Antibody Building and Guessing Game

Info Sheet

***Materials Needed**: Pencil or pen, scissors, tape, computer or laptop with internet access. Optional: crayons/markers/colored pencils. This activity can also be done using the whiteboard in zoom or another web meeting platform.*

Activity Overview

1. Ensure that students have all of the necessary materials

2. Cover background info including…
   A. (Question 1) What is their pre-existing knowledge of the immune system?

   B. (Question 2) Even though the memory cells can be developed in one's body, as suggested in the presentation, some diseases mutate rapidly, and the body can no longer recognize them. Additionally, the amount of antibodies from having the disease previously deplete over time, so a future reinfection might take longer to get over. It should be noted that this is exacerbated for some diseases because actually the body tends to target pathogens with certain characteristics like being symmetrical and having a repetitive protein pattern on its surface.

   C. Why this research is important (this was hopefully covered in the presentation)

   D. Potential and future applications of research

3. Go over directions for activity

4. Aid students in completing steps for activity

5. Complete questions

6. Discuss results

Beyond antibodies and immune responses, here is some pertinent information about Madie's Antibody research:

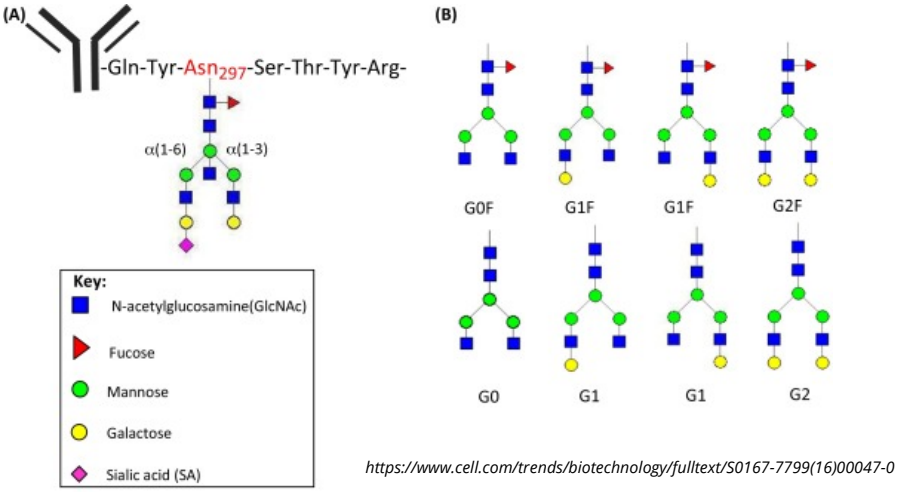
- Therapeutic technology would fall under passive immunity. Essentially, the person is given an antibody which can target and tag a specific pathogen. The monoclonal

antibodies in the medicine do not attack the pathogen themselves but flag it to facilitate an immune response where there otherwise may not be one, like with some types of cancer.

- Monoclonal antibodies are made by cloning specific white blood cells in the lab. Chinese Hamster Ovary (CHO) cells were used to generate the antibodies.

- The monoclonal antibodies in therapeutics can interact with B cells or T cells to bring about an immune response.

- Adding sugars to monoclonal antibodies is called glycosylation.



https://www.cell.com/trends/biotechnology/fulltext/S0167-7799(16)00047-0

Trends in Biotechnology

- As we know, there are different types of sugars that can be added. For example, a fucose can be added; this would be fucosylation. These sugar chains would be added to the middle of the antibody, where the light chains (the short, outer chains) end, and have different functions. For example, where more fucosylation exists, the antibodies are less likely to bind to immune cells, so the therapeutic is less effective. To prevent fucosylation of the antibodies, adding something like a fucosyltransferase inhibitor to the cell media might make them produce fewer antibodies with fucose.

  Stress that the sugars themselves do not automatically correlate to better binding, but for this activity their function can be simplified to show the ultimate goal which is to improve binding.

- *Answer to Question 3*: Viruses infect a host cell in the body; usually cells can be accessed via infection of mucous membranes (eyes, nose, etc.). Viruses inject their DNA into the host cell, so that the cell uses its materials to generate many more virtually identical viruses until the cell cannot function properly anymore. Then

the cell splits, releasing these viruses into the body's environment and the cycle continues.

Antibody Guessing Game Experiment

Instructions:

1. Choose someone to be the Antigen. Everyone else will be Antibodies/B cells.

2. Explain that the Antigen will be drawing a unique shape. No one will know what the shape is because it is new to the body, much like a virus would be. Everybody else (our antibodies/B cells) is to guess that shape not by drawing what the Antigen drew as their shape, but by drawing a shape that would fit that shape much like a hand would fit into a glove. In our own bodies, our B cells must create antibodies to bind to those antigens. This then "flags" those antigens for other immune cells to destroy them.

3. Shapes can be complex, so there will generally be a winner, which is just the person whose shape looks like it would fit the best.

4. Antigen draws a shape. Ex. Square, Letter (like L, C, M), Crescent, Circle, heptagon

5. Everyone else takes 30 seconds to come up with a guess. Then their guesses are revealed.

6. The Antigen hints at how each other person playing can change their drawing to fit their shape better.

7. Another round commences for revisions to everyone's shapes. Repeat the process until the boxes on the sheet are full (4 rounds). Then choose a winner.

Please NOTE: If you have additional questions, refer to the GAN Activity Sheet from Emma Benjamin's R2R: Meet the Researcher presentation; this activity is adapted from that one.

Students may have unexpected results if they draw complex shapes, so it might be helpful to monitor what the antigen draws before the game begins.

Prompt students to think about…
How this process can be a little bit time consuming and tricky. In real life, the shapes are very complex, and the body tends to want to make certain types of shapes over others, which is why people cannot fight certain diseases.

Build an Antibody Experiment

Instructions:
1. First, cut out each shape on the black line.

2. Then spread out the shapes in front of you on the desk to see how each part goes together. Antibodies fit together based on characteristics like geometry (think puzzle pieces), charge, and other chemical characteristics.

For this exercise:
a. Connect the antigens to the antibodies based on geometry by orienting them so that the edges line up.

b. Connect them based on chemical characteristics by lining up the same patterns.

c. Connect them based on charge by lining up the complementary charges. For example, a negative (-) antigen must connect to a positive (+) part of the antigen, and two antigens next to each other must have different charges.

3. Finally, tape can be added to attach the immune cells, the antigens, and the antibody to connect each relevant part to each other. This represents *bonds* and not the sugars physically linking; the sugars chemically link.

Prompt students to think about:

- Not all sugars will cause a chemical linking effect.
- All of the different supplements tune a specific glycosylation outcome, but it pushes the thousands of antibodies produced to look a certain way. There will still be a considerable number of antibodies that do not have the desired qualities. This outcome is ok, because later in the process they can be filtered out to some extent. Tuning the outcome just makes the production process more efficient because there will be less filtering.

Sources

Green, Hank, director. *Immune System, Part 1-3: Crash Course A&P #45-47*. *YouTube*, Crashcourse, 8 Dec. 2015, www.youtube.com/watch?v=GIJK3dwCWCw.

Whitcomb, I. (2020, August 9). *Why do we develop lifelong immunity to some diseases, but not others?* Livescience.Com. https://www.livescience.com/why-lifelong-immunity.html