



Education and Research: Testing Hypotheses

A Whale of a Tale:

Using BLAST to Identify the Source of Mitochondrial DNA from Whales

SUMMARY

In this lesson, students will be using the BLAST tool to compare mitochondrial DNA samples from unknown whale species to known sequences. Prior to this activity, students should have learned about cellular structures and DNA structure and function. Mitochondrial DNA (mtDNA) may be a new concept for many students, since biology classes primarily focus their study of DNA on nuclear DNA. In order to help students understand the structure and function of mtDNA, there is a WebQuest about mitochondrial DNA that the students can complete in class or as a homework assignment.

The BLAST portion of the lesson also provides the flexibility to tailor the lesson to student interests by providing three different scenarios from which to pick. Scenario 1, which involves determining the source of whale bones found in whale graveyard, focuses on the history of whaling. Scenario 2, which involves determining if the meat found at a restaurant came from a whale, focuses on wildlife crime and forensics. Scenario 3, which involves determining which bones belong to the real whale from which the model of the blue whale in the ocean hall of the American Museum of Natural History was created, would be a great follow-up to a field trip to the museum.

During a class period, students will cut and paste mtDNA sequences into the BLAST tool on the NCBI website. Teachers will need to make a digital copy of the sequences available to their students, either through a shared file or through a class website. The tool will compare these sequences to known DNA sequences on file to determine the source of the mtDNA. Students can then use that information to solve the problem outlined in their scenario.

KEY CONCEPTS

- Analyzing and interpreting data.
- Engaging in arguments from evidence.
- Obtaining, evaluating and communicating information.
- NGSS LS3.B: Variation of Traits
- NGSS LS4.A: Evidence of Common Ancestry and Diversity

OBJECTIVES

- Students will perform a WebQuest to learn about mitochondrial DNA
- Students will analyze the mitochondrial DNA from various scenarios using Nucleotide BLAST
- Students will interpret the data and form conclusions to solve the various mysteries

MATERIALS

- Computers with Internet Access
- Mitochondrial DNA WebQuest
- *Whale of a Tale* student handout
- *Unknown mtDNA Sequences* file

PROCEDURE

Preparation

1. The teacher should choose one of the three scenarios to use with his or her classes. The teacher will need to create a packet for each student that contains the chosen scenario page and the student handout. Teachers will need to make a digital copy of the unknown sequences available to their students, either through a shared file or through a class website.

Pre-lesson Activity

2. During the first class period, students can complete the optional mitochondrial DNA WebQuest. If class time is limited, the WebQuest can also be assigned as a homework assignment. The WebQuest is designed to help students understand the structure and function of mtDNA. It is an optional activity and completion of it is not required prior to completing the BLAST activity.

Lesson

3. Complete the BLAST activity. At the start of the period, the class should read through the chosen scenario and discuss the problem to be solved.
4. Students will obtain computers.
5. The teacher will provide students with a link to the unknown sequences and direct them to the NCBI webpage (<https://blast.ncbi.nlm.nih.gov/>) where students can begin walking through the procedure in the student handout.
6. Using the BLAST procedure, students will obtain the scientific and common names of the organism from which each of the samples was obtained. Their answers will be recorded in the data table in the student handout.

- Once the students have identified the source of all four samples, they should write a conclusion paragraph explaining the meaning of their findings with respect to the scenario. If class time is limited, this can be assigned for homework.

ANSWER KEY

Specimen #	Species Name	Common name
1	<i>Balaenoptera musculus</i>	Blue whale
2	<i>Megaptera novaeangliae</i>	Humpback whale
3	<i>Balaenoptera physalus</i>	Fin Whale
4	<i>Balaenoptera acutorostrata</i>	Minke whale

Scenario 1 Conclusion:

The DNA evidence shows mtDNA from four different whale species. The students will have brainstormed as to what the majority of the DNA would be from so answers will vary but should be supported with the information given in the scenario. As the samples are all from different whales, they could comment on why Minke would be included in the data and why Sperm whales were not found in the bone samples.

Scenario 2 Conclusion:

The DNA evidence shows that the restaurant owners were in fact selling whale meat in their restaurant, not venison as they claimed. All four samples came from different species of whales, indicating that they can be charged under the Marine Mammal Protection Act. Blue, Humpback, and Fin are all endangered species, so the restaurant owners can also be charged under the Endangered Species Act.

Scenario 3 Conclusion:

The DNA evidence shows that DNA specimen #1 came from the bones of the blue whale. Those bones could be from the actual whale from which the model in the Hall of Ocean Life at the American Museum of Natural History was created. The remaining three specimens came from bones of different species of whales.

ASSESSMENT

Performance—students will successfully complete the WebQuest and student activity sheet.

ADDITIONAL RESOURCES

Each scenario contains additional websites that teachers and students can use to learn more about the history, science and policy outlined in the scenario.

Teachers may want to watch the following YouTube video on how to use BLAST before completing the activity in class to improve their understanding of the search tool.

<https://www.youtube.com/watch?v=WP9B0R1vgs0>