**INTRODUCTION**

This worksheet will guide your exploration of *The Immune System* Click & Learn. After completing this worksheet, you will have more knowledge about how the immune system works. You will be able to apply that knowledge to everyday situations, such as getting a vaccine or having a fever.

**PART 1: Introduction to Immune System Anatomy**

Open *The Immune System* Click & Learn and go through the **"Immune System Anatomy"** section. This section explores the main organs of the immune system.

1. The body has physical and chemical barriers to prevent pathogens from entering and infecting tissues.
   a. Having a runny nose (and blowing your nose) protects your body from pathogens. How do you think that works?

   b. Why do cells that line the respiratory tract (including the nose and lungs) have hairs?

2. The table below is an example "report" from a blood test. It shows the numbers of five different cell types in a person's blood. It also shows the expected ranges of numbers if the person is currently healthy. (These values are just examples — other people's might be different.)

| **Type of cell** | **Number of cells** (per microliter of blood) | **Expected number of cells** (per microliter of blood) |
|---|---:|---:|
| Neutrophils | 4,165 | 1,560–6,450 |
| Lymphocytes (T cells, B cells, NK cells) | 1,050 | 950–3,070 |
| Eosinophils | 142 | 30–480 |
| Monocytes | 519 | 260–810 |
| Basophils | 24 | 10–80 |

   a. Where in the body are these types of cells produced?

   b. Are this person's numbers of immune cells within their expected ranges? If not, which cell types are *not* within their expected ranges?

3. Below is an example report for someone with **leukemia**, a cancer of immune cells. Cancer is caused by uncontrolled cell division.

| **Type of cell** | **Number of cells** (per microliter of blood) | **Expected number of cells** (per microliter of blood) |
|---|---:|---:|
| Neutrophils | 2,580 | 1,560–6,450 |
| Lymphocytes (T cells, B cells, NK cells) | 124 | 950–3,070 |
| Eosinophils | 30 | 30–480 |

| | | |
|---|---|---|
| Monocytes | 2,280 | 260–810 |
| Basophils | 60 | 10–80 |

a. Which parts of this report might show that this person has leukemia? Be specific.

b. One treatment for leukemia is a **bone marrow transplant**. First, doctors use various methods to kill the cancer cells in the person's body. They can then replace these cells with stem cells from the bone marrow of a person without leukemia. Why might a bone marrow transplant help a person with leukemia?

4. In very rare cases, a baby may be born without a thymus. How might this affect their immune system?

5. When a person is sick, a doctor may check the lymph nodes under their jaw and on each side of their neck. Swollen lymph nodes can be a sign that the body is responding to an infection. Why do you think this is?

6. An athlete injured their spleen during a game. At the hospital, doctors removed the spleen and then recommended that the athlete get all their vaccines, including the flu vaccine. **Vaccines** are medicines that help protect the body from infections. Explain why getting vaccines would be particularly important for someone without a spleen.

7. Label **two** organs of the immune system on the figure below, and explain how they work together.

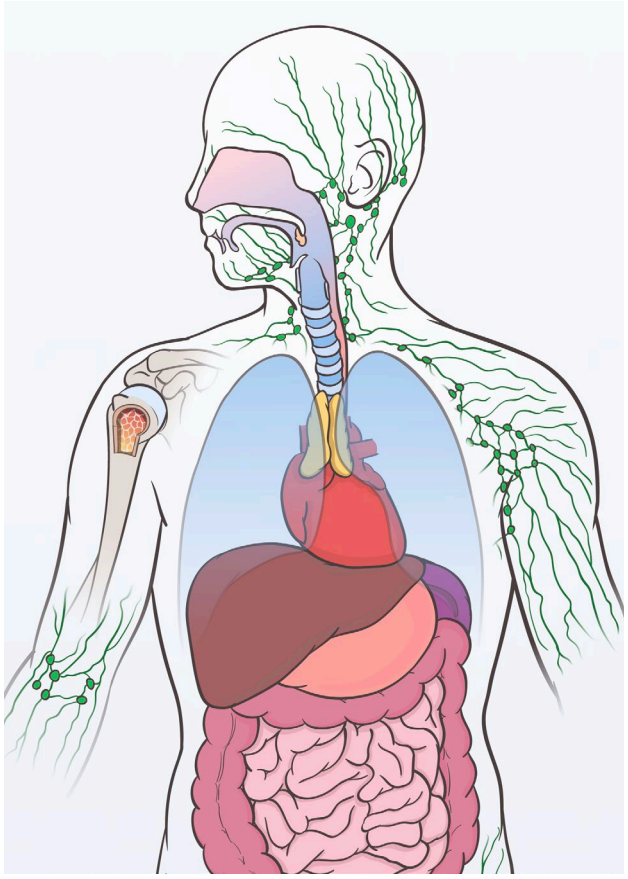


**Figure 1.** A diagram of the human body.

**PART 2: Immune Response**

Continue to the **"Immune Response"** section of the Click & Learn, which explores how the immune system responds to pathogens.

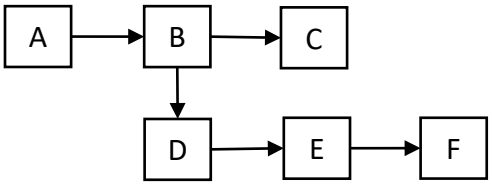
Read the **"Overview,"** then all the pages under the "**Innate Immune Response"** part of the **"Timeline"** tab. Stop when you reach the "Adaptive Immune Response" page.

8. Determine whether each statement in the table below is true or false. Write your decision in the "True or False?" column.

| Statement | True or False? |
|---|---|
| Innate immune cells can distinguish between specific types of viruses and bacteria. | |
| Innate immune cells can activate adaptive immune cells. | |
| The innate immune response provides longer-lasting protection than the adaptive response. | |
| The innate immune response includes phagocytes and proteins. | |

9. Cytokines are often referred to as "messengers." Provide **two** examples of "messages" that cytokines can deliver, and how cells or the body respond to each message.

10. Examine the diagram below. It represents some of the steps (A to F) that can occur when a person is infected.




Assign each letter in the diagram to a step in the table below. Some of the letters have already been filled in.

| Steps | Letter |
|---|---|
| Phagocytes with antigens on their surface activate T cells to start the adaptive immune response. | |
| Pathogens get through the body's physical and chemical barriers. | |
| Innate immune cells, which include phagocytes, respond to the pathogens. | |
| Pieces of pathogens (antigens) attach to proteins on the surface of phagocytes. | D |
| The adaptive immune response destroys the pathogens, and the infection ends. | |
| The innate immune response destroys the pathogens, and the infection ends. | C |

Read all the pages under the "**Adaptive Immune Response"** part of the **"Timeline"** tab. Stop when you reach the "Repeated Infections" page.

11. In two or three sentences, describe how the innate and adaptive immune responses interact.

12. Fill in the table below with the following terms:
    - humoral immune response
    - fever
    - inflammation
    - cell-mediated immune response
    - skin and mucous membranes

| Immune response | |
|---|---|
| **Innate** immune response | **Adaptive** immune response |
| | |
| | |
| | |

13. Hypogammaglobulinemia is a medical condition in which you have low levels of antibodies. People with hypogammaglobulinemia tend to get a lot of infections. Why do you think this is?

14. Explain the difference between an antibody and an antigen.

15. What does it mean to say that the adaptive immune response has “memory”?

**PART 3: Vaccines**

Read all the pages under the **"Repeated Infections"** part of the **"Timeline"** tab.

16. The figure below shows the antibody levels of an individual who was injected with a specific antigen. The individual was injected with this antigen twice: once in Week 1 and again in Week 5.

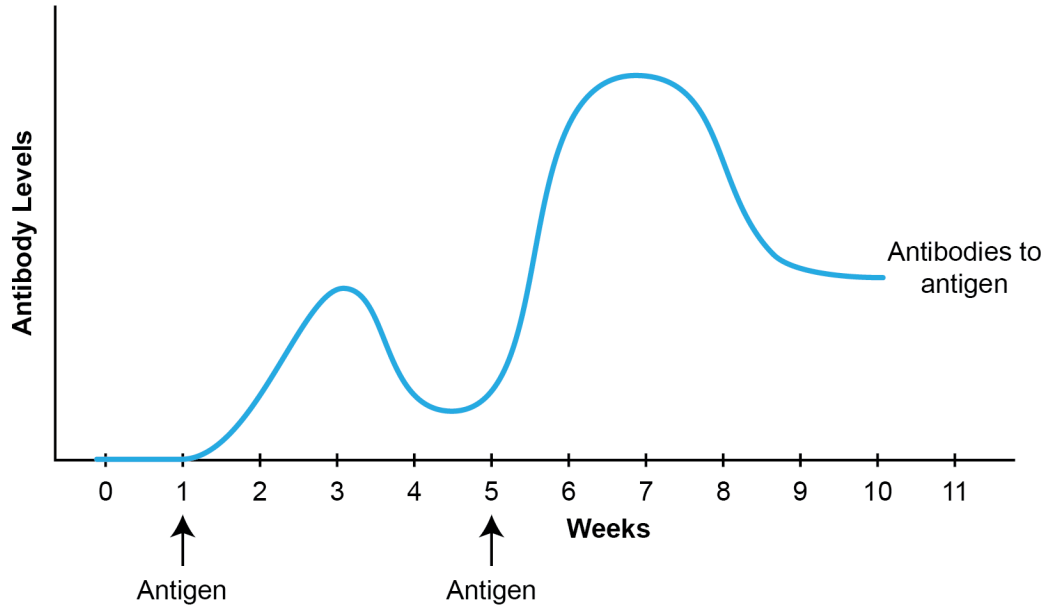



**Figure 2.** Antibody levels over time for an individual injected twice with a specific antigen.

a. Which cells produce antibodies?

b. Between the first and second antigen injections, when are antibody levels the highest?

c. Describe **two** differences between the antibody levels after the first and second injections.

d. What might explain the differences you described?

Now read the **"Vaccines"** tab under the **"Immune Response"** section.

17. The table below lists the four main types of vaccines.

a. Complete the table with a short description of what the vaccine consists of.

| **Type of vaccine** | **Description** |
|---|---|
| Live-attenuated | |
| Inactivated | |
| Subunit/recombinant | |
| Toxoid | |

b. Explain why vaccines do *not* cause disease.

18. The graph below shows how many cases of measles were reported in the United States from 1921 to 2015. **Measles** is an infectious disease caused by a virus.

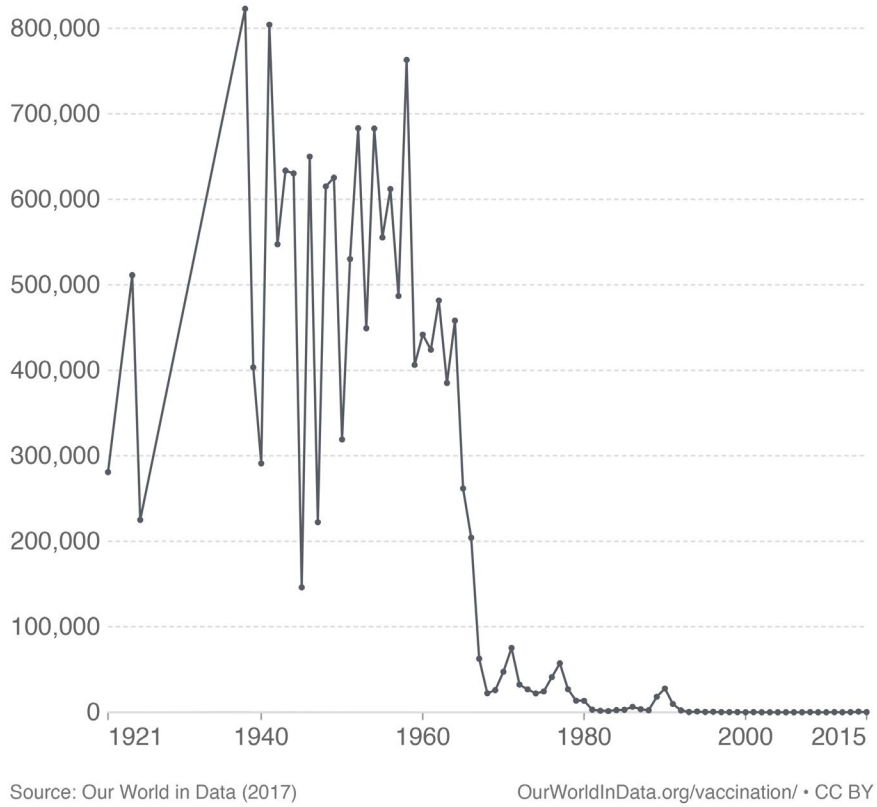



**Figure 3.** The number of reported cases of measles in the United States from 1921 to 2015.

The measles vaccine has been available in the United States since 1963. What happened to the number of reported measles cases at that time?