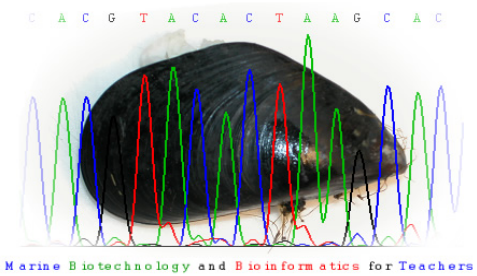

WHOSE DNA IS THAT?

Title of Lesson: Whose DNA is that?

Designed by:

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Background:

This project requires students to use knowledge in translating DNA sequences into amino acids, then search online database for the source of these amino acid sequences, in order to solve a murder case. Its purposes are to engage students' curiosity, practice their problem-solving skills, learn the molecular basis of gene expression, and enhance their computer literacy in bioinformatics.

Description of Audience:

This bioinformatics activity is designed for use by tenth grade biology students of various backgrounds and skill levels.

State Standards:

This bioinformatics activity fulfills the following Science Standards:

- State of California Biology 4: Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism.
- State of Georgia Performance Standards Biology 2: Students will analyze how biological traits are passed on to successive generations.

National Standards:

This bioinformatics activity fulfills the following National Science Standards:

- Content Standard C: Students should develop an understanding of the molecular basis of heredity.

STEM Connection:

Careers tied to this activity include clinical or medical geneticist, genetic counselor, and genetics laboratory technician.

Goals:

The goals of this lesson are to:

- understand the mechanism of gene expression
- learn how to use online databases to search for scientific information

Learning Objectives:

Upon completion of this lesson, students will be able to:

- translate DNA nucleotide sequences into mRNA codons and then to amino acid sequences
- search online bioinformatics databases as a process in scientific inquiry
- use scientific knowledge to solve problems

Purpose/Rationale:

Gene expression encompasses many molecular and cellular level processes, including transcription, translation, and protein synthesis. Each process involves the decoding of various classes of chemical compounds, such as the decoding of the DNA nucleotide sequence into amino acid sequence and finally the synthesis of protein. In order to help students actively involve in learning these complicated process, this lesson engages students in a mystery that requires the understanding of each step in the biochemistry of gene expression and the ability to translate genetic codes. Problem-solving skills are also activated in this inquiry-based lesson. The bioinformatics component of this lesson allows students to connect their scientific learning in a classroom to the world-wide science community.

Materials/Resources:

In order to complete this lesson, the following materials are needed:

Student lab worksheet
http://www.ncbi.nlm.nih.gov/ (Bioinformatics search)
http://en.wikipedia.org/wiki/Genetic_code (mRNA codons to amino acids table)
http://www.biochem.ucl.ac.uk/bsm/dbbrowser/c32/aacode.html (Single-letter Amino Acid codes)

Prior Teacher Preparation:

Research at the NCBI website was conducted to verify the validity of amino acid sequences and their corresponding DNA sequences. Additional research at the same website using “Blast” was conducted to ensure the expected results could be easily accessed and comprehended by students when they carry out this activity. In addition, to achieve the learning goals of understanding the transcription and the translation processes, reverse compliments of the DNA sequences and a table of mRNA codons to amino acids are provided to students, although direct conversion tables from DNA codes to amino acids are available.

3-Step Procedure:

#1 Introduction:

- Students have learned about the molecular structure of the DNA and the concept that genetic codes are written in its nucleotide sequence. This lesson extends their understanding to the mechanism by which genes are expressed, in the form of proteins, or amino acid sequences.

- Students will review their prior knowledge of nucleotides, the complementary base-pairing rule, and the replication process of the DNA molecule. Then the process of transcription, translation, and protein synthesis will be introduced. They will learn new vocabularies such as transcription, translation, protein synthesis, ribose, uracil, mRNA, tRNA, mRNA, codon, anticodon, amino acids, and ribosomes.

- Video clips and PowerPoint presentation will be used to accent instruction.

- The initial instruction and introduction of the lesson will be conducted as whole class discussion. The activity will be conducted in groups of four students. Each group will share one computer with network capability for bioinformatics and other online research, and each student will complete a worksheet individually. The conclusion of the activity will be a whole class discussion.

#2 Exploration:

- Students will be given a scenario to investigate a murder case in which three DNA samples are extracted on the victim's body. Students will first translate the DNA sequences mRNA and then into amino acid sequences. They will conduct online bioinformatics research to identify the proteins coded for by each DNA sample. With this information, students will determine which sample most probable belongs to the killer.

- The process of discovery to be followed – How is DNA sequence transcribed into mRNA? How is mRNA translated to amino acids? How do we identify a protein given the amino acid sequence?

- A lab worksheet is prepared for students to process information, record data, and answer questions. This worksheet will also outline the scenario and the students' tasks, along with all the information they must refer to in order to perform the tasks.

- Students discuss with their group to determine the sample that most probably belongs to the killer. Then they will share with the class why they select that one sample.

- Conclude, discuss, ask and answer questions, evaluate lesson, assess student understanding.

#3 Application:

- This lesson may be applied to decode any DNA sequence into amino acid sequence. The skill of using the bioinformatics internet resources may be applied to look up the amino acid sequences of proteins. Students may further explore the NCBI website and become advanced users and take advantage of many other research capabilities of the bioinformatics website.

- Many human genetic disorders involve abnormalities in only small portion of the DNA sequence. Today's lesson helps students make connection to their daily life in understanding how a change in the DNA can cause genetic disorders, or simple changes in how genes are expressed.

- Interest can be extended if students conduct bioinformatics research to find out how closely related organisms can have similar DNA sequences and thus similar proteins, or they may try looking up the amino acid sequences of different proteins of their interest.

- A good follow-up activity to reinforce concepts learned today will be asking the students to infer the consequences of changing one of the nucleotide bases, and the consequences of inserting or deleting one of the nucleotide bases. This follow-up activity will lead to a subsequent lesson that discusses various types of mutation.

- Another follow-up activity to reinforce concepts learned today will be asking the students to compare the amino acid sequences of the three samples and their sources (the three sources are a human being, a protozoan, and a chimpanzee). Students will find out the amino acid sequences of the human and the chimpanzee

show many similarities, while the one from the protozoan bears no resemblance to either the human's or the chimpanzee's amino acid sequence. This follow-up activity leads to the discussion of the genetic basis of phylogeny.

- Students will have a bioinformatics research assignment to compare and contrast the DNA and amino acid sequences of the normal human hemoglobin and the hemoglobin from sickle anemia sufferers.

- Careers in bioinformatics and biotechnology related to this activity include genetic counselors, clinical laboratory scientists or technicians, genetic engineers, and biochemists, etc.

Assessment:

- Students demonstrate their understanding by successfully completing all the tasks in the activity. The results on the worksheet will be used to assess student understanding.

- Goals and Learning Objectives are met when students can correctly identify the sample most probably belongs to the killer and explain the rationale for their choice.

- Students who have difficulty in this activity will be provided with shorter strands of the DNA sequence to practice. A list of the mRNA codons with the amino acids they code for may be provided as an alternative to the table format. Peer tutors may be assigned to assist students who need help. Further accommodation for the visually impaired may be provided by large print version of the student lab worksheet.

- The lesson may be extended by having students identify the killer from several suspects by matching the DNA sequence. They may be given an exercise to learn about DNA fingerprinting and gel electrophoresis.

Teachers' Self Evaluation

- *Incomplete*