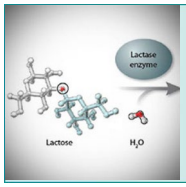


Blood Glucose Data Analysis

hhmi | BioInteractive

Activity
Educator Materials

OVERVIEW

This activity extends concepts covered in the film *Got Lactase? The Co-evolution of Genes and Culture*. Students infer whether someone is likely to be lactase persistent or nonpersistent based on the data from two different tests: the blood glucose test and the hydrogen breath test. The lesson involves graphing and analyzing actual research data.

Additional information related to pedagogy and implementation can be found on this resource's webpage, including suggested audience, estimated time, and curriculum connections.

KEY CONCEPTS

- Compounds in food are sources of energy for cells in the body. They first have to be broken down into simple molecules that can be absorbed and used by cells.
- Digestive enzymes, such as lactase, facilitate the breakdown of food molecules, including carbohydrates, proteins, and lipids.
- The human intestines contain billions of microorganisms, which play multiple roles, including fermenting undigested carbohydrates.

STUDENT LEARNING TARGETS

- Graph research data and appropriately label all graph components, including title, axes, units, and legends.
- Interpret data from different biological tests to infer whether someone is lactase persistent or nonpersistent.
- Make claims based on scientific evidence and support those claims using scientific reasoning.

PRIOR KNOWLEDGE

Students should be familiar with:

- constructing graphs, including using appropriate titles, axis labels, data plots, and legends

MATERIALS

- ruler
- colored pencils

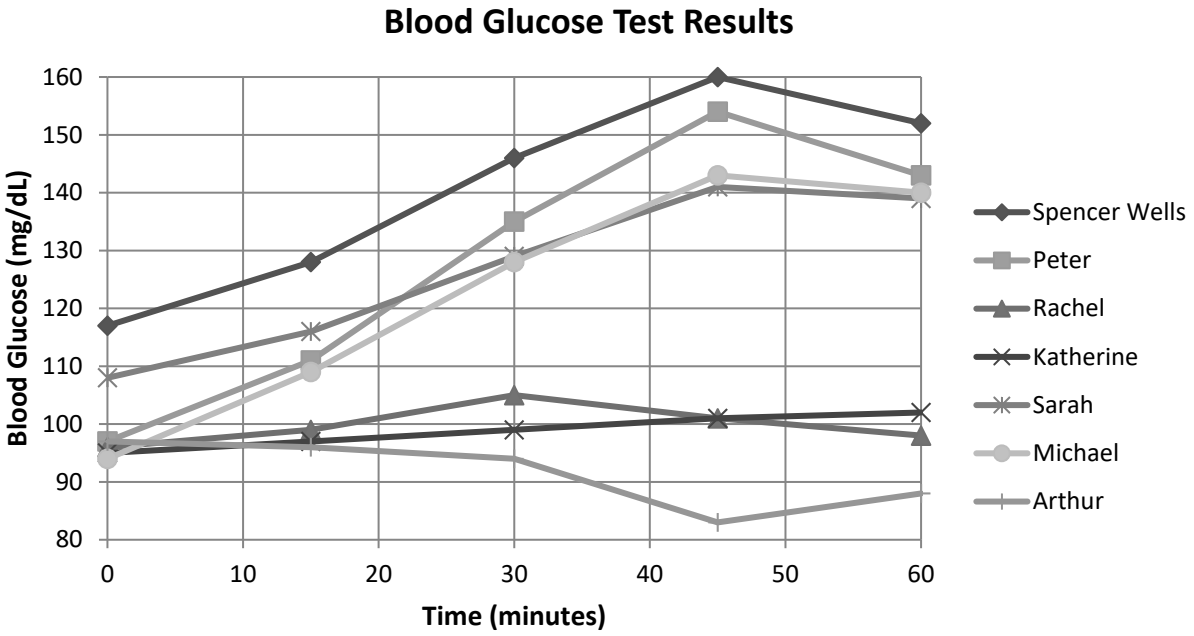
TEACHING TIPS

- Several parts of this activity refer to the short film *Got Lactase? The Co-evolution of Genes and Culture*. Have students watch the film before doing the activity.
- You may wish to have students work in pairs.
- In the graph shown in Question 1 of the "Student Handout," the *x*-axis uses increments of 10 minutes. However, the data points are plotted every 15 minutes. Students with limited graphing experience might need extra support to figure this out.
- To modify this activity for students with learning differences, consider having students plot fewer individuals or data points, graph the data on full sheets of graph paper, or use graphing software. You may also omit some of the questions if needed.
- You might want to discuss with students that blood glucose levels are not accurately regulated in people with diabetes, so variations in blood glucose levels cannot always be used to determine whether someone is lactase persistent.

- After students complete this activity, consider having them explore these related BioInteractive resources:
  - The complementary hands-on activity "Milk: How Sweet Is It?" has students measure glucose levels in samples of milk after adding lactase.
  - The Click & Learn *Regulation of the Lactase Gene* provides more information about how expression of the lactase gene is regulated.
- To learn more about Sarah Tishkoff's research, you may want to watch her 2011 Holiday Lecture *Genetics of Human Origins and Adaptation*.

ANSWER KEY

1. Plot the data in Table 1 on the graph below, which already includes the results for Spencer Wells. Add more entries to the legend as needed.
   An example graph is shown below.



2. Why might someone's blood glucose levels after drinking milk indicate their lactase activity?
   Lactase breaks down the lactose in milk to produce glucose. So higher glucose levels might indicate more lactase activity. (You may want to discuss with your students that this is an indirect test of lactase activity. It measures one of the products of a chemical reaction catalyzed by lactase, not lactase directly.)

3. Divide the individuals in Table 1 into two groups (A and B) based on their blood glucose test results. Write the names of the individuals in each group, including Spencer Wells, below.
   Group A: *Spencer Wells, Peter, Michael, Sarah*
   Group B: *Rachel, Katherine, Arthur*

   It is acceptable for students to have the same groups with the "A" and "B" labels switched. The answers given below use the group labels shown here.

4. Explain your rationale for dividing the individuals into these two groups. Use data from your graph to support your answer.
   Student answers may vary. Ideally, they should recognize that the individuals in Group A had a larger increase in their blood glucose levels after drinking milk. In contrast, the individuals in Group B had either no increase or a relatively small increase in their blood glucose levels after drinking milk.

5. Based on these data, do you think the individuals in **Group A** are lactase persistent or nonpersistent? Describe the evidence that supports your answer.
   They are probably lactase persistent, because their blood glucose levels increased significantly after drinking milk — by as much as 32 to 49 mg/dL within 45 minutes. Lactase breaks down the lactose in milk into smaller sugars, including glucose, which are then absorbed into the bloodstream. So the increase in blood glucose levels after drinking milk probably indicates the presence of lactase. (Students may also mention that Group A includes Spencer Wells, who, according to the film, is lactase persistent.)

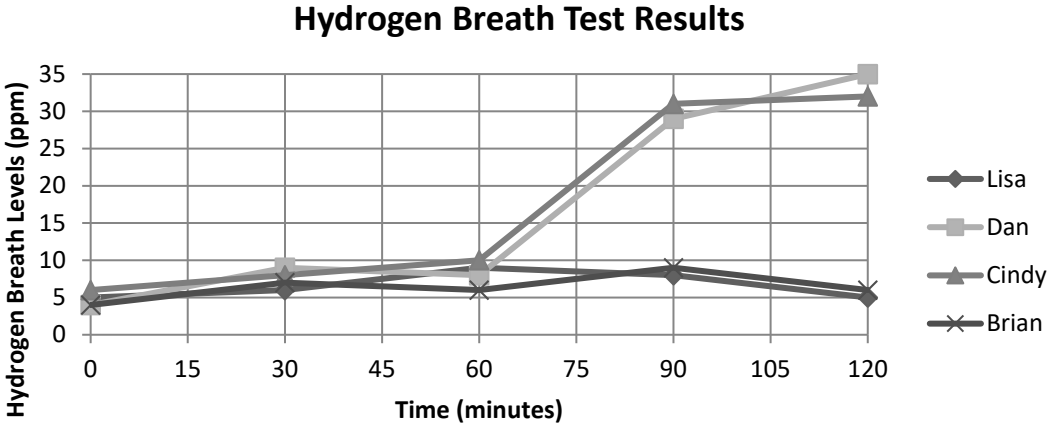
6. Based on these data, do you think the individuals in **Group B** are lactase persistent or nonpersistent? Describe the evidence that supports your answer.
   They are probably lactase nonpersistent, because their blood glucose levels did not increase significantly after drinking milk. For example, Rachel and Katherine had relatively small increases in blood glucose levels (7–9 mg/dL) an hour after drinking milk — much smaller than the increases for the individuals in Group A. Arthur's blood glucose levels even decreased over time. These data suggest that the individuals do not have lactase, or else they would have produced glucose from lactose and had higher blood glucose levels. (You might want to discuss with students that an increase of 30 mg/dL or more in blood glucose levels, within 40 minutes of consuming about a liter of milk, is typically an indication that someone is lactase persistent.)

7. If the blood glucose test was performed on people from the Maasai population in Kenya, would their results be more like those of the individuals in Group A or Group B? Explain your prediction. (Hint: As discussed in the film *Got Lactase? The Co-evolution of Genes and Culture*, the Maasai traditionally raise cows for food.)
   The Maasai's results would probably be more like those of the individuals in Group A, the lactase-persistent group. Because the Maasai raise cows for food, they are likely to consume milk and milk products. So there may have been selection in their population for the ability to digest lactose. (Students may also mention that the film says the Maasai have a mutation for lactase persistence.)

8. A person taking a blood glucose test is usually told to fast (i.e., to not eat or drink anything but water) before the test. Why do you think that might be necessary?
   Student answers may vary. Ideally, they should recognize that many types of food are eventually digested into glucose. If a person eats before taking the blood glucose test, their glucose levels might increase regardless of whether they produce lactase.

EXTENSION: The Hydrogen Breath Test

1. Create your own graph of the data in Table 2. Your graph should include a title, labels for the *x*- and *y*-axes, and a legend.
   An example graph is shown below.



2. Which individuals in Table 2 are likely to be lactase persistent? Use data from your graph to support your answer.
   Lisa and Brian are likely lactase persistent, since the levels of hydrogen in their breath did not increase significantly after drinking milk. People who are lactase persistent digest lactose in the small intestine, so the lactose cannot be fermented by bacteria in the large intestine. Without this fermentation, excess hydrogen gas is not produced and released in the breath.
3. Which individuals in Table 2 are likely to be lactase nonpersistent? Use data from your graph to support your answer.
   Dan and Cindy are likely lactase nonpersistent, since the levels of hydrogen in their breath increased significantly after drinking milk. People who are lactase nonpersistent do not digest lactose in the small intestine, so the undigested lactose passes into the large intestine, where it is fermented by bacteria. This fermentation produces various gases, including hydrogen, that are released in the breath.
4. Think of another type of test to determine whether a person is lactase persistent or nonpersistent. Describe your idea in one or two sentences.
   Student answers will vary. They might suggest doing a genetic test to look for a lactase-persistence mutation or directly testing for the lactase enzyme in a person's small intestine. Students could also mention measuring blood levels of galactose. (Although this is a reasonable answer, you might want to let students know that galactose is rapidly converted to glucose in the liver, so it cannot always be detected in the blood.)

CREDITS

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