Blubber versus Buoyancy

Grade Level
6th to 12th grade

Objectives
Students will discuss the importance of regulating buoyancy in marine animals.
Students will explain the concept of specific gravity.
Students will explain the development of blubber and loss of hair in large mammals.

Background
Mammals have hair. Hair evolved primarily as a device to insulate the body and allow a constant internal temperature to be maintained. Small mammals lose heat faster than large mammals and many of the largest mammals have lost their hair. Through evolution, the largest land animals: elephant, rhinoceros, and hippopotamus retain mere remnants of body hair as large size and thick hides eliminate the need for it.

It is not known whether the land animal that evolved into whales was hairless, but no whale today shows more than vestigial or sensory hair. The large layer of body fat, called blubber, they developed is a great insulator but, since the specific gravity of blubber is less than water (it floats), whales cannot have too much of it. Too much positive buoyancy would prevent these mammals from diving far below the surface. Whales have thus evolved a delicate balance of heavy muscle and bone along with blubber and heat regulatory systems.

Materials
Pitted olives (as models of whales)
Solid shortening or margarine (as blubber)
Plastic cups (transparent) or beakers
Water (and salt water for extension)
Staples
Wooden or plastic applicators (wood splints or Popsicle© sticks)

Procedures
1. Fill cups 2/3 full of tap water and place a pitted olive into them. Be sure it fills with water. Olive tissue, like animal flesh has a higher specific gravity than water; it has negative buoyancy and will sink.
2. To stimulate the effect of blubber, put a small amount of shortening into the opening of the olive, displacing water as necessary (do not drain). Test the olive after each dab you add to see any changes. Soon the olive will float. It now has a lower specific gravity than water (overall density is less than an equal volume of water). It has positive buoyancy and will float.
3. Now stick both points of a staple into the side of the olive. This simulates the effect of bone on buoyancy. Test it in the water now. It should be negative. If not, put another staple in the opposite side.
4. Your job now is to try to achieve neutral buoyancy; that is, make the olive so that it hangs in midwater neither sinking nor floating. It won’t be easy. This is a desirable condition for many marine animals since it allows them to stop and rest without a constant effort to maintain their position in the water column.

What condition of buoyancy would be best for whales?

What condition of buoyancy would be best for bottom-dwelling animals?
If open sea marine mammals attain bodies that have neutral buoyancy, what happens if they swim into the water of different density? Temperature and salinity affect the density of water.

5. Once you have a neutral olive, get an additional cup available containing warm water, ice water, salty water. Predict in the table below what would happen if you put your olive, which is now neutral in room temperature tap water, into each of these additional cups. Enter a prediction first then the result, and finally explain the results in terms of the effects of temperature and salinity on the density of water.

<table>
<thead>
<tr>
<th>New water</th>
<th>Prediction</th>
<th>Result</th>
<th>Explanation</th>
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</thead>
<tbody>
<tr>
<td>Warm</td>
<td></td>
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<tr>
<td>Cold</td>
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<tr>
<td>Salty</td>
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Should open ocean creatures have a way to regulate buoyancy?

How might whales regulate their buoyancy?

How do open water fish regulate buoyancy? Which fish don’t need to?