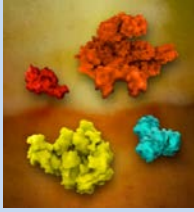


Regulation of the Lactase Gene



About This Worksheet

This worksheet complements the Click and Learn “Regulation of the Lactase Gene” developed in conjunction with the 2011 HHMI Holiday Lectures on Science “Bones, Stones, and Genes: The Origin of Modern Humans.”

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Key Concepts

- Eukaryotic gene expression is regulated at the levels of transcription, RNA processing, translation, and post-translation.
- Proteins called transcription factors bind to DNA and control transcription. Different types of transcription factors can increase or decrease transcription.
- Mutations in DNA regions that control gene expression can alter the way genes are expressed.
- Infants have high lactase levels so that they can digest their mothers’ milk, but lactase gene expression is turned off after weaning.
- Lactase persistence is the trait that allows adults to continue to digest milk. It results from a mutation in an enhancer region of the lactase gene.

Instructions

1. Go to BioInteractive.org.
2. In the menu bar under the masthead, mouse over Topics → Evolution → Interactive.
3. Scroll down the page and click on “Regulation of the Lactase Gene.”
4. Proceed through the slides, watch the embedded video clips, and answer the following questions in the space provided.

Questions

1. What is the difference between lactose tolerance and lactose intolerance? Be specific.

2. Why is lactose tolerance also called lactase persistence?

3. In which cells or tissues is lactase produced and what is its role?

4. What normally happens to the levels of lactase produced throughout a person’s lifetime?

5. In general, why is it important for a cell to regulate protein production?

6. What are the steps in gene expression that ultimately affect protein levels in a eukaryotic cell?

7. What is the role of general transcription factors and where do they bind?

8. How do activators and repressors affect transcription?

9. Where do activators bind?

10. What are two ways in which repressors can interfere with transcription?

11. Multicellular organisms are made up of different types of differentiated cells. Given that all cells in an organism have the same DNA—and thus the same genes—explain how it is that different genes can be expressed only in certain types of cells.

12. Is RNA processing a common way for regulating gene expression?

13. What is alternative splicing and why is it important?

14. What is translation?

15. RNA interference is a major mechanism of gene regulation in eukaryotes. Explain how RNA interference works.

16. Which proteins are marked for destruction?

17. How does a cell know which proteins should be destroyed?

18. How are these proteins destroyed?

19. At what level (i.e., transcription, translation, or protein processing) is the lactase gene (*LCT*) regulated?

20. Using your knowledge of activators and repressors, hypothesize two ways in which transcription of the *LCT* gene could be turned off.

21. In what regions of the world is lactase persistence most prevalent?

22. How is lactase persistence an example of human evolution?

23. Explain the effect of the mutation that occurs among northern European people on *LCT* gene expression.

24. What are the similarities and differences between the lactase persistence mutations found in African populations and the one found in European populations? (Consider, for example, type of mutation, location, function.)

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As part of its mission to strengthen science education, HHMI presents the Holiday Lectures on Science, an annual series that brings the latest developments in a rapidly moving field of research into the classroom. The lectures are given by HHMI investigators and other leading scientists. The 2011 Holiday Lectures, *Bones, Stones, and Genes: The Origin of Modern Humans*, were the 19th in the series, which began in 1993.

To complement the Holiday Lectures and enhance their usefulness in the classroom, HHMI produces a variety of free science education materials. Lecture summaries, biographies of the lecturers, and other resources are available at www.holidaylectures.org. DVDs and CD-ROMs can be ordered through HHMI's Catalog at <http://catalog.hhmi.org>.

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