

# Marine Biotechnology and Bioinformatics

for Teachers

## Blast that DNA!



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### Background

This lesson requires students to use knowledge in translating DNA sequences into amino acids, and skills to search online database for the source of these amino acid sequences, in order to solve a murder case.

#### State 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

**Science Content Standard C** Students should develop an understanding of the molecular basis of heredity.

#### STEM Connection

Careers tied to this activity include bioinformatics researcher, clinical or medical geneticist, genetics laboratory technician, forensic scientist, and crime scene investigator.

### Instructional Goal

- Engage students' curiosity
- Promote problem-solving skills
- Learn the molecular basis of gene expression
- Enhance computer literacy in bioinformatics by using online databases to search for scientific information

### Instructional Objectives

- 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 and logic to solve problems

### Method

- Ensure students have the prior knowledge of gene expression by the processes of transcription, translation, and protein synthesis
- Introduce students to the scenario of investigating a murder case in which three DNA samples are extracted on the victim's body.
- Students perform the following tasks:
  - Transcribe the DNA sequences into mRNA codons
  - Translate mRNA codons into amino acid sequences
  - Conduct online bioinformatics search to identify the protein coded for by each DNA sample
  - Determine which sample belongs to the killer



Students work in groups of 2-4 to perform bioinformatics search in order to solve a murder case. A computer with internet access is shared among each group.

Screen shot of NCBI BLAST webpage, the online bioinformatics database that we use in Part 2 of this activity. Students enter the 20 amino acids they decode in Part 2 of the activity into this database to find out the proteins they code for.



A worksheet is prepared for students to process information and record data. Here is a student work sample with teacher commentary.

### Learning Outcomes

A pre-test and a post-test are administered to assess the students' gain in gene expression content knowledge, and their general ideas about bioinformatics and biotechnology. In addition, students complete surveys after the lesson to provide feedback on their learning experience. Analysis of the results in the tests and survey yields these data:

80% of the students demonstrated gain in the content knowledge of gene expression.

88% of the students demonstrated increased knowledge in bioinformatics and biotechnology.

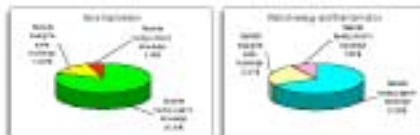
84% of the students felt that the student worksheet had sufficient instructions to guide them through the activity.

37% of the students felt that this activity was fun.

49% of the students felt more confident in using computer technology after this activity.

17% of the students thought this activity increased their interests in bioinformatics or biotechnology careers.

57% of the students thought this activity increased their interests in STEM careers.



Students' gains and losses in their knowledge before and after the lesson, based on surveys in pre- and post-lesson.



Sample of student feedback on this lesson collected from the survey.

### Materials/ Resources

- Student worksheet
- Student assessment (pre-test and post-test)
- Student survey
- Computers with Internet access
- <http://www.ncbi.nlm.nih.gov/BLAST> (Bioinformatics search)
- <http://www.accessioncelle.org/TC/VL/GG/genetic.html> (Translating mRNA codons to amino acids)
- <http://www.biochem.ucl.ac.uk/bm/bbrowner/32/aacode.html> (Looking up single-letter Amino Acid codes)

### Conclusion

This student-oriented lesson is effective in promoting contextual learning as an enhancement activity. Prior knowledge of students plays an important role on the learning outcome, thus an acquisition lesson is essential prior to the activity.

Students with higher level of understanding in the content find the activity interesting and challenging, while students with lower level of understanding struggle to complete the tasks. Students who have difficulty in this activity should be provided with shorter strands of the DNA sequences to practice the amino acid translation process. Grouping structure may be designed to pair up peer tutors with students who need help.

A good follow-up activity to reinforce concepts learned in this lesson is inferring 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 the various types of mutation, such as point mutation and frameshift mutation.

### Contact

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