Course: Marine Biology
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This course will provide a survey of marine biology from the ocean as a complex environment to the well-adapted life forms that inhabit it and how they are all interconnected. Early sections will focus on the marine environment – what makes it special and how it affects the organisms that live there. The next two sections are called the survey of marine life. These sections will introduce us to live and preserved specimens and allow us to explore what organisms eat. Next, we will learn about the impact of humans on the oceans, from the historical affects of man on the sea through the effects that our current activities have on the oceans. Off-site activities, including a tour of the New England Aquarium, a visit to a wetland reserve and hands-on dissections will get us one step closer to the animals we are studying.

Section 1: Seawater
In all subsequent sections we will study the living things in the ocean, however, in this section we are going to focus on the non-living (abiotic) parts of the ocean. We'll study seawater properties and the ocean as an environment. This section will make you think about the following questions:

What does (a)biotic mean? What are examples of (a)biotic things in the ocean?
What makes seawater different from freshwater?
What is in seawater?
What tools can we use to determine the properties of seawater?
How might some of these properties affect the organisms that live in the ocean?

Section 2: Marine Environments
In this section we'll explore different ocean habitats that organisms can live in. We'll learn how organisms have adaptations that allow them to survive in a particular marine environment. We'll also use our new knowledge to design a marine organism adapted to one of these environments. In this section you will be asked to think about:

What is an adaptation?
What land environments do organisms live in?
What adaptations do land organisms have that allow them to survive there?
What marine environments exist?
What adaptations do some marine organisms have to their ocean environment?

Section 3: Survey of Marine Life – the little guys (Includes invertebrate dissections)

Section 4: Survey of Marine Life – THE BIG GUYS

Section 5: Field trip to Waquoit Bay Reserve (Includes vertebrate dissections)

Section 6: Human Impacts on the Marine World

Section 7: Field Trip to New England Aquarium

Lesson Plan
Section 1: Seawater

Bellwork: Students find the following question written on the board when they come in to the room. They are asked to use the first 5 minutes of class to write down answers to the following question and hand it in when they are finished:

What are the differences between lakes and oceans?

Invitation: Have students share some of their ideas from bellwork.
Pull out 2 large flasks; one containing seawater and the other does not. Explain that today we are going to focus on what makes seawater different from other water.

Activity 1 (Which Water is Which?) - Pair students up in groups of 3-4 students. Cup A contains saltwater, Cup B contains freshwater.

- Materials – random objects in baggies, 2 cups of water (one fresh, one saltwater)
- Experimentation – use all senses except tasting and any of the available objects to determine which cup contains saltwater
- Assessment – students will describe the procedure they used, the results and what conclusion they drew on a group worksheet
- Post-activity discussion questions – How many people think that cup A contained freshwater? Cup B? What observations led you to that conclusion (have some groups describe their procedure?
- Reveal – which cup is saltwater and which is freshwater.

Activity 2 (Ice melting challenge) – Students stay in their groups.

- Materials - 2 ice cubes and 2 stopwatches.
- Prediction – Before you do anything else, write down your predictions on how the ice will behave when you put it in each cup. Will it sink or float? Will the ice melt at the same rate in both cups or will ice melt faster in one type of water over the other? Write down your predictions and why you think they might happen. Students watch as ice is dropped into the two beakers at the front of the room and are asked why they think the ice floated in both types of water.
- Experimentation – Students place ice in their own cups and watch it melt for 1-2 minutes before they are asked which they think is melting the fastest. After a few minutes add 2 drops of blue dye to their water.
- Assessment - students are asked to write on their group worksheet which is melting fastest, why they think that is true, and what the dye indicates. Students are asked to turn in their responses to activities 1&2.
- Post-activity discussion questions – students are asked
    - when do you think this might happen in nature?
    - How might animals that are adapted to seawater be affected if melting ice leaves freshwater on the surface of saltwater?

***Activ**ity 3 (Mysterious Sinking Ice) – group demonstration

- Materials – beakers of freshwater, saltwater, mystery solution 1, mystery solution 2, several blue tinted ice cubes.

So at this point we've observed that when ice cubes melt they behave differently in freshwater than they do in salt water. We've observed that fresh water melted from ice cubes will float on top of saltwater and that when ice cubes are dropped into different fluids (drop cubes into each of the first 2 flasks) they float. So why does ice always float?

(get around to it being less dense than water and salt water and soda etc.)

Drop ice cubes into mystery solution 1 and ask students to do a quick write:

What might your observations tell you about the fluid in the beaker? (1 minute)

Next drop ice cubes into mystery fluid 2 and have students observe for 3 minutes. Then have students do a 2 minute quick write (same question).

We are going to test some of your theories.

***Activity 4 (Determining Density)** – students broken into groups

Materials – balances, graduated cylinders, flasks full of each type of fluid, short-lab worksheets

Instructions – each group will measure out a certain volume of each liquid and ice (1.0 mL, 16 mL, 43 mL). Each substance will then be weighed on a balance to determine its mass. The mass and volume will be recorded in the data table and the density of each substance will be calculated. See worksheet for further instructions and questions.

Assessment – Student understanding will be verbally assessed during the procedure to ensure that they understand procedure and to determine if they have any predictions based on what we have done in class already. Worksheet questions will provide quantitative assessment tool for understanding. Questions 1-6 are procedural and thought questions that are designed to enlighten and challenge misconceptions. Questions 7-12 are designed to make students independently apply knowledge to a new situation and explain the findings in the context of what we have already explored.

Activity 5 (Making Seawater) – In this activity students will learn what seawater is made of, what properties it has (density, salinity, pH, gas content, pressure at depth, dissolved organic matter) and what tools are available to measure these properties. Students will be challenged with questions like where did the oceans come from? Why are they salty? Follow up exercises will explore how these properties might affect the living things in the ocean.

1. Think back to our classroom observations from today and fill in the following blanks. There may be more than one answer for each blank. Fill in all that apply.

    a. Ice floats in _____.

    b. Ice sinks in _____.

    c. Freshwater floats in _____.

    d. Freshwater sinks in _____.

    e. Saltwater floats in _____.

    f. Saltwater sinks in _____.

2. Write the names of the substances that you measured in class in order from lowest density to highest density value.

3. How does the density of ice compare to the density of the solutions that it floats in?

4. How does the density of ice compare to the density of solutions that it sinks in?

5. How do you think the mass of 108 mL of fresh water will compare to the mass of the fresh water you measured? Why?

6. How do you think the density of 108 mL of fresh water will compare to the density of the freshwater you measured?

7. Use the following instructions to measure the volume of your volunteer.
   Have your volunteer stand with their hands at their side and follow these instructions to measure their length, width and height.
   a. Using a ruler or measuring tape, measure the distance from shoulder to shoulder. This is your volunteer's length. Insert the number in the proper space below for inches or cm depending on the units of your measuring tool. If you used inches, multiply by 2.5 to convert to centimeters (cm).
   b. Next, measure the distance from your volunteer's bellybutton to his/her back. This is your volunteer's width. Insert the number in the proper space and convert if necessary.
   c. Finally, measure the distance from the top of their head to the floor. This is your volunteer's height. Insert the number in the proper space and convert to cm.

Volunteer Length (shoulder to shoulder) = ____ inches X 2.54 = ____ cm

Volunteer Width (bellybutton or shin to back) = ____ inches X 2.54 = ____ cm

Volunteer Height (floor to head) = ____ inches X 2.54 = ____ cm

Volunteer Volume = Length X Width X Height (all in cm) = ___ cubic cm (cc's or mL)
Put this number into your table under volunteer volume.

Weigh your volunteer on a scale or ask them to estimate how much they weigh in pounds.
On Earth, the weight of an object can be converted to tell you its mass or how much matter is in it. (On the moon, or anywhere else in the universe, the weight of the object would change because there is less gravity, but the amount of mass would not change. Good thing we're doing this lab on Earth!)

Convert _____ pounds to grams by multiplying pounds X 453.6. Enter your answer in the table under mass of volunteer.

8. Calculate the density of your volunteer by dividing the mass of your volunteer by the volume of your volunteer. Insert the density in the proper space in your table on page 1.

9. Rewrite the entire list of substances in order from least dense to most dense, including your volunteer on the list this time.

10. Compare the density of your volunteer with the density of the fluids. Predict what will happen if your volunteer was placed in a giant beaker full of mystery solution 1. Do you think he/will float or sink?

11. What makes you think that?

12. How much heavier would your volunteer have to be in order to make them sink in saltwater?

Density Short Lab

- ☐ Use a pipette to measure out ___ mLs of each fluid. (You will be given the same volume of ice as well.)
- ☐ Measure the mass of each of the four liquids and the ice.
- ☐ Together with your partners, fill in the table on your Density "Short Lab" Report
- ☐ Calculate the density of ice and each liquid by dividing the number in the mass column by the number in the volume column. This will give you the density in grams per cubic centimeter (cc), which is also known as grams per milliliter.
- ☐ Answer questions 1-6 in class.
- ☐ Show your table and answers to questions 1-6 to your instructor before you leave class.
- ☐ Once you get home you will complete your table by finding the mass and volume of any volunteer.
- ☐ Answer the remaining questions and hand in your "Short Lab" report during our next class.

Substance	Mass Measured (in grams)	Volume Measured (in cc's or mL)	Density (mass/volume) don't forget units!!
FreshH20			
Salt H20			
Ice			
Fluid A			
Fluid B			
Volunteer			