SN IN HIGH SCHOOLS
April 1, 2017

Cancer's Sweet Cloak

Student Guide: Mowing Down Cancer Cells

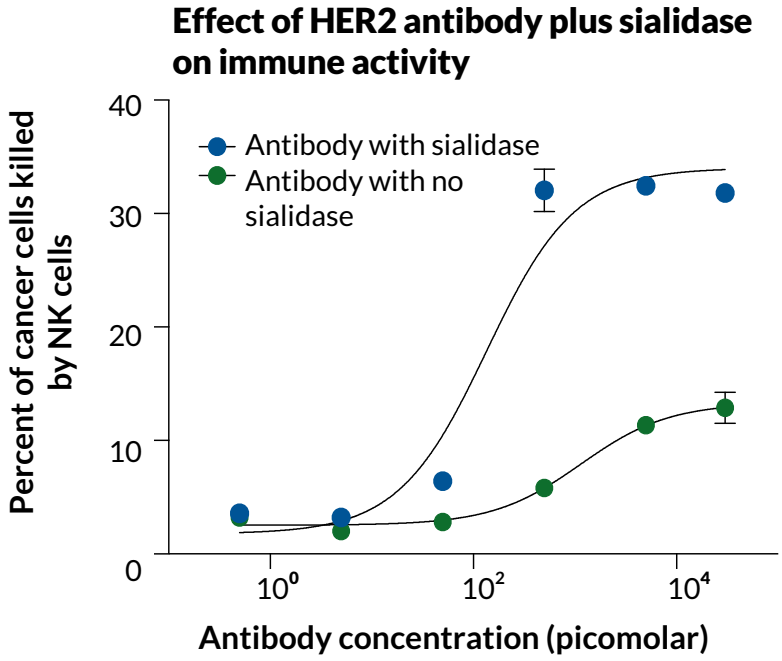
Purpose: To analyze a data graph from an experiment testing two different cancer treatments against laboratory-cultured breast cancer cells.

Introduction: The graph titled "Effect of HER2 antibody plus sialidase on immune activity" is from an experiment with laboratory-cultured populations of ZR-75-1 human breast cancer cells, which compared with normal breast cells have elevated (but not astronomical) levels of the HER2 protein on their surfaces. HER2 protein is a growth factor receptor, which helps to sense signals from the environment telling cells to grow. If cells have too much HER2, they can grow and divide too much, a hallmark of cancer cells.

The graph shows the effect of two different treatments on these cells:

- Herceptin, or trastuzumab, an antibody that specifically binds to the HER2 protein.
- Herceptin-sialidase, the same antibody connected to a bacteria-produced sialidase enzyme that trims sialic acid sugars.

For each of these two treatments, the graph plots the "Percent cytotoxicity" (the percent of cancer cells killed by natural killer cells) versus the treatment concentration in picomolar (pM = 10^{-12} M). Circles show measured data points, and curves extrapolate the apparent trend for the data points.



Directions: Analyze the graph and explore cancer immune therapy treatments by answering these related questions:

1. Using your ruler and a calculator, add and label the pM concentration for at least five additional tick marks on the x-axis.

2. If you were repeating this experiment, what additional concentration might you want to test? What result would you expect to see?

3. Using a ruler, approximately what is the lowest percent cytotoxicity?

4. Why might there be a nonzero amount of cytotoxicity even with no treatment?

5. Using a ruler and estimating from the log scale on the x-axis, approximately what is the highest treatment concentration tested?

6. At the highest concentration of the Herceptin only treatment, approximately what is the percent cytotoxicity? How much larger is that value (in percentage points) than the lowest measured cytoxicity?

7. At the highest concentration of Herceptin-sialidase treatment, approximately what is the percent cytotoxicity? How much larger is that value than the lowest measured cytoxicity (in percentage points)?

8. At the highest concentration, approximately how much more cytotoxicity does Herceptin-sialidase cause than Herceptin (approximately what multiplicative factor)?

9. Using a ruler and estimating from the log scale on the horizontal axis, at approximately what concentration does Herceptin have half of its maximum possible effect?

10. Using a ruler and estimating from the log scale on the horizontal axis, at approximately what concentration does Herceptin-sialidase have half of its maximum possible effect?

11. Herceptin and Herceptin-sialidase treatments require different concentrations to achieve half of their maximum effects. What's the fraction of Herceptin-sialidase required relative to Herceptin alone?

12. Based on what you know, by what mechanism(s) does Herceptin kill ZR-75-1 breast cancer cells in this experiment?

13. Based on what you know, by what mechanism(s) does the Herceptin-sialidase treatment kill ZR-75-1 breast cancer cells in this experiment?

14. Which treatment does a better job of killing ZR-75-1 breast cancer cells? How is that shown in this experiment, and what difference in mechanism explains that difference in results?

15. Why is it important to test both Herceptin and Herceptin-sialidase in the same experiment? What else might you want to see tested at the same time and why?

16. What experiments could you do with cultured cells to test how safe Herceptin and Herceptin-sialidase treatments might be?

17. Would you expect Herceptin and Herceptin-sialidase to be effective against all types of breast cancer cells? Why or why not?

18. Name an additional factor that might affect the success of Herceptin-sialidase treatment in a whole animal or human?

19. How could you change the design of Herceptin-sialidase to help minimize problems in a whole animal or human?

20. How could you change the design of Herceptin-sialidase to target other types of cancer cells?

21. If you changed the design of Herceptin-sialidase to target some other type of cancer cells, what sort of simple experiments could you do with cultured laboratory cells?