Vaccinations

1 A vaccine for the viral disease known as chicken pox would contain
(1) a large amount of live virus
(2) a dead or weakened form of the pathogen
(3) several different antibiotics
(4) a small number of white blood cells

Base your answers to questions 2 on the information below and on your knowledge of biology.

Since 1980, the vulture population in India has declined from 40 million to 60 thousand due to poisoning by a pain reliever used in cattle. If only 1% of the cattle carcasses fed on by vultures are animals that have been treated with the drug, it can lead to a drastic decline in the vulture population. The grim picture is that over 10% of the carcasses have been found to contain this drug.

Vultures feed exclusively on the carcasses of dead animals. This helps to prevent the spread of diseases such as rabies and anthrax among wildlife, livestock, and humans. Without as many vultures present, other scavengers such as dogs have moved in and taken advantage of the newly available food. The abundance of these other scavengers has led to an increase in the number of cases of human rabies and an outbreak of tuberculosis, anthrax, and foot-and-mouth disease. These diseases are not spread to humans by vultures.

2 Dogs can be vaccinated against the rabies virus. When a vaccinated dog is exposed to the rabies virus, the dog will most likely
(1) develop a mutation that will make the dog sick and the dog will be unable to recover
(2) have a damaged immune system and will not be able to be protected
(3) have an immune response and will be able to fight the microbes
(4) develop a response that will allow the immune system to attack some of the body’s own cells

3 A student received a flu shot in the fall. During the flu season, the student caught a cold. The most likely reason the vaccine he received did not prevent the cold was that
(1) his illness was not caused by a pathogen
(2) he did not get the vaccine at the right time of year
(3) his body produced antibiotics in response to the vaccine
(4) the vaccine he received contained only flu virus antigens

Base your answers to questions 4 on the information and data table below and on your knowledge of biology.

Measles: Eliminated?

Measles is a highly contagious viral disease. Infected people first experience a fever, cold-like symptoms, and a rash. Several complications can develop, such as ear infections, diarrhea, pneumonia, encephalitis (swelling of the brain), and death. Prior to the widespread use of the measles vaccine in the 1960s, it is estimated that 3–4 million people were infected every year. The Centers for Disease Control and Prevention declared measles eliminated in the United States in 2000. This was accomplished, in part, due to a highly effective vaccination program. However, since 2016 the disease has made a comeback, and there has been an increase in measles cases in recent years.

Number of Measles Cases 2010-2016

Year	Number of Cases
2010	63
2011	220
2012	55
2013	187
2014	667
2015	188
2016	70

Source: www.cdc.gov/measles/cases-outbreaks.html

Directions: Using the information in the data table, construct a line graph on the grid below, following the directions below.

4 The reason for the dramatic decline in the number of measles cases from the 1960s to 2010 in the United States was because the vaccine
(1) contained pathogens to fight against this highly contagious virus
(2) prevented the development of serious complications after infection
(3) exposed many people to a weakened form of the measles virus, making them immune
(4) contained an antibiotic that killed the measles virus, preventing its spread

5 A new vaccine was developed and then tested on a large sample of individuals. This new vaccine will be considered effective if it helps prepare the body to fight future invasion by
(1) inhibiting the response of red blood cells
(2) stimulating the reproduction of microbes
(3) inhibiting the action of immune cells
(4) stimulating the production of antibodies

6 When getting a vaccination, which substance is injected into the body?
(1) bacteria to combat a pathogen
(2) white blood cells to engulf a pathogen
(3) a weakened form of a virus
(4) antibiotics to kill a virus

Base your answers to questions 7 on the passage below and on your knowledge of biology.

Polio is a virus that can cause paralysis or death. At its peak, the disease affected about 500,000 people a year worldwide before the development of an effective vaccine in 1955.

When the first polio vaccine was developed, it was tested in experiments using thousands of children as subjects. The children were injected with either the experimental vaccine or given a harmless injection without the vaccine. Only after these extensive tests was the vaccine finally accepted as being successful in preventing the disease.

Although, at this time, polio has been nearly eliminated in the Western Hemisphere, certain countries in the world still report new cases of the disease. Complete elimination of the disease can be achieved in these countries by vaccinating all of the children at the same time with the polio vaccine.

7 Identify the substance in the polio vaccine that makes it effective. [1]

Base your answers to questions 8 on the data table below and on your knowledge of biology.

Vaccines Received by Children

Patient	Measles Vaccine	Polio Vaccine
child A	✓	
child B	✓	✓
child C		✓

8 State the specific expected result of administering these vaccines to child B. [1]

Base your answers to questions 9 on the passage below and on your knowledge of biology.

A Vaccine to Treat Addiction

A vaccine for cocaine addiction has been developed. This vaccine temporarily blocks the effects of cocaine. The vaccine consists of a cocaine molecule attached to the surface of an inactive, harmless cholera protein.

Since cocaine molecules alone are too small to stimulate the immune system to create antibodies, they are attached to the cholera protein. When people are injected with the vaccine, their bodies make antibodies against cholera. They also make antibodies against cocaine. When cocaine later enters the bloodstream, the antibodies bind to cocaine and prevent it from leaving the bloodstream, so it does not reach the brain. If the drug does not reach the brain, the user does not feel its effect. When antibodies were blocking the cocaine, people who took cocaine didn’t get an effect from it, so the drug lost its appeal. Later, an enzyme breaks down the cocaine and it is flushed out of the body.

One problem revealed by the trial was that only 38 percent of vaccinated subjects developed high levels of antibodies against the drug. Additionally, the vaccine’s protection seems to last for only about two months. Users need to receive booster shots every few months for approximately two years to make a complete recovery from the addiction.

9 Identify the two main substances contained in the vaccine. [1]
_____ and
_____

Base your answers to questions 10 on the information below and on your knowledge of biology.

Some viruses can enter cells by first attaching to the cell membrane. The flu virus targets and attaches to the cells of the nose and mouth. The hepatitis virus targets only specific cells of the liver.

10 Most people who get vaccinated develop immunity to the disease. Explain why the contents of the vaccine usually do not cause people to get sick. [1]

Base your answers to questions 11 on the passage below and on your knowledge of biology.

Here, Eat This Vaccine

Munching on bacteria could be a good way to stimulate your immune system. Biologist Simon Cutting of the Royal Holloway University of London has transformed bacterial spores into an edible vaccine. He and his collaborators genetically altered the common bacterium Bacillus subtilis so that it produced harmless fragments of the toxin produced by tetanus. Then his team starved the bacterium so that it turned into a spore — a desiccated [dehydrated] packet tough enough to survive a trip through the digestive tract and into the bloodstream. Most of the mice that inhaled or ate the modified spores were then able to survive a lethal dose of tetanus.

"We selected tetanus because the immunology regarding this disease is well understood," Cutting says. But engineered bacteria could be similarly tailored to train the immune system to fight anthrax, traveler's diarrhea, and other illnesses. Edible vaccines would eliminate the need for needles and sterilizing equipment. Moreover, spores can withstand extreme heat and dryness, remaining viable [alive] for thousands of years. Cutting plans to start clinical trials in about two years. If the results measure up, spore vaccines could slash the cost of immunization programs, especially in poor countries where refrigeration is unreliable and transportation can be slow.

Source: http://discovermagazine.com/2003/aug/breakeat/ Here, Eat This Vaccine, by Zara Herskovits August 1, 2003

11 Describe one way the immune system could respond when it is exposed to the genetically altered Bacillus subtilis. [1]

Base your answer to question 12-14 on the information below and on your knowledge of biology.

12-14 In order to enroll in most schools, students must be vaccinated against certain viral diseases, such as mumps. Even with these vaccinations, many students still suffer from other diseases. Discuss how a vaccination works and why some students still become infected with other diseases. In your answer, be sure to:
• identify what is present in a vaccine that stimulates an immune response [1]
• describe how a vaccine protects against disease [1]
• state why a student vaccinated against mumps can still be infected by the pathogens that cause other diseases, such as chicken pox [1]

Base your answers to questions 15 on the information below and on your knowledge of biology.

In an experiment to test the effectiveness of a new vaccine, 50 rats received an injection of equal doses of the vaccine and 50 other rats received an injection of equal doses of a weak salt solution. Two months later, all of the rats received injections that contained equal doses of live, disease-causing organisms.

The experimental results are shown in the chart below.

Effectiveness of a New Vaccine

Injection: 50 Rats Received	Number of Rats That Developed the Disease	Number of Rats That Did Not Develop the Disease
vaccine	7	43
weak salt solution	48	2

15 State one possible reason why two of the rats did not get sick even though they did not receive the vaccine. [1]

16 A child became ill with the measles. Measles is a disease that is highly contagious. The child's mother did not get sick, even though she and the child were close while the child was ill. State one reason why the mother did not get sick with the measles. [1]

Base your answer to question 17-20 on the information below and on your knowledge of biology.

An Experimental SARS Vaccine Works in Animals

Scientists reported that they had protected animals from the effects of the SARS virus by using an experimental vaccine. The SARS virus causes an acute respiratory illness in humans and other animals.

This vaccine was sprayed once into the nostrils of each of four African green monkeys. Four weeks later, these monkeys were exposed to the virus that causes SARS. The monkeys showed no sign of the disease in their respiratory tracts. Blood tests confirmed the presence of proteins known as neutralizing antibodies that indicate protection against disease.

The scientists also sprayed a placebo (a substance that did not contain the vaccine) into the nostrils of each of four other African green monkeys. After exposure to the virus that causes SARS, all of these monkeys developed symptoms of this condition.

17-20 Briefly explain the nature of a vaccine and some steps that should be taken before a vaccine is available for public use. In your answer, be sure to include:
- a description of what a vaccine is [1]
- an explanation of why one group had a placebo sprayed into their nostrils before exposure to the virus [1]
- an explanation of why scientists used monkeys to test the SARS vaccine [1]
- a statement of what could be done to verify the results [1]

Answer Keys

1 2

2 3

3 4

4 3

5 4

6 3

7 Allow 1 credit. Acceptable responses include, but are not limited to:
- — dead/weakened pathogen
- — antigens
- — a small piece of the virus/viral coat
- Note: Do not accept “a little bit of the disease” or “a small amount of the virus.”

8 Allow 1 credit. Acceptable responses include, but are not limited to:
- — Child B should be immune to both measles and polio.
- — Child B will form antibodies against both diseases.
- — Child B will not get measles or polio.

9 Allow 1 credit. Acceptable responses include, but are not limited to:
- — cocaine molecule and cholera protein
- — cocaine and harmless or inactive cholera protein

10 Allow 1 credit. Acceptable responses include, but are not limited to:
- — The vaccine contains only dead organisms or chemicals associated with pathogens.
- — The contents of a vaccine are not functional pathogens/not able to reproduce and make you
- sick.
- — The vaccine contains weakened pathogens that will not make people sick.
- Note: Do not accept a response that indicates the vaccine contains “a little bit” of the disease or
- a “small amount” of the virus.

11 Allow 1 credit. Acceptable responses include, but are not limited to:
- — The immune system may produce antibodies to fight the tetanus bacteria.
- — The immune system may produce more white blood cells to fight the tetanus bacteria.

12-14 The student's response to the bulleted items in the question need not appear in the following order.

- 12. Allow 1 credit for identifying what is present in a vaccine that stimulates an immune response. Acceptable responses include, but are not limited to:
- — dead/weakened virus/germ
- — antigens
- — small pieces of the virus/viral coat
- Note: Do not allow credit for "a little bit of the disease" or "a small amount of the virus."
- 13. Allow 1 credit for describing how a vaccine protects against disease. Acceptable responses include, but are not limited to:
- — It causes an immune response, so that your body can respond quicker next time you are exposed to the same pathogen/organism.
- — It causes the body to produce antibodies that fight the disease.
- 14. Allow 1 credit for stating why a student vaccinated against mumps can still be infected by the pathogens that cause other diseases, such as chicken pox. Acceptable responses include, but are not limited to:
- — Vaccines protect only against specific diseases.
- — Antibodies are specific.

15 Allow 1 credit. Acceptable responses include, but are not limited to:

- — The rats may have had a natural immunity to the disease.
- — Those rats that did not get sick had a variation that protected them.
- — They may have already had the disease and are immune.
- — Their immune system fought off the virus.

16 Allow 1 credit. Acceptable responses include, but are not limited to:

- — The mother had antibodies against the measles.
- — The mother had been vaccinated against measles.
- — The mother had measles when younger and still had immunity to measles.
- — The mother is immune to the measles.
- — The mother had a mutation that made her resistant.

17-20 The student’s response to the bulleted items in the question need not appear in the following order.

- 17. Allow 1 credit for a description of what a vaccine is. Acceptable responses include, but are not limited to:
- — a substance injected to stimulate the immune system to produce antibodies
- — A vaccine contains a dead/weakened pathogen that stimulates an immune response.
- — a substance that is administered that contains antigens
- — It has a small piece of the virus/viral coat, which causes the formation of antibodies.
- Note: Do not accept a response that indicates that a vaccine contains “a little bit” of the disease or “a small amount” of the virus.
- 18. Allow 1 credit for explaining why one group had a placebo sprayed into their nostrils before exposure to the virus. Acceptable responses include, but are not limited to:
- — The group that received the placebo was the control group.
- — to see if the vaccine makes a difference
- 19. Allow 1 credit for explaining why scientists used monkeys to test the SARS vaccine. Acceptable responses include, but are not limited to:
- — Scientists used monkeys to test the vaccine because of their biological similarity to humans.
- — Monkeys are affected by the SARS virus, also.
- — There are stricter regulations regarding testing on humans, that must be followed.
- 20. Allow 1 credit for stating what could be done to verify the results. Acceptable responses include, but are not limited to:
- — researcher could repeat the experiment
- — use a larger sample size
- — verify blood samples were not contaminated
- — check that equipment is working properly