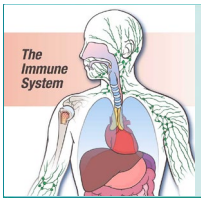


The Immune System

hhmi | BioInteractive

Click & Learn
Student Worksheet (Immunotherapy)

INTRODUCTION

The immune system is a network of organs, cells, and proteins that work together to keep the body healthy. Scientists make new discoveries about how the immune system works every day. These discoveries may lead to new medical treatments.

In this activity, you will explore the immune system to understand how it functions. You will then apply your knowledge to explain a new treatment for prostate cancer.

PART 1: Organs of the Immune System

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 thymus is essential for preventing the immune system from attacking self-antigens.
   a. Define "antigen" and "self-antigen."

   b. What happens to T cells that bind to self-antigens?

   c. What type of condition may be caused by T cells that bind to self-antigens?

2. How does the body replace immune cells and red blood cells that have died? Where does this process occur?

PART 2: The Immune Response

Continue to the **"Immune Response"** section of the Click & Learn, which explores how the immune system responds to pathogens. Go through the **"Timeline"** tab, then answer the following questions.

3. The innate immune response includes both cells and proteins.
   a. Give one example of a **cell** in the innate immune system, and briefly describe its function.

   b. Give one example of a **protein** in the innate immune system, and briefly describe its function.

4. Any cell in the body that accumulates DNA mutations can become a cancer cell. Cancer cells divide uncontrollably and cause disease. Which type of innate immune cell can destroy cancer cells by making them undergo apoptosis (cell death)?

5. Both the innate immune response and the adaptive immune response involve dendritic cells.
   a. Briefly describe the function of dendritic cells in the **innate** immune response.

   b. Briefly describe their function in the **adaptive** immune response.

6. List **three** ways in which the innate immune response differs from the adaptive immune response.

7. What are antigen-presenting cells (APCs)? What do they do?

8. How does the function of helper T cells differ from the function of cytotoxic T cells?

9. What do B cells do?

10. Do antibodies affect the function of the *innate* immune response in any way? If so, how?

PART 3: Vaccines

Read all the pages under the **"Repeated Infections"** part of the **"Timeline"** tab.
The graph below, which is also in the Click & Learn, shows two types of immune responses. The **primary immune response** is what happens when a pathogen infects a person for the first time. The **secondary immune response** is what happens when the same pathogen infects the person a second time.

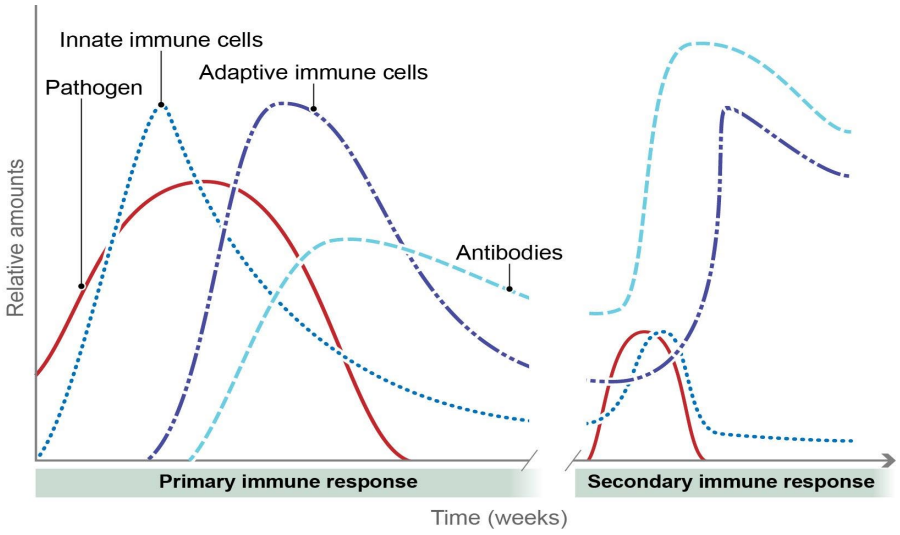
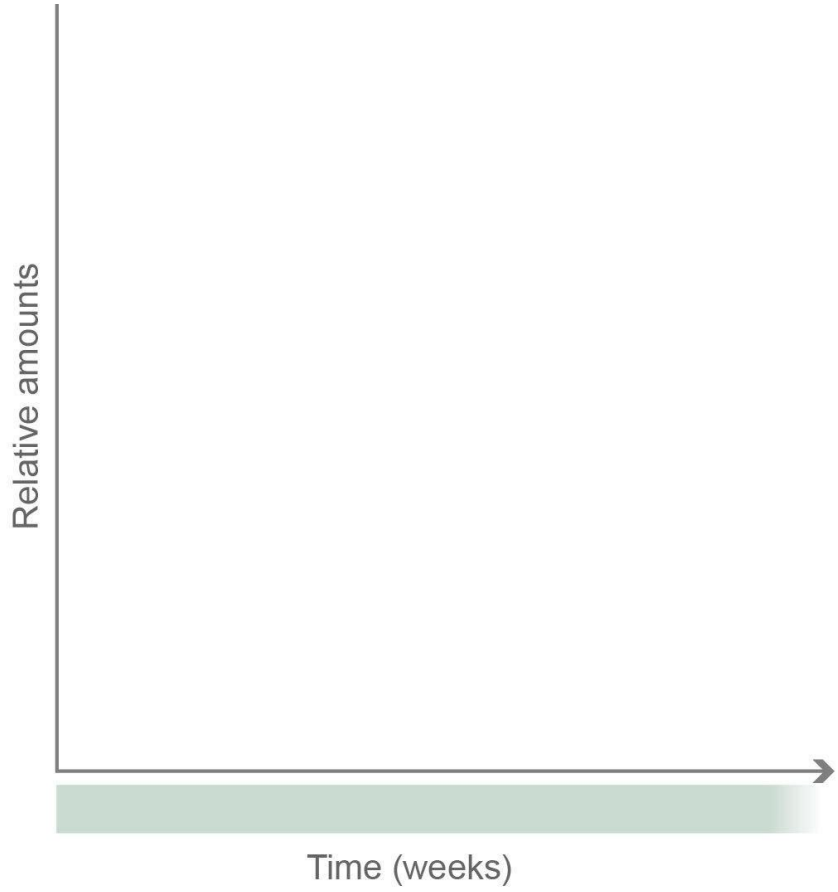


Figure 1. The typical primary and secondary immune responses of a person infected with a pathogen. The person was *unvaccinated* against this pathogen.

11. Draw a graph showing what the **primary** immune response would look like if this person had been *vaccinated* against the pathogen. Include the relative amounts of pathogen, innate immune cells, adaptive immune cells, and antibodies.



PART 4: Using the Immune System in a Cancer Treatment

You'll now apply what you've learned to explain a new treatment for **prostate cancer**: cancer of the prostate gland. The prostate gland is a small organ found at the base of the bladder in most men. It produces a fluid that nourishes and protects sperm. Prostate cancer is the second most common type of cancer in American men. According to reports from the National Cancer Institute, about 1 in 9 men in the United States are diagnosed with prostate cancer in their lifetime.

Immunotherapy is a type of cancer treatment that uses the body's immune system. **Sipuleucel-T** (trade name PROVENGE) is a type of immunotherapy for prostate cancer. It works as follows:

- A doctor collects the patient's dendritic cells, then sends these cells to a lab.
- In the lab, scientists bind the dendritic cells' MHC proteins to an antigen produced *only by prostate cancer cells*. This antigen is called **prostatic acid phosphatase (PAP)**.
- The dendritic cells with the PAP antigen are now antigen-presenting cells. The doctor infuses these antigen-presenting cells back into the patient's blood.
- Once in the body, these antigen-presenting cells activate T cells that bind to the PAP antigen. The activated T cells attack prostate cancer cells that have the PAP antigen.

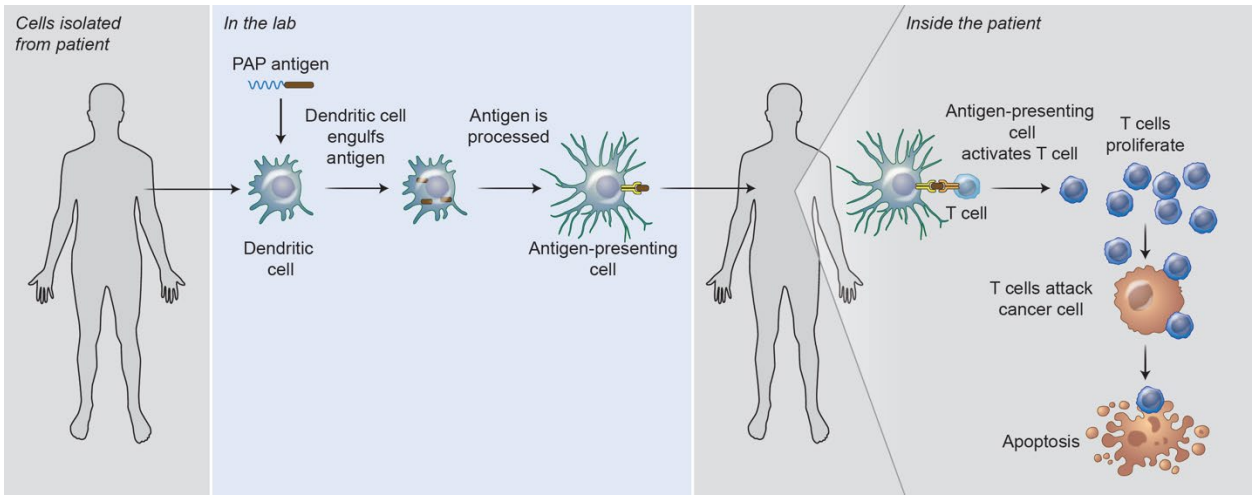


Figure 2. A diagram of the sipuleucel-T treatment for prostate cancer.

12. Which type of T cell would you expect to attack cancer cells after being activated by sipuleucel-T?

13. Which other types of immune cells would you expect to be activated and recognize the PAP antigen?

14. For each type of cell you listed in Questions 12 and 13, briefly explain how it might help destroy the cancer cells.

15. Some news articles refer to sipuleucel-T as a "cancer vaccine."
    a. How is sipuleucel-T *similar* to a typical vaccine against a pathogen?

    b. How does sipuleucel-T *differ* from a typical vaccine?

16. The thymus removes all immune cells that recognize self-antigens. So why would a prostate cancer patient have immune cells that recognize the PAP antigen?