

Lesson Plan: The Information in DNA

Key Concepts Covered^{1,2}

NATURE OF GENETIC MATERIAL; REPRODUCTION:

- DNA is the genetic material for all living organisms.
- Genes are segments of DNA that encode information critical for development. DNA is organized into structures called chromosomes.
- The genome is all the genetic information within an organism.
- The amount of genetic information within an organism is not a product of size or complexity.
- Genome sequencing involves producing and organizing short overlapping DNA sequences.

GENE EXPRESSION AND REGULATION:

- Genes exist in different forms called alleles.
- The expression of genetic information generally flows from DNA to RNA to protein. This occurs through transcription of DNA into RNA and translation of mRNA into protein.
- Virtually all cells within a human body contain the same genetic information.
- For traits primarily influenced by single genes, certain combinations of alleles lead to predictable patterns of inheritance. Other more complex traits involve the influence of multiple genes. The functions of genes and their products can be affected by the environment and other genes at one or many steps involved in producing a trait.

Overview:

This 60 min lesson plan covers what DNA means to organisms. It starts with definitions of several terms and then uses the story of the sequencing of the human genome project to introduce Genomics as the study of the entire genome (all of the DNA) in an organism. We make use of the competition between the public and private groups who were sequencing the human genome, to grab student's attention as they race to put in order (or align) their own overlapping sequence reads. After completing the paper DNA alignment, our attention turns to the central dogma of biology (DNA->RNA->PROTEINS). We use several learning strategies to help students understand the important processes of transcription and translation. Students watch an animation of the processes, discuss the processes, and then complete a transcription and translation exercise for the sequence they have just aligned. We end with a presentation on the effects of genotype and environment on phenotype.

Learning Objectives:

By the end of this lesson, students will be able to:

- order overlapping DNA sequence reads and merge these reads into one aligned sequence.
- transcribe and translate a DNA sequence into a protein sequence.

Resources Needed:

Laptop/ projector for watching animation

Photocopied DNA sequences

Handout, 1 printout per student (see attached PDF, MSL OUTREACH GENOMICS worksheet)

Introduction/Pre-Assessment:

Now that you can isolate DNA, what could you do with it now?

Activity: Genome Sequencing- HGP

- Students use the laptops provided to look up the terms; genome, DNA sequencing and to answer the question “Has the human genome been sequenced?” They write their answers in their own words in their handout. We go over answers as a class and probe further by asking and explaining why sequencing more human genomes is important.
- Watch short video about the HGP. <http://www.genome.gov/25019885> (Introduction).
- Distribute a set of 6 short overlapping sequence reads to each group of 4-6 students. Students compete against each other to get the sequences in order. The DNA sequences are at the end of this document. We wait for and congratulate each team for finishing.

Activity: Transcription and translation

- Show image of DNA, RNA and Proteins. Introduce the central dogma concept.
- Watch video: http://www.youtube.com/watch?v=41_Ne5mS2ls (Transcription and Translation from the PBS production DNA: Secret of Life)
- Students will now transcribe and translate the sequence order in the above activity. Demonstrate with the first two codons as a group. Students use their handout to write out their own transcription and translation sequences. The handout contains the codon table.

Presentation/ Discussion: Genotype/ Environment and Phenotype

Explain terms genotype and phenotype. Ask for examples of human phenotypes. Discuss single gene traits as well as complex traits that may be influenced by more than one gene. Explain that eye colour is determined genetically, while height is dependent on other factors aside from genetics. Can they think of what this can be? Toxins! Nutrition! Introduce the concept of environment. Re-iterate that most phenotypes are due to both the environment and genetics.

Post- test/ Summary Students come up with one question they have regarding anything covered so far. They discuss their question with their group. Unanswered questions are asked to the group at large, and we discuss answers.

Key Concepts adapted from:

¹ B.C. Ministry of Education. Grade 9 Curriculum Package, online. www.bced.gov.bc.ca/irp [April 11, 2012]

² Dougherty M, Pleasants C, Solow L, Wong A, et al. (2011) A Comprehensive analysis of High School Genetics Standards: Are States Keeping Pace with Modern Genetics? CBE- Life Sciences Education (10): 318-327.

Credits: This lesson plan was developed by Jennifer McQueen, Jody Wright, and Joanne Fox as part of the science outreach efforts at the Michael Smith Laboratories at the University of British Columbia, <http://bioteach.ubc.ca>