DOLPHIN RESEARCH CENTER
Dolphin Divers

Grade Level: 6th-8th

Objectives: Students will be able to apply their knowledge of buoyancy and density to the physiology of diving dolphins.

Florida Sunshine State Standards:
Science
SC.A.1.3.1 The student identifies various ways in which substances differ (e.g., mass, volume, shape, density, texture, and reaction to temperature and light).
SC.F.2.3.3 The student knows that generally organisms in a population live long enough to reproduce because they have certain survival characteristics.
SC.H.1.3.2 The student knows that the study of the events that led scientists to discoveries can provide information about the inquiry process and its effects.

National Science Education Standards:
Content Standard A (5-8) – Abilities Necessary to do Scientific Investigations: Develop descriptions, explanations, predictions, and models using evidence; Think critically and logically to make the relationships between the evidence and explanations; Communicate scientific procedures and explanations.
Content Standard C (5-8) – Diversity and Adaptations of Organisms: Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.

Key Terms

Buoyancy: The upward force exerted by a fluid on a submerged or floating body, equal to the weight of the fluid displaced by this body.
Density: Mass per unit volume of a substance.

Background: Buoyancy is the upward force exerted by a fluid on a submerged or floating body. The force is equal to the weight of the fluid displaced by the body. In order for an object to float in water, the weight of the object must be less than the weight of the water that is displaced. For example, an object with a volume of 25mL must weigh less than 25mL of water in order to float. A 25mL object that is denser than 25mL water will sink, while a 25mL object that is less dense than 25mL of water will float.

These are very important concepts that students often learn in physical science, but it is also important that students understand how these concepts relate to living organisms. Dolphins are relatively buoyant at the surface. Dolphins will spend some of their time diving, and an understanding of buoyancy is essential to understand how dolphins dive using minimal energy.

Dolphin Divers

For a long time, scientists thought that dolphins used strong, continuous strokes of their tail to propel them down into the water, and then used these strong strokes again to return to the surface. However, a group of researchers proved this theory wrong by attaching a camera to a dolphin and watching the dolphin dive. The camera showed that the dolphin used a few powerful strokes of the tail to get started. The tail then stopped moving, and the dolphin seemed to just sink towards the bottom. When it was time to return to the surface, the dolphin used a few powerful strokes to begin its ascent, and then the tail stopped moving as the dolphin continued to rise to the surface.

Upon further investigation, scientists realized that this efficient diving technique was related to the dolphin's amazing anatomy. Dolphins have a very flexible rib cage, and this assists them during deep dives. At a certain depth, high pressure causes a dolphin's lungs to collapse. The flexible rib cage facilitates this. Any air remaining in the lungs is compressed, and the dolphin is now dense enough to sink deeper into the water. This process reverses as a dolphin ascends to the surface. To learn more about dolphin diving, look at the ***Physiology*** information file.

Unlike dolphins, humans do not have a flexible rib cage. Even though the air in the human body may be compressed and/or dissolved in the blood, the lung cavities still remain, and the density of the body is not great enough to cause it to sink. Typically, divers will wear wetsuits. Wetsuits are made of neoprene, a material that has lots of air bubbles. Wetsuits typically keep a swimmer more buoyant than he/she would be without the wetsuit. However, as a diver descends, the air bubbles are compressed and the wetsuit's density increases (similar to what happens as a dolphin descends). Divers use weights and buoyancy control devices to control their buoyancy throughout their dives.

Materials:

For each student or group:

- Empty plastic soda bottle
- Water
- Cup
- Glass eye dropper
- Wax (the type used for ear plugs) or clay

Teacher Prep Notes: Prior to the day of the lesson, ask students to bring in empty soda bottles or water bottles. (Any size will do.) The day of the lesson, make copies of the ***Dolphin Divers*** handout for each student. Students may complete this activity independently or in groups. Make sure each student or group has the proper materials.

Procedures:

1. Review the concepts of buoyancy and density with students.
2. Ask students how these factors would impact marine animals such as dolphins.
3. Explain to students that they will be completing an activity that will help them understand how these concepts relate to both dolphins and humans as they dive!

Dolphin Divers

4. Distribute the ***Dolphin Divers*** handout, and provide students with the necessary materials for the activity.
5. Have students complete the warm-up questions, and discuss as a class.
6. Ask students to complete the activity and questions in Part I.
7. Once the students have completed Part I, take some time to discuss their observations. Students should have observed that the Cartesian diver sank when pressure was applied to the bottle. This occurred because the increased pressure on the bottle caused the air in the dropper to compress and additional water moved into the dropper. Therefore, the dropper was denser and sank to the bottom. When the pressure was released, the air in the dropper expanded, the density decreased, and the dropper rose to the top.
8. Instruct students to complete Part II.
9. Once the students have completed Part II, take some time to discuss their observations. Again, the students should have observed that the Cartesian diver sank when pressure was applied. This time, the wax prevented water from moving into the dropper. Instead, the air in the dropper compressed, still making the diver dense enough to sink. Students should observe that the rubber bulb on the dropper is compressed. This is similar to what happens to a dolphin's lungs when the dolphin dives! As the pressure increases, the lungs collapse and the dolphin is dense enough to sink. This is a more accurate representation of a diving dolphin because the dolphin does not take in additional water during a dive.
10. Instruct students to complete Part III.
11. Once the students have completed Part III, take some time to discuss their observations. This time, the diver will not sink to the bottom. The pressure applied to the bottle does not effect the air inside of the dropper because it is a closed system and the sides do not compress. This is more like human lungs, which do not collapse like dolphin lungs.
12. This discussion of dolphin diving can be supplemented with a video listed in the resource section. There is a two to three minute clip on dolphin diving that can be found approximately 30 minutes into the video.

Wrap Up: Ask a few students to summarize why an understanding of concepts like buoyancy and density can aid in understanding living organisms.

Taking it Further:

- Relate this lesson to a discussion of the gas laws (especially Boyle's law).
- Examine how fish use swim bladders to regulate their buoyancy in water.

Resources:

- **Video**
  The Ultimate Guide: Dolphins. The Discovery Channel, 1999.