Module # 1 Snorkel Knowledge Development outline

Physics

I. Light, Heat and Sound in Water

A. **Why does water dissipate body heat faster than air does, and at what rate does it do so?**

1. Water absorbs tremendous amounts of heat.

2. Water conducts heat more efficiently than air because water molecules are closer together.

3. Air is a good insulator because it does not conduct heat efficiently.

B. **What effect does water's ability to dissipate heat have on a Snorkeler?**

1. Because of water's high heat capacity, the human body when submerged in water loses heat more than 20 times faster than in still air.

2. This means a snorkeler will become chilled in water at temperatures that would be considered comfortable in air.

C. **What does light do when it passes from air into water, or vice-versa, and how does this affect a snorkeler?**

1. The speed of light depends on the density of the medium it is traveling through – the denser the medium, the slower the speed.

2. When light goes from one medium to another, it changes speed. This causes the light ray to change direction, or "bend."

3. **What is refraction?** This bending of light is referred to as *refraction*.

4. Light coming to a diver's eyes underwater moves through three different media – water, glass and air – refracting each time.

5. To the diver, refraction magnifies objects, making them appear larger/closer. This magnification occurs a ratio of about 4:3 according to their actual and apparent distance. To be magnified by a factor of about 33 percent.

D. **What is visual reversal, and how does it affect a Snorkeler?**

1. Turbidity can partially obscure an object so that it appears hazy, which in air the eye associates with being distant. So, the diver may perceive objects as *farther away* than they actually are.

E. **Why does sound travel faster in water than in air, and how much faster is it in water?**

1. Because sound travels in pressure waves, it travels faster in more dense mediums such as water than in less dense mediums like air.

2. Sound travels slightly more than 4 times faster in water than in air.

F. **How does the speed of sound in water affect hearing?**

1. Your brain determines sound direction by the slight delay between when a sound reaches one ear or the other. In water, the faster speed of sound reduces the delay so much that the brain interprets the sound as reaching both ears at the same time. This makes most sounds seem to come from directly overhead, despite their actual source.

G. **Buoyancy and the Weight of Water?**

1. An object that weighs less than the water it displaces floats and is positively buoyant.

2. An object that weighs exactly the same as the water it displaces neither floats nor sinks. It is called neutrally buoyant and adding or removing weight will make it sink or float.

3. An object that weighs more than the water it displaces will sink and is called negatively buoyant.

H. **Pressure and Water?**

1. Pressure is equal to the force over a unit of area, and may be expressed as kilograms per square centimeter or pounds per square inch.

$$\text{PRESSURE} = \frac{\text{FORCE}}{\text{AREA}}$$

Pressure is equal to the force over a unit of area, and may be expressed as kilograms per square centimeter or pounds per square inch.

1. In diving, the easiest pressure unit to use is the *atmosphere* or *bar. One atmosphere or bar is the pressure* equal to the air pressure at sea level. There's a slight difference between bar and atmospheres, but in diving they're treated as equal.

2. 10 meters/33 feet of sea water exerts 1 atmosphere/bar of pressure.

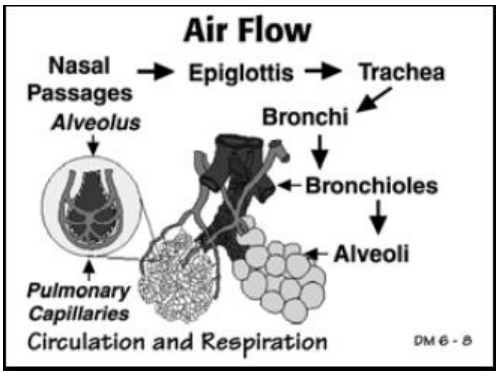
3. 10.3 meters/34 feet of fresh water exerts 1 atmosphere/bar of pressure.

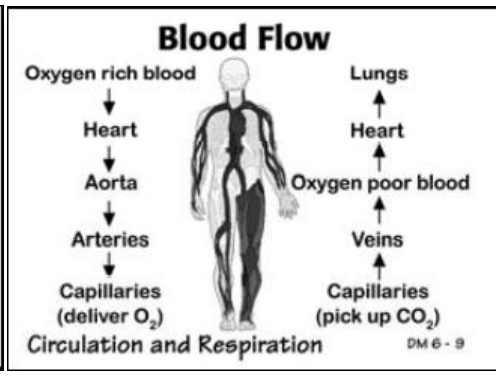
Physiology

What are the primary purposes of the respiratory and circulation system?

1. The primary most urgent purpose of these systems is to supply tissues oxygen and to remove and eliminate waste carbon dioxide.

2. When carbon dioxide rises, they signal the diaphragm, a large muscle below the lungs, to flex downward, causing lower internal pressure.





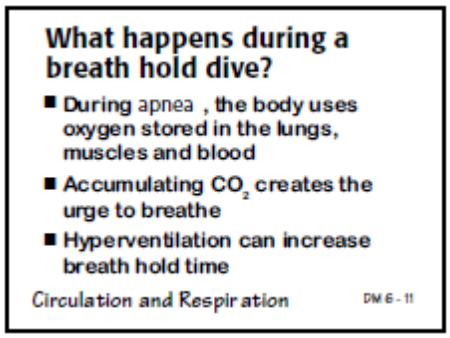
What is the dead air space, and how do you avoid problems caused by it?

1. The portion of tidal volume that plays no part in gas exchange-volume in bronchi, trachea, mouth and sinuses.

2. Equipment increases dead air space (snorkel/regulator)

3. In shallow breathing, dead air space is proportionately high in tidal volume and carbon dioxide level rise, stimulating a higher breathing rate.
   A. if breathing remains shallow, breathing rate will continue to increase.
   B. rapid breathing requires more effort to overcome air resistance and this rasistance and this raises carbon levels further.
   C. May lead to hypercapnia (discussed shortly).

How does the body respond when breathe hold diving, and how can you extend breath-hold time?



1. During apnea (breath holding the circulatory system uses oxygen store in the lung, muscle and blood to supply tissues.

2. Accumulating carbon dioxide creates urges to breathe and eventually it is too great to ignore, forcing the diver to surface and breathe.

3. You can increase breathing hold time by first hyperventilating (breathing deeply and rapidly) three or four times.

What is carotid-sinus reflex, and how do you avoid it?

1. Carotid sinus receptor monitor pressure of arterial blood reaching brain through carotid arteries.

2. Low blood pressure triggers a higher heart rate and high blood pressure triggers a lower heart rate.

3. Receptor interprets pressure from an excessively tight hood or wet suit constringes neck as high blood pressure.

4. The heart rate slows, reducing blood flow to the brain, but pressure remains, causing yet slower heart rate.

5. Avoid by not wearing excessively tight hoods, wet suits or dry suit neck seals.

What is hypercapnia, and how do you avoid it?

1. Hypercapnia is excessive carbon dioxide.

2. It caused by dead air space, skip breathing (holding the breath periodically), shallow rapid breathing, overexertion or a combination these. in rare cases, air supply may be high in carbon dioxide.

3. Causes headache and increased.

4. If involving overexertion, leading to even greater breathing demand-cycle stop all activity and rest.

What are hypocapnia and shallow water black out, and how do you avoid them?

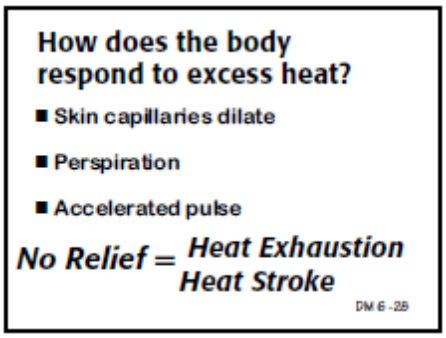
1. Hypocapnia is insufficient carbon dioxide.

2. Too little carbon dioxide may interrupt normal breathing cycle because carbon dioxide stimulates breathing.

3. May cause by hyperventilation due to stress or fright while scuba diving causes light headache.
4. Primarily a concern with breath-hold diving and excessive hyperventilation causes shallow water blackout.

How does the body respond to excess heat?

1. Heat is mainly a problem before or after wearing full wet suits or dry suits in hot weather.
   -Body responds to excess heat, progressively by:
   A. Dilating skin capillaries to promote cooling.
   B. Perspiring to cool skin through evaporation.
   C. Accelerating pulse to circulate blood faster for cooling.
   D. Continuing until snorkeler cools exhausts physiological ability to cool.



What causes heat exhaustion and heat stroke and how do they differ physiologically?

1. Exposure suits interfere with body ability to cool self-perspiration is ineffective in a wet or dry suit.

2. Heat exhaustion-condition in which body works at full capacity to cool.
   -weak, rapid breathing
   - Weak rapid pulse
   - Cool clammy skin
   - Profuse sweating
   - Dehydration

3. Heatstroke-condition in which cooling has failed an emergency medical condition.
   - Pulse strong and rapid
   - No perspiration
   - Skin flushed, hot to the touch
   - Brain damage, system damage or death possible.

How does the body respond to insufficient heat?

1. Water conducts heat 20 times faster than air.

2. Temperatures that are warm in air can lead to excessive heat loss in water.

3. Body responds to heat loss progressive by:
   - Vasoconstriction-reduced blood flow to extremities to reduce heat loss- causes finger/toe numbness.
   - Shivering to generate heat through muscle activity signals a losing battle against the cold.

What are the basic function, organs and structure of the ears and sinuses?

1. Ears-divided into:
   - Outer ear
   - Middle ear
   - Inner ear

What are barotraumas and squeeze?

1. Barotraumas means (pressure injury), and results when a body air space is not equalized ad pressure continues or increases.

2. An un-equalized air space is also called a squeeze.

What are the cause and physiology of mask squeeze?

1. Mask squeeze-caused by failure to equalize mask.

   A. Tissues well, forced un equalized mask by pressure, capillaries in skin and eyes rupture.
   B. Looks very dramatic and severe, but generally clears without complication.

Environment and Rescue

Explain why an unconscious, nonbreathing snorkeler should be resuscitated while being towed to shore even if no pulse is suspected

You can never be fully certain if a pulse does or doesn't exist if it is taken in the water. You might be wearing gloves, or have difficulty in getting to the carotid artery due to the diver's exposure suit. Even if you can check the pulse, you might be unable to detect it due to the decreased sensitivity of your fingers from prolonged immersion in water.

Therefore, you shouldn't even bother checking for a pulse while in the water. Just assume an unconscious, non-breathing diver has a pulse and ventilate.

Concentrate on towing the victim to assistance while providing adequate ventilations. If you determine that you are more than five minutes from the need shore or boat, you to evaluate whether the victim has any movement or other reactions to ventilations.

If the victim shows some response to ventilations, but doesn't completely resume self-sufficient breathing, it still indicates that ventilations are having a positive effect.

You should continue to ventilate during the tow because the person may be able to regain control through your efforts.

If the person regains complete breathing control, you should discontinue ventilations but continue to monitor the diver during the tow.

If you determine that you are more than five minutes from the shore or boat, and the victim has no reaction to ventilations- for example, has no movement and appears extremely pale or blue- you should stop ventilations and tow the victim to shore as quickly as possible.

In this case the victim is probably in cardiac arrest and needs advanced life support which is only available on the shore or boat.

Ventilations only slow down the tow and do not assist the victim who has no heartbeat.

State the compression-to-ventilation ratio for administering one-rescuer CPR.

The rate of compressions must be sufficient to maintain artificial circulation for the victim regardless of what the rescuer is able to do.

This rate is 120 compressions per minute. While a rescuer might be able to sustain a faster rate at first, it's doubtful whether such a rate could be maintained.

Therefore, the rescuer should concentrate on maintaining the 120 compression rate. A good way of judging this is to compress slightly faster than once per second.

When administering one-rescuer CPR, the ratio of compressions to ventilations is **30 compressions followed by 2 ventilations.**

You may see this procedure altered in two-person CPR. However, two-person CPR is considered an advanced life support technique and is not commonly taught in basic first aid courses like Emergency First Response.

Explain what action should be taken with a victim of a near-drowning accident.

You get the victim to shore and he begins to breathe on his own, and shows signs of responsiveness. Several minutes later he appears fully conscious and alert. Embarrassed by the incident, he tells you he feels all right and wants to be taken home.

What action should you take?
Often victims of near drowning appear to recover only to be found dead a few hours later. This phenomenon has been termed "secondary drowning" and requires an understanding of the physiology of the lungs.

The lungs contain a substance referred to as a surfactant.
This surfactant keeps the tiny airways of the lungs from collapsing; if they do collapse, it keeps them from sticking together.
When a person is involved in a near-drowning accident, and they inhale even a slight amount of water, some of this surfactant can be diluted or washed away.

Once the surfactant is removed the tiny airways can collapse, remain closed and fill with fluid (edema).

This is a progressive disorder taking hours to manifest itself as a problem.

The only way to deal with this condition is under medical supervision.

As a result, anyone involved in a near-drowning accident must be hospitalized even if they apparently recover at the scene and “feel fine.”

common signs/symptoms of marine life injuries.

a. Loss of consciousness, weakness and nausea
b. Mental confusion
c. Spreading numbness
d. Paralysis
e. Local swelling, inflammation or welts

What are the recommended first aid measures for wounds?

Resulting from venomous marine life? Often, even those trained in first aid will think in terms of applying ice in the event of an injury. This is precisely what should not be done in the case of wounds resulting from venomous marine life. In this case, after carefully removing any foreign matter, the area should be soaked in hot water (43° to 48°C/110° to 120° F) for at least 30 to90 minutes. Try to keep the victim positioned so that the wound is below the level of his heart. Finally, treat the victim for shock.

Explain how tides are caused.

Tides are caused by the gravitational influence of the **sun** and the **moon**, with the **moon** having the greater effect. The moon has the greater effect because it is so much closer to the earth than the sun.

Given the nature of the circulation of major ocean currents (Coriolis Effect), state the direction of flow for such currents in relation to the coastline of any continent.

1. The major oceanic current off the southwest coast of Africa flows in a **south** to **north** direction. The southwest coast of Africa is in the southern hemisphere. Therefore, the major ocean currents flow in a counter-clockwise motion. This would bring cold polar water up from Antarctica northward along the coast.

2. The major oceanic current off the coast of Europe flows in a **north** to **south** direction. Europe is in the northern hemisphere, and its coastline faces west. Therefore, as the major ocean currents flow in a clockwise motion, the currents flow from north to south.

What forces are responsible for currents?

1. From a marine science perspective, currents are a complex topic. From a dive professional’s point of view, there are a few basic concepts you need to understand including:

   a. Large, global currents are caused primarily by the influence of surface winds that consistently blow over large areas, moving significant volumes of water horizontally across the oceans.
   b. The Earth’s rotation also affects the major ocean currents. In the northern hemisphere, major currents deflect to the right and in the southern hemisphere to the left.

c. Currents occur in oceans, but also in seas, large lakes and smaller water bodies, to some extent.

d. Changing tides can cause local currents in and out of bays, rivers, harbors and inlets.

e. Waves cause local currents.

• A longshore current occurs where the waves approach the shore at a slight angle and push water down the shoreline.

• A rip current occurs when waves push water over a long obstruction such as a sand bar or reef. The water can't flow out through the obstruction, so it funnels back to see where there is an opening.

How do you recognize a current and plan a snorkel tour when there is a Current?

1. You recognize a longshore current by observing water generally moving down the coast, pushed by waves approaching the shore at an angle and assisted by the prevailing wind direction.
   a. To snorkel in a longshore current, you need to be prepared to either walk back up the beach to your start point at the end of the snorkel, or leave a vehicle at your planned exit point so you can snorkel back.

2. The best way to plan a snorkel where tidal currents exist is to first know the expected time of high and low tides at your snorkel site. We'll discuss this in more detail next.

3. You can usually recognize a rip current as a line of turbid, foamy water moving away from shore. It may disrupt the waves where it rushes out to sea.
   a. You want to avoid a strong rip current that will carry snorkeler too far off shore. If one exists, it may be best to go to another snorkel site.

   b. With a mild rip current, you may be able to carefully choose the entry and exit point to avoid it.

4. When boat snorkeling, you can recognize the current direction by noticing the way the boat sits on the mooring or anchor.
   a. If the current is mild, start the snorkel into the current.

   b. If the current is strong, you may want to move to a more protected snorkel site or organize the snorkel as a drift snorkel.

5. Most drift snorkeling takes place from a boat in offshore currents.
   a. In areas where drift snorkeling is popular, currents can vary in strength, but generally are consistent in direction.

   b. Always verify the direction and strength and plan the snorkel to follow drift snorkeling procedures.

What causes the tides, and what affects the range of tides in an area?

1. Tidal movement results from the gravitational interaction of the earth, moon and sun, which creates two water bulges, or waves, on opposite sides of the earth.
    a. As the relative positions of the sun and moon change, the bulge rotates around the earth.

    b. As a coastline rotates into the bulge, the tide rises. As it rotates out, the tide falls.

2. Tide duration, number and range depend on the relative position of the earth, moon and sun, the shape and depth of the specific ocean basin, and the local topographical features.
    a. Some places have a single high and low tide daily. Other places have two roughly equal high and low tides, and still other have mixed tides where there are two unequal high and low tides daily.

    b. Because the moon has about twice the influence on tides as the sun, the difference between high and low tides changes throughout the month based on the phase of the moon.

    c. Large, wide ocean basins tend to have a smaller tidal range than narrow, shallow basins.

What is a wave, and what disturbing forces cause waves?

1. A wave is the transmission of energy through water.
    a. As energy moves through water, the water moves back and forth or rotates, but then returns to its original position.

    b. For example, when a stone drops into water, waves ripple away from the splash. However, the water particles do not move away, only the energy moves as a series of waves away from the disturbance.

2. It is disturbing forces, like a stone entering the water, that create waves. The intensity and duration of a disturbing force helps determine the wave size and characteristics.
    a. Wind is the most common disturbing force that causes ocean waves, but other events such as seismic activity, undersea landslides and volcanoes can also cause waves.

3. Restoring forces, such as gravity and surface tension, attempt to resist ocean wave formation.
