MOBY-DICK

JAKE HEGGIE AND GENE SCHEER

SCIENCE: Whale Classification

Students will

- Choose and research a type of whale
- Identify and classify the whale using Linnaean-based classification
- Create a Fact Sheet containing the whale's characteristics and habits
- Present their findings to the class

Copies for Each Student: *Moby-Dick* Synopsis, "Cetology, Taxonomy and the Linnaean Classification System", Activity Worksheet

Copies for the Teacher: *Moby-Dick* Synopsis, "Cetology, Taxonomy and the Linnaean Classification System", Activity Worksheet, Examples

Getting Ready

Have students read the *Moby-Dick* Synopsis.
Decide which section(s) of the lesson you wish your group to complete.
Prepare materials for the lesson, such as internet access and a class period in the library for research.
Gather pens, pencils, encyclopedias, dictionaries, and any additional materials deemed necessary for your students to complete this activity.

Instructional Time: One to two 45-minute class periods, plus time needed for students to work on their own

Introduction

Moby-Dick is an American opera in two acts by composed by Jake Heggie with a libretto written by Gene Scheer. It is based on Herman Melville's classic novel of the same title. Both the opera and novel tell the story of Ahab, captain of the whaling ship *Pequod*, seeking revenge on the white sperm whale he blames for the loss of his leg.

In the novel, there is a chapter called "Cetology" in which the character Ishmael attempts to scientifically name and classify the types of whales he encounters while at sea. His attempt, while noble, is flawed because he uses a classification system of his own invention rather than utilizing the scientific knowledge of his day to guide him as he records his findings. Even Moby-Dick, the bane of Captain Ahab's existence, is described inaccurately, and while it may have not been obvious during the time in which the story is written, it is quite obvious with what we know about whales today.

Guided Practice

Have the students read through "Cetology, Taxonomy and the Linnaean Classification System". Make sure they understand that Linnaeus's classification system would likely have been the one used by scientists to identify whales during the time *Moby-Dick* was written (mid-19th century) and is still used today to classify living things. Also, be sure that it is clear that taxonomy can change as new discoveries are made. Refer to the Glossary if there are any terms with which students are unfamiliar.

Present the Activity Worksheet to the students. Have them choose a type of whale to research from the Whale List provided.

Independent Practice

Depending on your grade level, the ability of your students, and time constraints, you may choose to have students work as a class, in small groups, with a partner, or individually. It is our recommendation that students work in pairs or groups for this project and that they have access to the library and internet for their research.

For Part I of the Activity Worksheet, students will use the Whale Classification Chart. Students will classify their whale using proper scientific terms for each classification level: kingdom, phylum, class, order, family, genus, species. Students may simply fill out the chart provided or use it as an example to create a chart of their own. In the "Explanation" portion of the chart, they must supply the reason the whale is classified as such in that level of classification (or taxon). For example:

Classification Level	Whale Name: Sperm Whale	Explanation (Why?)
Kingdom	Animalia	Whales have many cells, ingest food, and are formed from a "blastula" (a fertilized egg). All of these are characteristics of organisms found in the Animalia kingdom.

*Refer to the EXAMPLE **Whale Classification Chart** provided for the full classification of the sperm whale.*

In Part II of the Activity Worksheet, students will create a Fact Sheet outlining the specific characteristics of the whale they have chosen using the guidelines provided. Any additional interesting facts or details about the whale may be included as well.

If Time Allows

Once the students have completed the whale's classification and created their Fact Sheet, have them present their findings to the class.

Evaluation

- Did students choose and research a whale from the list?
- Were the students able to classify their whale?
- Did the students create a Fact Sheet and present their findings to the class?

Prove it!
The Dallas Opera wants to see your classroom's hard work! Take pictures or videos of your students' work and email them to: education@dallasopera.org for a chance to be featured on The Dallas Opera Website (http://dallasopera.org/learn/) and/or at the pre-show for the Student Matinees™!

TEKS – Science

6th Grade
112.18. b. 3 D Scientific investigation and reasoning
The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to: (D) relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content.

112.18. b. 12 C,D Organisms and environments
The student knows all organisms are classified into Domains and Kingdoms. Organisms within these taxonomic groups share similar characteristics which allow them to interact with the living and nonliving parts of their ecosystem. The student is expected to: (C) recognize that the broadest taxonomic classification of living organisms is divided into currently recognized Domains; (D) identify the basic characteristics of organisms, including prokaryotic or eukaryotic, unicellular or multicellular, autotrophic or heterotrophic, and mode of reproduction, that further classify them in the currently recognized Kingdoms.

7th Grade
112.19. b. 3 D Scientific investigation and reasoning

The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to: (D) relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content.

112.19. b. 11 A,B Organisms and environments
The student knows that populations and species demonstrate variation and inherit many of their unique traits through gradual processes over many generations. The student is expected to: (A) examine organisms or their structures such as insects or leaves and use dichotomous keys for identification; (B) explain variation within a population or species by comparing external features, behaviors, or physiology of organisms that enhance their survival such as migration, hibernation, or storage of food in a bulb.

8th Grade
112.20. b. 3 D Scientific investigation and reasoning
The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to: (D) relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content.

112.20. b. 11 B,C,D Organisms and environments
The student knows that interdependence occurs among living systems and the environment and that human activities can affect these systems. The student is expected to: (B) investigate how organisms and populations in an ecosystem depend on and may compete for biotic and abiotic factors such as quantity of light, water, range of temperatures, or soil composition; (C) explore how short- and long-term environmental changes affect organisms and traits in subsequent populations; and (D) recognize human dependence on ocean systems and explain how human activities such as runoff, artificial reefs, or use of resources have modified these systems.

High School: Aquatic Science
112.32. c. 3 B,D,F Scientific process
The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to: (B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials; (D) evaluate the impact of research and technology on scientific thought, society, and the environment; (F) research and describe the history of aquatic science and contributions of scientists.

112.32. c. 10 A Science concepts
The student knows environmental adaptations of aquatic organisms. The student is expected to: (A) classify different aquatic organisms using tools such as dichotomous keys.

High School: Biology
112.34. c. 8 A,B,C Science concepts
The student knows that taxonomy is a branching classification based on the shared characteristics of organisms and can change as new discoveries are made. The student is expected to: (A) define taxonomy and recognize the importance of a standardized taxonomic system to the scientific community; (B) categorize organisms using a hierarchical classification system based on similarities and differences shared among groups; and (C) compare characteristics of taxonomic groups, including archaea, bacteria, protists, fungi, plants, and animals.

Correlates: Math

Gardner's Intelligences: Visual-Spatial, Interpersonal, Logical-Mathematical

Bloom's Taxonomy: Understand, Analyze, Evaluate, Create

Resources
Linnaeus, Carolus. 1802. *Systema Naturae*. London: Lackington, Allen, and Co., Temple of the Muses, Finsbury Square.
Melville, Herman. 2003. *Moby-Dick*. Mineola, N.Y.: Dover Publications.
Wallace, Robert K, Karen Almond, Herman Melville, and Gene Scheer. 2013. *Heggie And Scheer's Moby-Dick*. Denton, Tex.: University of North Texas Press.

Online Resources
"5 Scientific Inaccuracies You Didn't Know Were In 'Moby-Dick'". 2014. *The Huffington Post*.
http://www.huffingtonpost.com/2014/11/14/scientific-inaccuracies-moby-dick_n_6134356.html.
"Alaska Fisheries Science Center Homepage". 2016. *Afsc.Noaa.Gov*. http://www.afsc.noaa.gov/default.htm.
"Cetology Of Moby-Dick". 2016. *Wikipedia*. https://en.wikipedia.org/wiki/Cetology_of_Moby-Dick.
"US NSF - Biology Classroom Resources". 2016. *Nsf.Gov*. https://www.nsf.gov/news/classroom/biology.jsp.
"Whale Classification - Enchanted Learning Software". 2016. *Enchantedlearning.Com*.
http://www.enchantedlearning.com/subjects/whales/classification/index.shtml.

Moby-Dick
Synopsis

ACT ONE

Scenes 1 to 4. Day One: The whaling ship Pequod *has been at sea for one week*

Captain Ahab stands alone on deck in the hours before dawn. Below deck, while most of the crew sleeps, the harpooneer Queequeg prays and wakes Greenhorn, a loner and newcomer to whaling. Dawn breaks and the call is made for "All Hands!" While the crew is raising the ship's sails, Starbuck, Stubb, and Flask talk about Ahab, whom no one has seen since the ship left Nantucket.

The crew sings of whales, wealth and home when suddenly, Captain Ahab appears. He tells them of Moby-Dick, the white whale that took off one of his legs, then nails a gold doubloon to the mast and promises it to the man who first sights him. This is the real reason they have sailed, he explains: to search the globe to find and destroy this one whale. His rousing call of "Death to Moby-Dick!" excites everyone but the first mate, Starbuck. To no avail, he confronts Ahab about what he sees as a futile and blasphemous mission.

Starbuck instructs Greenhorn about the dangers of whaling. When he ponders never again seeing his wife and son, he is overcome with emotion and orders Queequeg to complete the lesson. Stubb sights a pod of whales, but Ahab will not allow the eager crew to hunt since they have not yet found Moby-Dick. Starbuck orders the crew to sail on and sends Greenhorn up to the lookout on the masthead, joined by Queequeg.

As the sun begins to set, Ahab looks over the wake of the ship and mourns that his obsession deprives him of any enjoyment of beauty. All is anguish to him. At the masthead, Queequeg and Greenhorn look over the world, while Starbuck, on deck, bemoans Ahab's madness.

Scenes 5 to 7. Day Two: Three months later

After three months without a single whale hunt, Stubb jokes with the young cabin boy Pip about the sharks circling the ship. The song ignites a dance for the full crew, but rising tensions take over and a dangerous racial fight erupts. When Greenhorn suddenly sights a pod of whales, Starbuck is at last able to persuade Ahab to let the men hunt. Starbuck and Stubb harpoon whales, but Flask's boat is capsized and Pip is lost at sea.

On board the Pequod, an enormous whale is being butchered and the oil rendered in the burning tryworks. Flask tells Ahab that the search for Pip is under way, but Ahab thinks only of finding Moby-Dick. As they butcher the whale, the crew imagines Pip lost and struggling in the heart of the sea. Flask tells Starbuck that many oil barrels are leaking and he goes below to tell Ahab they must find a port for repairs.

Ahab is unmoved by Starbuck's report, and is concerned only with the white whale. When Starbuck refuses to leave, Ahab grabs a musket and orders him to his knees. From afar, Greenhorn shouts that Pip has been found. Ahab orders Starbuck out of the cabin.

On deck, the crew listens to Greenhorn describe how Queequeg rescued Pip. As the men return to work, Greenhorn pleads with Starbuck to get help for Pip, who has gone mad. But, the first mate ignores him. Greenhorn observes how life really works on the ship and decides to befriend Queequeg.

Starbuck returns to Ahab's cabin, where he finds the captain asleep. He picks up the musket with which Ahab had threatened him and contemplates what he should do. Pull the trigger and he may survive to see his wife and child again. When Ahab cries out in his sleep, Starbuck replaces the musket and leaves the cabin.

ACT TWO

Scenes 1-3. Day Three: One year later

An enormous storm is approaching, but Stubb, Flask and the crew sing a jolly work song. From the mastheads, Greenhorn and Queequeg talk of traveling together to his native island. Greenhorn wants to learn Queequeg's language and write down their adventures. Suddenly, Queequeg collapses. The crew gets him down and Ahab announces he will take the masthead watch himself, as he wants to sight Moby-Dick first.

Below deck, Queequeg tells Greenhorn that he is dying and asks that a coffin be built for him. Pip enters from the shadows and sings a lament, joined by Greenhorn.

The massive storm now surrounds the *Pequod*. As Ahab sings defiantly to the heavens, bolts of lightning engulf the ship and the masts glow with St. Elmo's fire. Ahab demands that the men hold their posts, promising them the white flame is a sign from heaven to guide them to the white whale. The crew is inspired once again by the captain, much to Starbuck's distress.

Scenes 4 to 7. Day Four: The next morning

The ship has made it through the storm. From afar, the voice of Gardiner, captain of the *Rachel*, calls out. He pleads with Ahab to help him search for his 12-year-old son who was lost in the storm, but Ahab refuses. Pip shouts to Gardiner of the *Pequod*'s own lost boy. Pip cuts himself and gets blood on Ahab's clothes. The captain orders the ship to sail on, leaving Gardiner behind. Ahab contemplates the heartless God who devastates so many lives and baptizes his new harpoon with Pip's blood.

Below deck, Greenhorn sees Queequeg's newly built coffin and contemplates the madness that seems to surround him.

On deck, Ahab and Starbuck gaze over the horizon. Ahab describes his forty years at sea and all he has left behind. And why? To what end? He cannot say. But he sees in Starbuck's eye a human soul and it touches him deeply. Starbuck seizes the moment and persuades Ahab that they should return to the wives and sons who wait for them in Nantucket.

Just as Ahab appears to relent, he sights Moby-Dick on the horizon. Great excitement ensues and the whale boats are lowered. Ahab looks again in Starbuck's eye and orders him to stay on board. The crew declares its loyalty to Ahab. During the chase, Moby-Dick destroys two whaleboats in succession, drowning their crews. Then, the *Pequod* is rammed and sunk, killing all aboard. Ahab's boat is then attacked and all but the captain jump or fall off. Finally alone with the white whale, Ahab cries out and stabs at Moby-Dick before being dragged down into the sea.

Epilogue: Many days later

Greenhorn floats on Queequeg's coffin, barely alive, softly singing his lost friend's prayer. Gardiner calls from afar, thinking he has at last found his missing son. Instead, he learns that Ahab and all the crew of the *Pequod* have drowned, except for this one survivor.

Moby-Dick

Cetology, Taxonomy and the Linnaean Classification System

In Herman Melville's novel, *Moby-Dick*, there is a chapter called "**Cetology**" in which the character Ishmael attempts to scientifically name and classify (or taxonomize) the types of whales he encounters while at sea. His attempt, while noble, is flawed because he uses a classification system of his own invention rather than utilizing the scientific knowledge of his day to guide him as he records his findings. Even Moby-Dick, the sperm whale at the center of the tale in both the novel and the opera, is described inaccurately. While these scientific inaccuracies may have not been obvious during the time in which the story was written, it is quite obvious with what we now know about the taxonomy of whales today.

Taxonomy is the part of science that focuses on naming and classifying, or grouping organisms. It can change over time as new discoveries are made. Because there are millions of species on our planet, scientists need a method or system to name and organize them. During the 18th century, a Swedish naturalist named Carolus Linnaeus, who is considered the '"Father of Taxonomy", developed a way to name and organize species. His two most important contributions to taxonomy were:

- A hierarchical classification system
- The system of binomial nomenclature (a 2-part naming method using Latin words)

Linnaeus's system or the **Linnaean Classification System** is based on a simple hierarchical structure. Linnaeus divided all of nature into three broad groups called **kingdoms**. These kingdoms were animals, plants, and minerals. He divided each of these kingdoms into **classes**. Classes were divided into **orders**. These were further divided into **genera** (genus is singular) and then **species**. Today, we still use this system, but because new discoveries have been made since Linnaeus's time, there have been some changes and additions:

- The current system excludes minerals and is **only used** to classify living organisms.
- The groupings of organisms has expanded. List from largest to smallest they are as follows: **domain, kingdom, phylum, class, order, family, genus, species**.
- Traditionally, in the U.S., 6 kingdoms are recognized: Protista, Fungi, Plantae, Animalia, Eubacteria and Archae.*

While there are other systems and methods in existence for the purpose of naming and identifying species, Linnaeus's system is one that has been expanded, changed numerous times, but is still universally known and used in the science world. Because the system is an invention of the 18th century and it is still used today in the 21st century, it also would likely have been one used by scientists during the mid-19th century when *Moby-Dick* was written. Therefore, it is no stretch to conclude that Ishmael's whale descriptions would have been more scientifically accurate if he had used the Linnaean Classification System to classify whales while aboard the Pequod instead of inventing one of his own.

**In other countries, 5 kingdoms are recognized Protista, Fungi, Plantae, Animalia and Monera.*

Moby-Dick
Glossary

Binomial nomenclature: The two-word naming system developed and used by Carolus Linnaeus in his classification system

Cetology: the branch of marine mammal science that studies the approximately eighty species of whales, dolphins, and porpoise

Domain: highest taxonomic rank of organisms. There are three domains: Archaea, Bacteria, and Eukarya. Each of these domains contains kingdoms.

Kingdom: A kingdom contains one or more phyla (plural of phylum).

Phylum: Group of related or similar organisms. A phylum contains one or more classes. A group of similar phyla (the plural of phylum) forms a Kingdom.

Class: Group of related or similar organisms. A class contains one or more orders. A group of similar classes forms a phylum.

Order: A group of related or similar organisms. An order contains one or more families. A group of similar orders forms a class.

Family: A group of related or similar organisms. A family contains one or more genera (plural of genus). A group of similar families forms an order.

Genus: The first word (Latin) of the two-part scientific name of an organism

Species: the second word (Latin) of the two-part scientific name of the organism. It is written lowercase and may indicates something specific about the organism (i.e. what it looks like, where it is found, or who discovered it)

WHALE LIST

Andrew's beaked whale
Antarctic blue whale
Antarctic or southern minke whale
Arnoux's beaked whale
Baird's beaked whale
Beluga whale
Blainville's Beaked whale
Blue whale
Bowhead whale
Bryde's whale
Common minke whale
Cuvier's beaked whale
Dwarf minke whale
Fin whale
Gervais' beaked whale
Ginkgo toothed beaked whale
Gray whale
Gray's beaked whale
Hector's beaked whale
Hubb's Beaked whale
Humpback whale
Longman's beaked whale
Narwhal whale
North Atlantic right whale
North Pacific right whale
Northern bottlenose whale
Omura's whale
Perrin's beaked whale
Pygmy beaked whale
Pygmy blue whale
Pygmy Byrde's whale
Pygmy right whale
Right whale
Sei whale
Shepherd's beaked whale
Southern bottlenose whale
Southern right whale
Sowerby's beaked whale
Spade-toothed whale
Stejneger's beaked whale
Strap-toothed whale
True's beaked whale

Name: _____ Date: _____

Activity Worksheet

Part I

Instructions: Fill in the chart below with the information about your chosen whale according to the Linnaean Classification System. Please note: [Suborder] is not required, but you may list it if applicable.

Whale Classification Chart

Classification Level	Whale Name: _____	Explanation
*[Domain]		
Kingdom		
Phylum		
Class		
Order		
*[Suborder]		
Family		
Genus		
Species		

Whale Fact Sheet

Part II

Guidelines:

Please include the following when creating your **Whale Fact Sheet**:

- **Name of Whale** *(common name, not scientific)*
- **Physical Appearance**
    - **Size** *(Average Length and Weight)*
    - **Color(s)**
    - **Does it have blowhole? Location?**
    - **Teeth or Baleen?**
- **Where it lives** *(ocean name(s), hemisphere, etc.)*
- **Distribution** *(where it lives: ocean name(s), hemisphere, etc.)*
- **Migration? What is the migration route?**
- **Feeding** *(what it eats)*
- **Average life span** *(how long it lives)*

Example

Part I

Instructions: Fill in the chart below with the information about your chosen whale according to the Linnaean Classification System. Please note: [Suborder] is not required, but you may list it if applicable.

Whale Classification Chart

Classification	Whale Name: Sperm Whale	Explanation (Why?)
[Domain]*	Eukarya	A eukaryote is any organism whose cells contain a nucleus and other organelles enclosed within membranes.
Kingdom	Animalia	Whales have many cells, ingest food, and are formed from a "blastula" (a fertilized egg) - All of these are characteristics of organisms found in the Animalia kingdom.
Phylum	Chordata	Because an animal from the phylum Chordata has a spinal cord and gill pouches.
Class	Mammalia	Whales are warm-blooded animals, breathe air, and the mothers produce milk to feed their young
Order	Cetacea	Cetaceans are mammals who live completely in the water.
[Suborder]*	Odontoceti	Sperm whales have teeth and a blowhole
Family	Physeteridae	Whales belonging to this family have large heads
Genus	*Physeter*	A genus is a group of species that are more closely related to one another than any group in the family. *Physeter* the first word (genus) of the two-part scientific name of the sperm whale.
Species	*macrocephalus*	A species is a grouping of individuals that interbreed successfully. *Macrocephalus* the second word (genus) of the two-part scientific name of the sperm whale.

Example

Whale Fact Sheet

Part II

WHALE NAME: Sperm Whale

- Physical Appearance
  - Size *(Length and Weight)*
    - Adult Males- grow up to 60 ft. long; 35-45 tons
    - Adult Females – grow up to. 43 ft. long; 13-14 tons
  - Color(s)
    - dark, brownish grey with light streaks, spots & scratches
  - Does it have blowhole? Location?
    - Yes. The blowhole is located at the left of the forehead.
  - Teeth or Baleen?
    - Teeth
- Distribution *(where it lives: ocean name(s), hemisphere, etc.)*
  - Sperm Whales can be found in all oceans in both the Northern and Southern Hemispheres. The males tend to be found in higher latitudes. All others remain in the warmer tropical and sub-tropical waters of the Pacific, Atlantic, and Indian Oceans year-round.
- Migration? What is the migration route?
  - Yes. The largest males migrate from higher latitudes to the breeding grounds close to the equator.
- Feeding *(what it eats)*
  - Giant squid, octopus, fish, shrimp, crab and small bottom-living sharks
- Average life span *(how long it lives)*
  - 50-70 years