxygen → carbon dioxide + water + energy
   (3) carbon dioxide + water → glucose + oxygen
   (4) fats → sugar molecules

5. Which statement correctly relates the two organisms in the illustration at the right?



(1) A carries out cell division, but B does not.
(2) B transports needed organic materials, but A does not.
(3) Both A and B carry out cellular respiration to release energy from organic molecules.
(4) Neither A nor B is able to use energy to combine carbon dioxide and water to make organic compounds.

6. A plant cell that lacks chloroplasts will not
(1) give off oxygen
(2) take in food
(3) give off carbon dioxide
(4) take in water

7. Which process removes carbon dioxide from the atmosphere rather than adding it?
(1) cellular respiration
(2) combustion of gasoline
(3) photosynthesis
(4) deforestation

8. Which process in plants produces carbon dioxide?
(1) respiration
(2) photosynthesis
(3) coordination
(4) digestion

9. The size of the openings in a leaf through which gases move in and out is controlled by the
(1) root cells
(2) chloroplasts
(3) chromosomes
(4) guard cells

10. What process does the following word equation represent?

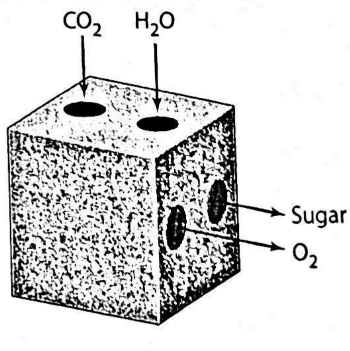
$$\text{glucose} + \text{oxygen} \xrightarrow{\text{enzymes}} \text{carbon dioxide} + \text{water} + \text{energy}$$

(1) photosynthesis
(2) breathing
(3) transport
(4) respiration

11. The major source of weight gain in a growing plant is
(1) sunlight
(2) carbon dioxide
(3) oxygen
(4) soil

12. Green plants do not release large amounts of CO_2 all the time because they use CO_2 in the process of
(1) photosynthesis
(2) respiration
(3) reproduction
(4) evolution

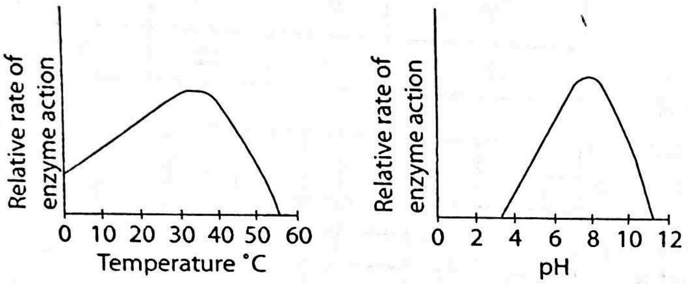
13. The following diagram represents some events that take place in a plant cell. With which organelle would these events be most closely associated?



(1) mitochondrion
(2) chloroplast
(3) ribosome
(4) vacuole

14. An enzyme that digests starch will not act upon the sugar sucrose. This fact is an indication that enzymes are
(1) specific
(2) synthetic
(3) starches
(4) generalized

15. Which statement best describes the enzyme represented in the following graphs?



(1) This enzyme works best at a temperature of 37°C and a pH of 8.
(2) This enzyme works best at a temperature of 55°C and a pH of 12.
(3) Temperature and pH have no effect on the action of this enzyme.
(4) This enzyme works best at a temperature near freezing and a pH above 4.

16. The body usually responds to foreign material by forming
(1) hormones
(2) antibodies
(3) vaccines
(4) antigens

17. A sudden increase in the number of white blood cells in a human may be an indication of
(1) growth
(2) color blindness
(3) mental retardation
(4) an infection

Part B

Base your answers to questions 18 and 19 on the following equation and on your knowledge of biology.

$$C_6H_{12}O_6 + 6\,O_2 \longrightarrow H_2O + 6\,CO_2 + 36\ ATP$$

(glucose) + (oxygen) ⟶ (water) + (carbon dioxide) + ATP

18. The equation represents the process of
(1) excretion
(2) photosynthesis
(3) respiration
(4) coordination

19. Explain the energy connection between the glucose and the formation of ATP in this process.

Base your answers to questions 20 through 24 on the following selection from the work of an early scientist and on your knowledge of biology.

A sprig (stem with leaves) of a nettle plant was put in a jar full of air fouled by breathing so as to extinguish a candle; it was placed in a room and left overnight; the next morning the air was found to be as bad as before. At 9 o'clock in the morning, the jar was put in the sunshine and, in the space of two hours, the air was so much corrected that it was found to be nearly as good as common air.

20. The "jar full of air fouled by breathing" probably contained an excess of what gas?

21. The fact that "the air was found to be as bad as before" was due to a process taking place in the plant. Name that process.

22. What process did the plant perform to produce air nearly as good as "common air"?

23. Identify the gas produced by the plant in the process that improved the air in the jar.

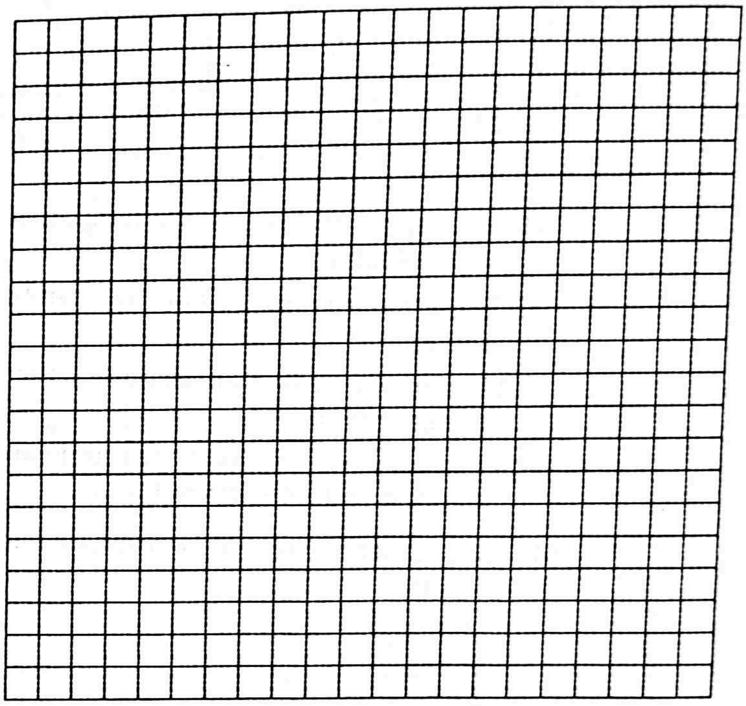
24. Identify the gas that was produced by the plant in the dark.

Base your answers to questions 25–29 on the following information and data table and on your knowledge of biology.

An investigation was designed to determine the effect of temperature on respiration in germinating seeds. Two sets of test tubes were prepared. In each set of two test tubes, one tube contained a number of germinating peas, and the other tube contained an equal number of glass beads. An equal amount of chemical was placed in each tube to absorb the carbon dioxide produced so that the volume of oxygen consumed could be measured. One set of tubes was placed in a controlled-temperature water bath at 10°C. The other set of test tubes was placed in a controlled-temperature water bath at 26°C. Total oxygen consumption was measured every 5 minutes for a period of 20 minutes. The data are summarized in the data table.

Data Table

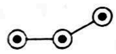
Time (in minutes)	Total Oxygen Consumption (mL)			
	10°C		26°C	
	Beads	Peas	Beads	Peas
0 (Start)	0	0.0	0	0.0
5	0	0.3	0	0.5
10	0	0.6	0	1.0
15	0	0.9	0	1.5
20	0	1.2	0	2.0



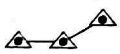
Use the information in the data table at the right and follow the directions in questions 25–27 to construct a line graph on the grid provided.

25. Label each axis and mark an appropriate scale on each axis.

26. Plot the data for oxygen consumption by peas at 10°C on the grid. Surround each point with a small circle and connect the points.

Example: 

27. Plot the data for oxygen consumption by peas at 26°C on the grid. Surround each point with a small triangle and connect the points.

Example: 

28. State one conclusion that relates the rate of respiration in germinating peas to temperature.

29. State one reason for including the tube containing the glass beads in each set.

30. The greenhouse effect leads to global warming by trapping heat in our atmosphere. Carbon dioxide produced through the burning of coal and oil for industrial processes, power generation, and transportation is one of the main atmospheric gases that contributes to the problem. Some people have suggested that planting many long-lived trees along the interstate highways in New York and other states could help counteract the greenhouse effect. Explain how this could help.

Base your answers to questions 31 through 34 on the following reading passage and on your knowledge of biology.

Lyme Disease

Since 1980, the number of reported cases of Lyme disease in New York State has been increasing. The vector (carrier) of Lyme disease is the black-legged tick, *Ixodes scapularis*. The disease is spread from infected animals to ticks that bite these animals. Humans bitten by these ticks may then become infected.

The symptoms of Lyme disease do not always occur immediately after a tick bite. An individual may develop a skin rash several days to weeks after being bitten by a tick. Flu-like symptoms, such as headaches, muscle aches, joint pain, and fever, may also develop. Generally, these symptoms clear up even if the individual does not seek medical help. Also, in some cases, there may be no symptoms other than a sudden onset of arthritis. However, in a small number of cases, if the infection is not treated, it may lead to chronic arthritis, disorders of the heart and nervous system, or in a few cases, death. A blood test can help to confirm a diagnosis, and antibiotics are effective in treating the infection.

People may take preventive action by frequently checking themselves and their pets for ticks, tucking their pant legs into socks when walking through woods or high grass, wearing light-colored clothing to aid in spotting a tick, and using insect repellent.

31. Describe how Lyme disease is transmitted.

32. State one way people might protect themselves from Lyme disease.

33. State two symptoms that may occur if a person has Lyme disease.

34. State one danger of ignoring any symptoms that may develop after a tick bite.

Use the information provided below to answer questions 35 through 37.

Twenty-five geranium plants were placed in each of four closed containers and then exposed to the light conditions shown in the data table. All other environmental conditions were held constant for a period of two days. At the beginning of the investigation, the quantity of carbon dioxide (CO_2) present in each container was 250 cm³ (cubic centimeters). The data table shows the amount of CO_2 remaining in each container at the end of two days.

Data Table

Container	Color of Light	CO_2 (cm^3) at Start	CO_2 (cm^3) After 2 Days
1	blue	250	50
2	red	250	75
3	green	250	200
4	orange	250	150

35. The variable in this investigation was the
(1) type of plant
(2) color of light
(3) amount of CO_2 in each container at the beginning of the investigation
(4) number of days needed to complete the investigation

36. State the problem being investigated in this experiment.

37. Identify the source of the carbon used in photosynthesis.