SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Epigenetics **Grade 11 – Genetics and Cellular Biology**

Lesson Plan

Assessment	AFL, AOL
Cross-curricular	Languages, Phys. Ed

Big Ideas

Strand:

Scientific Investigation Skills and Career Exploration

- A1. demonstrate scientific investigation skills (related to both inquiry and research) in the four areas of skills (initiating and planning, performing and recording, analysing and interpreting, and communicating);

Cellular Biology

- B1. evaluate the impact of environmental factors and medical technologies on certain cellular processes that occur in the human body;

Genetics

- D1. evaluate some social, ethical, and environmental implications of genetic research and related technologies;

Learning Goals

- I know and understand the following terms: DNA, genes, chromosomes, and meiosis.
- I can explain the difference between genetics and epigenetics.
- I can state that the structure of chromatin includes DNA and histones coiled together.
- I can demonstrate how chemical tags that attach to the chromatin help the chromatin uncoil.
- I can explain how environmental factors may affect the transmission of the genetic code through epigenetics.

Specific Expectations:

A1.3 identify and locate a variety of print and electronic sources that enable them to address research topics fully and appropriately

B1.2 analyse the effects of environmental factors on cellular processes that occur in the human body (e.g., the effect of lead on nerve cells; the effect of electromagnetic radiation on brain cells)

D1.2 evaluate, on the basis of research, some of the effects of genetic research and biotechnology (e.g., genetically modified organisms [GMOs]) on the environment

Description:

In this lesson students will learn about epigenetic "tags" and how gene expression can be affected by environmental factors. **This lesson is intended for the college level**.
Note: This lesson should occur after students have learned about the process of meiosis, and how it accounts for the transmission of hereditary information from generation to generation and may be included when students are learning about genetic disorders.

Materials

Epigenetics Visuals
Epigenetics Presentation Rubric
Model of a Chromatin: For the activity, teachers should have students separate into groups of 3. Each group will need:

- A pair of 24 inch long plastic tubing (small diameter) or bungee cords
- Tape to secure both ends of the tubes
- Pen caps, pencils or pieces of chalk to act as “histones”
- Two binder clips

Safety Notes

There are no safety issues in this lesson plan.

Introduction

Begin with a think-pair-share about what makes twins alike and what makes individuals the same or different.

- Are Twins Identical?
- With a partner, consider any sets of identical twins you know. What makes them identical?
- Make a list of characteristic that individuals have that make them seem alike or different: traits describing how they look, sound, move, or even their attitudes and verbal expressions. What makes us alike or different?

We have already learned that ***meiosis*** is a type of cell division that results in four ***gamete*** (reproductive) cells each having half the number of chromosomes of the parent cell. These ***haploid*** daughter cells have 23 chromosomes instead of 46 in the parent ***diploid*** cell and in all other types of cells. During reproduction, the gamete cells from two parents unite to form a ***zygote***, allowing for mixing of genetic material. In this way, genetic instructions are passed down from parents to a child through ***DNA***, which codes for all heritable traits.

Identical twins come from the same fertilized egg and have an exact copy of each other’s DNA. Watch the Epigenetics video from PBS LearningMedia to find out how identical twins, sharing the same genetic code, may be different.
http://www.pbslearningmedia.org/resource/biot09.sci.life.gen.epigenetics/epigenetics/

Epigenetics refers to how environmental and lifestyle factors can change the expression of our genes. Chemical tags attach to DNA or to structures surrounding DNA (such as DNA methylation or histone modification) and can control gene expression by activating certain genes or "silencing" others. Since these tags are independent of the DNA, they are called "epi"genetics (epi = in addition to, outside of). These changes in expression do not involve changes to DNA sequences (genetics). Learn more about epigenetics using the Epigenetics Visuals (See Link).

Action

You may recall that ***chromosomes*** are large ***chromatin*** structures found within a cell that are essentially bundled up strands of DNA wrapped around proteins called ***histones***. The DNA is bundled up because otherwise it would be too long to fit into a cell. DNA codes for all of the genetic traits that make up an individual and is made up of two sugar-phosphate backbones and four different bases. These bases are paired together and held together by chemical bonds.

We are going to make a model of chromatin and see how epigenetic tags can control gene expression, or determine which proteins the cell creates.

- Take two tubes or bungee cords, hold them together so that the tubes or cords are parallel to each other, and tape the ends together.
- With one person on either end, twist the tubes together into a spiral. This is your DNA double helix.
- Place some marker caps or pieces of chalk into the spiral every 10-15 cm and spool the DNA around them. These represent the protein histones.
- Keep twisting the tubes together as they form knots and keep twisting until the knots form a secondary spiral. You have now created nucleosomes, which condense the DNA into small packages so that the DNA is not too long to fit into the cell.
- Next, attach binder clips to the histones at two ends of a 10-15 cm section in the middle of the DNA double helix. These binder clips represent methyl groups or tags, which allow the histones to unbind the DNA between them.
- Have the third person in the group carefully unwind the tubes between the clipped histones. When the DNA double helix is unwound, the DNA strands can be "read" by enzymes and the information coded within used to make proteins.

As students perform the activity, the teacher may circulate to observe the groups, and ask students:

1. Identify the parts of your chromatin model.
2. What is the purpose of the histones wrapped within the nucleosome?
3. Why might it be difficult for enzymes to "read" the DNA in a coiled nucleosome?
4. How do the methyl "tags" (binder clips) enable the chromatin to unwind?
5. What would happen if the methyl tags stayed attached to the histones?

Consolidation/Extension

In the activity, you investigated how an epigenetic "tag" might allow certain genes (a section of DNA) that codes for a certain RNA or protein product to be overexpressed. A different tag might suppress or silence other genes. These sections of DNA code for proteins that are linked statistically to a growing variety of diseases, some examples include Type 2 Diabetes, Schizo-Affective Disorder, Anxiety Disorder, Depression, Drug Addiction, and Infertility.

Epigenetics Presentation

Now research one disease that has been linked to epigenetics and prepare a short (3-4 slide) presentation or graphic organizer.

1. What are epigenetics? How can epigenetic tags allow genes to be overexpressed? (Knowledge and Understanding/ Thinking and Investigation, Communication)
2. How might this disease be related to environmental factors? Reflect on what this means for your own life/lifestyle choices. (Thinking and Investigation, Communication)
3. How might epigenetic research affect how this disease (or persons with this disease) is (are) treated? (Thinking and Investigation, Communication)
   Note: All sources should be cited appropriately. (Communication)

Note: Teachers can use the Epigenetics Presentation Rubric to assess the presentation or graphic organizer (See Link).