## Mystery Meat Student Directions



# An Introduction to Your Scientific Investigation

You are biologists visiting a meat market in a foreign country. When you come across some meat labeled "Kujira" you ask your guide and translator what "Kujira" means. She tells you *kujira* is whale meat and that lots of different kinds are sold here. You are mildly aware of laws protecting some whales from being hunted and are concerned about declining whale populations. You are curious what type of whales the meat comes from and if it is legal. But when you look closely you realize that it is impossible to identify the type of whale just by looking at the meat.

Scott Baker and Steve Palumbi are two biologists who took on such a challenge. In this investigation, you will follow in their footsteps to arrive at your own conclusions about the legality of what is being sold as whale meat using a technique called **DNA barcoding**.

# I. Begin the Investigation

An important part of most scientific investigations is having an understanding of relevant background information related to the questions or observations you are interested in.

- 1. With your teacher, brainstorm several questions you need to answer before you can investigate the legality of meat being sold as whale.
- 2. List your questions below, and then use the **Background Information Sheets** and any other resources your teacher provides to answer your questions:

## **Background Questions:**

**Investigation Question(s):** What is/are the scientific question(s) you will be investigating?

# **II.** Form Alternative Hypotheses

Many times researchers have several logical ideas about what new data might suggest before they begin collecting their data. Before you collect and analyze the DNA evidence, you should form multiple hypotheses about what you could expect to find. Below is just one possible hypothesis for any given piece of whale meat you collect. Write at least two more alternative hypotheses.

### Hypotheses for each piece of meat being tested:

- 1. The meat comes from a whale species that is legal to hunt and sell for commercial use.
- 2.
- 3.

Based on what you learned from your background investigation, what evidence would support each of the hypotheses you listed above?

Evidence that would support hypothesis 1:

Evidence that would support hypothesis 2:

Evidence that would support hypothesis 3:

## **III.** Collect and Analyze the Data

Often times a scientific investigation involves creative problem solving. In the case of Baker and Palumbi, one of their big challenges was figuring out how to get the DNA barcode data. Usually sequencing DNA is done in a lab, but it is illegal to transport whale tissue across international borders because whales are covered by the Convention on International Trade in Endangered Species (CITES). So these scientists carried portable equipment that allowed them to extract DNA and then to PCR amplify target gene sequences right in their hotel room!

Obtaining and analyzing the DNA barcode for each of your samples should be easier. Go to <u>http://www.paleobio.org/MysteryMeat/MysteryMeat-Unknowns.html</u> and follow the directions. Record your data in Data Table 1 below.

| Unknown<br>Meat   | Common Name of the Closest Species<br>Inferred from DNA Analysis | Specimen Similarity (%) |
|-------------------|--|-------------------------|
| <i>Sample #</i> 1 |  |                         |
| 2                 |  |                         |
| 3                 |  |                         |
| 4                 |  |                         |
| 5                 |  |                         |
| 6                 |  |                         |

#### Data Table 1: Identification of Market Samples Sold as Whale Meat

# **IV. Interpret the Data**

Getting and analyzing the data is one thing, but now it is time to determine what the DNA barcodes tell you about the legality of the meat being sold. Go back and review the hypotheses you wrote earlier. Use the *Hunting Status of Whales* Data Table to determine the status of each whale species you came across. Complete the following for each meat sample.

| Data Table 2: Hypothesis Analysis |             |  |  |
|-----------------------------------|-------------|--|--|
| Identified                        | Identified  | Which hypothesis/hypotheses does your data support? Explain. |  |
| Meat                              | Meat Sample | If the data does not support any of your hypotheses, write a |  |
| Sample #                          | Name        | revised or alternative hypothesis.                           |  |
| 1                                 |             |  |  |
|                                   |             |  |  |
|                                   |             |  |  |
| 2                                 |             |  |  |
|                                   |             |  |  |
|                                   |             |  |  |
| 3                                 |             |  |  |
|                                   |             |  |  |
|                                   |             |  |  |
| 4                                 |             |  |  |
|                                   |             |  |  |
|                                   |             |  |  |
| 5                                 |             |  |  |
|                                   |             |  |  |
|                                   |             |  |  |
| 6                                 |             |  |  |
|                                   |             |  |  |
|                                   |             |  |  |

#### **Data Table 2: Hypothesis Analysis**

1. What is your reaction to your findings?

2. Use the data you collected and analyzed to write a conclusion for each **Investigation Question** you posed **in Part I.** 

## V. Analyze and Compare the Results

Scientists share their findings with others, as part of a review process to ensure their findings are the result of a logical and fair investigation. It is also important that the findings become part of the body of scientific knowledge for others to use. Baker and Palumbi published their findings in a paper "Which Whales Are Hunted? A Molecular Genetic Approach to Monitoring Whaling" Science (1994). They concluded that some whale meat comes from whale species that are illegal to hunt. Moreover, they determined that some of the meat did not actually come from whales.

This is the phylogenetic Tree from Baker and Palumbi's published paper.

- 1. What can you conclude from their data about the meat being sold as whale?
- 2. How do Baker and Palumbi's data compare to what you found? Give at least two similarities and two differences between your results and theirs.
- 3. Does their data support your conclusions? Explain.

# VI. Apply What You Learned

The results of many investigations often lead to ideas for further investigations. Results can also be used to inform policy, solve problems, address societal issues, develop technology,

and/or to simply build upon our basic understanding of the natural world.

- 1. What new questions or ideas would you pursue if you could continue this investigation?
- 2. Explain at least two potential benefit and/or outcomes of the investigation.

