Immunotherapy: How Antibodies Can Be Used to Treat Diseases

Name: _____

Date: _____

Student Worksheet—*Answer key*

Part 1: Antigens and the Structure and Function of Antibodies

1. Below, describe in your own words what an antigen is. Give an example of where an antigen can come from.

   An antigen is any foreign substance or molecular structure that triggers an immune response. Antigens can be entire pathogens, specific parts of a pathogen, allergens, toxins, specific molecules, or special surface features or molecular structures on the pathogen's cell surface that our immune system can recognize as foreign.

2. Below, take notes about what you have learned about the structure and function of antibodies in the video and during your first activity.

   Student answers might vary.

   Key points of the video include:

   - *Our immune system helps keep us healthy in case of a germ (pathogen) attack.*
   - *Pathogens have different markers on them called antigens.*
   - *Antigens are recognized by the immune system, which responds by custom-making an antibody that attaches to the antigen.*
   - *Antibodies bound to a pathogen tell other parts of the immune system to destroy the pathogen.*
   - *Antibodies stay in our bodies in case we have to fight the same pathogen again.*
   - *Antibodies are also made when people get vaccines.*
   - *Building up lots of antibodies allows the body to fight many different germs.*

   Key learning points from lesson Part 1 and its activity include:

   - *Antibodies are y-shaped proteins with a constant region and a variable region. Antigen-binding sites exist at the tips of the variable region.*
   - *Antibodies are specific and only match one antigen. Antibodies and antigens work like a lock and key mechanism.*
   - *Antibodies bind to their matching antigen and flag it for destruction.*

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Part 2: Monoclonal Antibodies

1. Below, describe in your own words what monoclonal antibodies are.

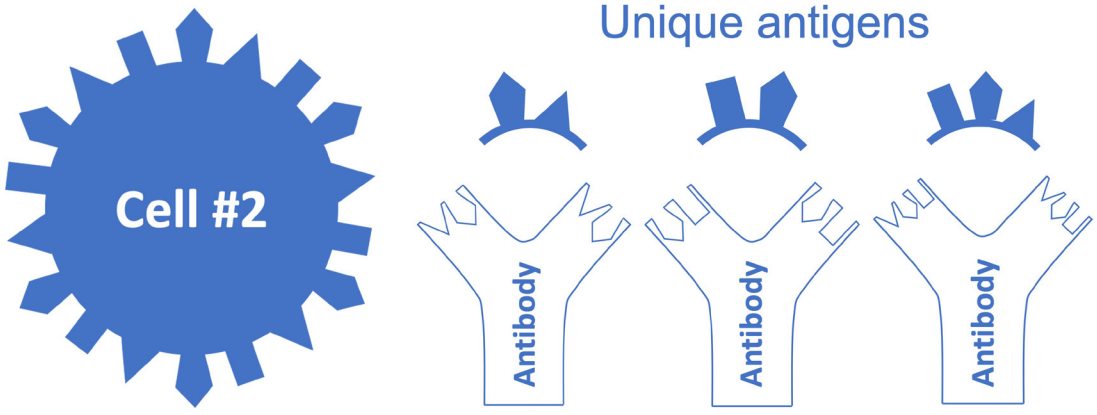
   Monoclonal antibodies are identical antibody molecules produced in the laboratory from a single clone of cells that all bind to the same antigen.

2. Write down the cell number that represents a cancer cell you need to develop a monoclonal antibody drug for.

   Cell # *[depends on the note the student group received]* represents a cancer cell. All other cells represent healthy body cells.

3. *Target discovery*: Carefully review the cells in your monoclonal antibody handout. Then draw the specific antigen you identified as an appropriate target for your cancer cell below.

   The selected target antigen(s) depend on the cell number the students received. The example below shows possible unique antigens for cell #2 and their corresponding antibodies.



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4. *Antibody development*: Design and draw your monoclonal antibody drug. Remember that it should bind to your target antigen only and should not harm any other cells.

   The antibodies depend on the cell number the students received. An example showing possible unique antigens for cell #2 and their corresponding antibodies is shown above.

5. Below, take notes about what you have learned about monoclonal antibodies.

   Student answers might vary.

   Key learning points from lesson Part 2 and its activity include:

   - *Monoclonal antibodies look and behave like natural antibodies but are made in the laboratory from a single clone of cells.*
   - *Monoclonal antibodies have identical antigen-binding sites that are designed to bind to disease-associated targets, such as antigens on the surface of cancer cells.*
   - *Monoclonal antibodies can be used to treat cancer. They can act on cancer cells in different ways. They can block molecules that cancer cells need to grow, flag cancer cells for destruction by the body's immune system, or deliver harmful substances to cancer cells.*
   - *The first monoclonal antibody drug was approved in 1986, and currently, there are over 100 monoclonal antibody drugs on the market. Additional ones continue to be approved by the FDA.*

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Part 3: Bispecific Antibodies

1. Below, describe in your own words what bispecific antibodies are.

   Bispecific antibodies are antibodies produced in the laboratory that contain two different antigen-binding sites and can thus bind to two different types of antigens.

2. Look at your monoclonal antibody handout. Cell #1 represents a cancer cell, and cell #2 represents an immune cell. All the other cells represent healthy body cells. Your goal is to develop a bispecific antibody that can bind to the cancer and immune cells simultaneously. Your bispecific antibody handout shows a selection of 23 different antigen-binding sites and an antibody template. From this selection, identify the antigen-binding sites that accomplish the goal of your bispecific antibody drug.

   a. Which antigen-binding sites are unique for cell #1, the cancer cell?

   #5

   b. Which antigen-binding sites are unique for cell #2, the immune cell?

   #11, #20, #22

   c. On your bispecific antibody handout, write the number of the antigen-binding sites you chose for your bispecific antibody in the grey boxes of the antibody template.

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3. Below, take notes about what you have learned about bispecific antibodies.

   Student answers might vary.
   Key learning points from lesson Part 2 and its activity include:
   - *Bispecific antibody drugs are new types of antibody medicines that have two different antigen-binding sites. This means they can bind to two different antigens simultaneously.*
   - *Bispecific antibodies are more effective in treating complex diseases that require the targeting of multiple disease-causing antigens.*
   - *The first bispecific antibody drug was approved in 2009, and currently there are more than five bispecific antibody drugs approved by the regulatory authorities. Additional ones continue to be approved by the FDA.*