Controlling the Code: molecules at work

Description of activity

Controlling the Code focuses on the work done by several scientists in determining how DNA code is regulated. Students assume the role of an employer seeking to fill positions in a cell's lactose regulation division. This eases students into the complexities of the lac operon and gene regulation.

Learning outcomes

Students will:

1. understand that scientists work together to solve problems.
2. appreciate the contribution each scientist made to our understanding of DNA.
3. be able to explain the difference between positive and negative feedback.
4. realize that gene regulation involves a specific sequence of events.
5. know the difference between an operon and an operator.
6. be aware of the roles played by the promoter, repressor, activator, inhibitor, DNA, RNA, and RNA polymerase in the production of beta-gal.

Assumptions of prior knowledge

Students should know the basic structure of DNA. They should also be familiar with the Central Dogma (how the code is read and how proteins are made).

Misconceptions

Students often think that every gene in a cell is turned on all of the time. Some also think that different cells in multicellular organisms contain different genes…hence the differences.

Implementing the lesson

Become familiar with the *DNA Interactive (DNAi)* web site (www.dnai.org) and how to navigate through it. Provide students with information about navigating the site, and how to play animations and video clips.

Before class:

Photocopy student pages for each student.

During class:

The question being investigated in this segment of *DNAi* is "How does a cell determine which genes will be expressed and which will be silent at any given moment?"

To provide students with a context for the complex material they will work through in *Controlling the Code*, review with them the structure of a typical gene.

Mention that only a fraction of the genes in a cell are expressed at any given time. Be certain students understand that a gene that is being expressed is one that is transcribed into mRNA. Ask students how a cell would "know" to turn a particular gene "on" or "off." Also ask students why it would be detrimental to a cell to have all genes turn on all of the time.

Further explorations

Presentation

Develop a computer slide show presentation. This should explain to viewers just how the lac operon functions. It should provide the same information required in the narrative while clearly illustrating the process graphically.

Models

Use common materials such as clay or pipe cleaners and beads to construct two 3-D models

of the lac operon—one that is transcribing RNA and one that is not. Each key component should be labeled.

Research

Ask students to find out more about the role of packing and unpacking DNA in gene regulation. Have teams of students prepare a short video in which one of them plays the role of a researcher being interviewed for *DNAi*. Prior to filming, students should prepare a list of questions to which they rehearse answers. The videos can then be shown to the class.

Explanation

Successive levels of coiling of DNA and its associated proteins can be observed. During interphase, the DNA of active genes is only lightly packed. Inactive DNA is packed more tightly. Presently, scientists think that packing plays a role in keeping genes turned off. Explain how the tortoiseshell pattern observed on some female cats provides evidence that packing plays an important role in gene regulation.

Glossary

B-gal

E. coli

Enhancer

Inhibitor

Lac operon

Lactose

messenger RNA (mRNA)

Negative feedback

Operator

Operon

Positive feedback

Promoter

Regulatory gene

Repressor

RNA polymerase

Resources

Web

Access Excellence @The National Health Museum (1994-2003). *ae@nhm: the Site for Health & Bioscience Teachers and Learners*, www.accessexcellence.com

Cold Spring Harbor Laboratory (2002). *DNA From the Beginning: an animated primer on the basics of DNA, genes, and heredity*, www.dnaftb.org

Woodrow Wilson National Fellowship Foundation (2002). *Leadership Program for Teachers: Teacher Resources > Core Websites*, www.woodrow.org/teachers/Teacher_Resources/CORE/core.html

DVD

DNA Interactive (2003). NTSC version produced by Cold Spring Harbor Laboratory and Red Green & Blue Company; funded by Howard Hughes Medical Institute. Available at www.dnai.org

Books

Alberts, Bruce et al. (1994) *Molecular Biology of the Cell, (3^4d Edition)*, Garland Publishing Inc., New York.

Campbell, Neil and Reece, Jane (2001). *Essential Biology*, Benjamin Cummings, San Francisco.

Micklos, David A., Freyer, Greg A., and Crotty, David A. (2003). *DNA Science: A First Course, (2nd Edition)*, Cold Spring Harbor Laboratory Press, New York.

Activity pages include:

Student worksheets with "work wanted" ads.

Answer sheets (includes further explorations).