

Marine Biology

Worksheet III

Selected Answers

Fish, Reptiles, Birds, and Mammals

3. Define the following terms:

- a. **Spiracle:** The spiracle is a vestigial gill slit found in Chondrichthyes. In sharks it is used to provide oxygenated blood directly to the eye and brain through a separate blood vessel. In Skates and rays it is large and more developed and is used to actively pump water over the gills while the animal is buried in the sand.
- j. **Rostrum:** The “nose” of the shark. The part of the face in front of the mouth.
- k. **Nictitating membrane:** A thin layer of tissue that can be drawn across the eye in sharks, reptiles, birds, and a few mammals. It acts as a third eyelid that protects and moistens the eye.



Nictitating membrane of a chicken

6. How do sharks prevent osmotic loss of water in a marine environment?

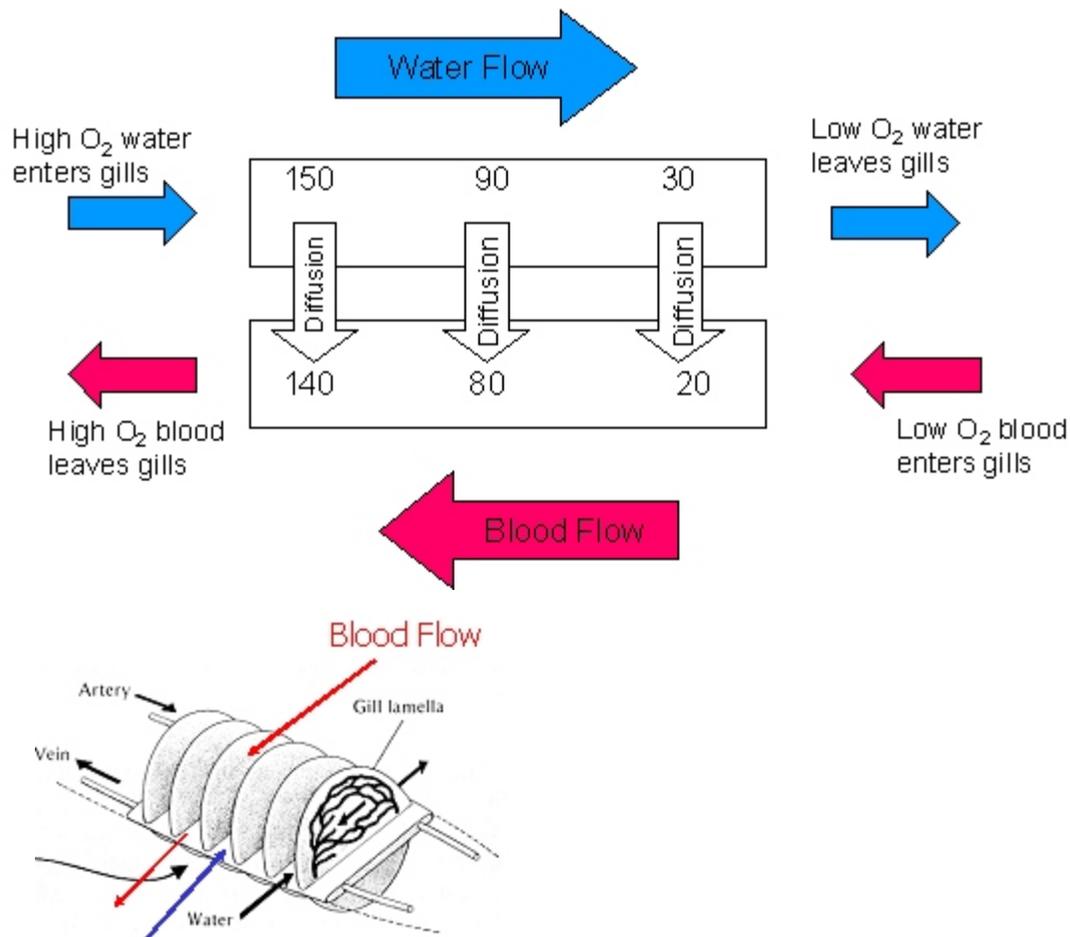
In contrast to bony fishes, sharks are generally isosmotic to sea water. This is because they maintain high blood levels of urea and trimethylamine N-oxide (TMAO). When a shark dies the urea is broken down into ammonia. Thus a dead shark will gradually start to smell like ammonia.

8. What is the largest shark and what does it eat?

The largest shark is the whale shark. (Up to 60 feet). The second largest shark is the basking shark (Up to 50 feet). Both are filter feeders that feed on plankton.

Why would you expect the largest sharks on the planet to be plankton feeder? (Review what you know about the pyramid of biomass to answer this!)

10. Complete the following diagram and explain why the countercurrent system increases the efficiency of oxygen from the water to the blood in fish gills.



Blood and water flow through the gills in opposite directions. This is called countercurrent flow. This enables diffusion of oxygen from the water into the blood across the entire gill surface. The most highly oxygenated blood which is leaving the gills is still able to absorb oxygen from the water. This is because the mostly highly oxygenated blood is flowing next to water that is just entering the gills.

As water moves across the gill surface oxygen is removed from it. Thus water leaving the gills is low in oxygen. This low oxygen water still has more oxygen than blood entering the gills so diffusion of oxygen from the water to the blood still occurs as water is leaving the gills.

11. Define the following terms:

B. Cryptic coloration

A type of coloration that enables an animal to blend in with its environment.

D. Anadromous fish:

Fish like salmon and the lamprey that spend part of their life cycles in fresh water and part of their life cycles in sea water.

12. Give an example of:

A. A fish with chromatophores - Halibut and other flat fish.

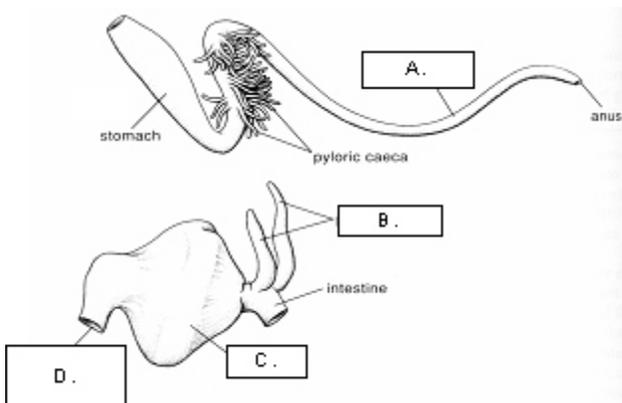
B. A fast swimming fish - Tuna, swordfish, marlin

C. A filter feeding fish - Anchovy, sardine

D. A herbivorous fish - Parrot fish

E. An anadromous fish - Salmon, lamprey

14. Name structures A - D and list their functions:



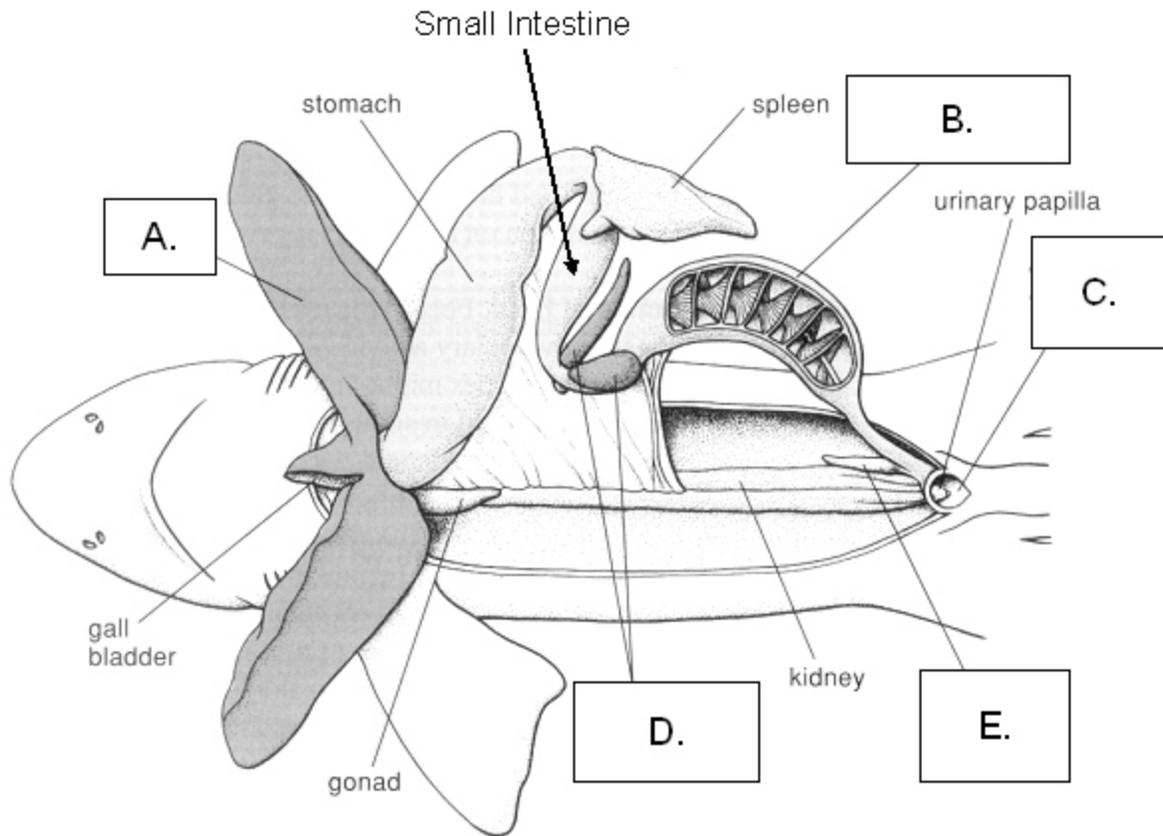
A. Intestine: Digestion and absorption of nutrients.

B. Pyloric caeca: These are blind out-pockets of the first part of the intestine that function to increase the surface area of the gut for absorption. The pyloric caeca function in both digestion, they secrete digestive enzymes, and nutrient absorption. They also have been found to function in osmoregulation in salmon.

C. Stomach: The stomach is primarily a storage organ

D. Esophagus: Transports food to the stomach

15. Name structures A - E and list their functions:



Structure	Function
A. Liver	Detoxifies poisons, makes bile, and stores glycogen. In sharks the liver is extremely oily and functions in buoyancy.
B. Intestine (Ileum)	The intestine of carnivores such as a shark is very short. The spiral valve inside the ileum increases the surface area for nutrient absorption and slows the passage of material through the shark's short intestine.
C. Cloacal opening	The cloaca is a common passageway for feces, urine, sperm in males, and eggs in females.
D. Rectal gland	The rectal gland concentrates and secretes excess salts.

16. Define the following terms:

- A. Artery: Transports blood away from the heart
- B. Vein Transports blood toward the heart
- C. Capillary A microscopic blood vessel that is only one cell thick. The diameter is so small that blood cells move through this vessel one at a time. This enables nutrients and oxygen to diffuse across the walls of the capillaries to the tissues. Wastes from the tissues can diffuse across the wall of the capillaries into the blood so that the blood can carry wastes such as carbon dioxide away from the tissues.
- D. Amniotic egg : A waterproof egg. The eggs of reptiles and birds are examples of amniotic eggs.
- E. Internal fertilization: When the egg is fertilized inside the body of the female. Mammals, birds, and reptiles have internal fertilization.

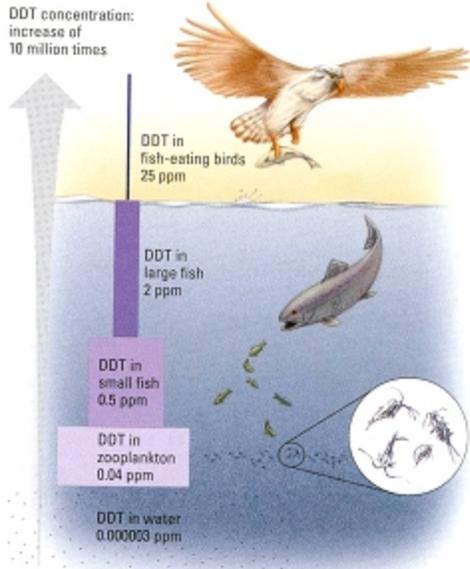
Most fish have external fertilization. This means that the egg is fertilized outside the body of the female. Sharks are an exception to this. A male shark has **claspers** that are inserted into the cloaca of a female. The sperm travels along a groove in the clasper and is deposited inside the body of the female enabling internal fertilization

19. Metabolism of proteins results in the production of nitrogenous wastes. What are the primary nitrogenous waste produced in:

- A. Fishes: Ammonia
 - B. Birds: Uric acid
 - C. Reptiles: Uric acid
 - D. Mammals: Urea
- Sharks also excrete urea**

26. What does the term *Biological Magnification* mean?

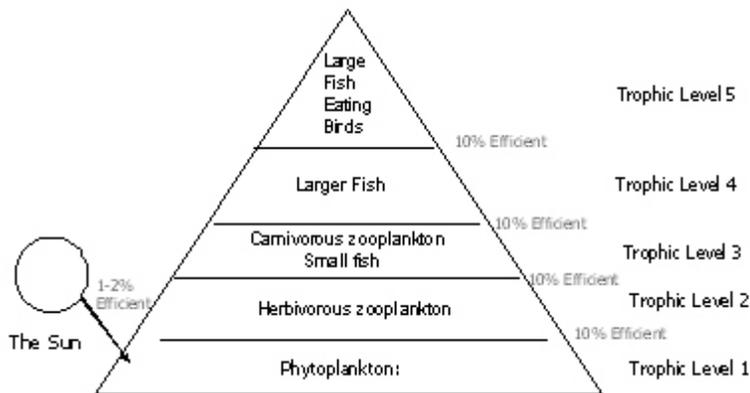
Biological Magnification



Biological Magnification - DDT

- .000003 ppm runoff
- .04 ppm zooplankton
- .5 ppm minnows
- 2.0 ppm needlefish
- 25.0 ppm birds
- Note
 - 1 ppm = 1 inch in 16 miles
 - 1 ppm = 1 minute in 1.9 years
 - 1 ppm = 1 pound in 500 tons
 - 1 ppm = 1 cent in \$10,000.00

Trophic Levels



Biological magnification is when fat soluble toxic chemicals become more concentrated as you move up the food chain or as you move to higher trophic levels.

Look at the top diagram. Note that the concentration of DDT is very low in the water and in zooplankton. However, the levels of DDT are very high in fish eating birds. This is because DDT is fat soluble and cannot be eliminated in the urine. Once it is ingested it is stored in the fatty

tissues of animals. Small fish eat zooplankton. They ingest a dose of DDT with every zooplanktonic organism that they eat. Thus small fish have higher concentrations of DDT than zooplankton. Large fish eat small fish. Every time they consume a small fish they get a dose of DDT. Large fish eating birds eat large fish. Large fish have high concentrations of DDT in their tissues. Thus large fish eating birds get a large dose of DDT each time they feed. Thus the animal at the highest trophic level has the highest levels of DDT in its tissues!

28. What is the effect of high concentration of DDT in the tissues of bald eagles, brown pelicans, and ospreys? Why do these species of birds have such high concentrations of DDT in their tissues compared to a house sparrow?

DDT interferes with calcium metabolism in birds. It causes egg shell thinning. When a bird sits on its eggs in the nest, the eggs crack. Thus no offspring are produced by birds with high levels of DDT in their tissues. The brown pelican, bald eagle, and osprey almost went extinct because of this.

The house sparrow is an herbivore, it eats seeds. It feeds at low trophic levels thus it does not concentrate high levels of DDT in its tissues.

32. What are some adaptations found in marine mammals to reduce heat loss?

Blubber: Whales, seals, sea lions

Dense water-proof fur: Sea Otter

Huge size: This results in a decreased amount of surface area exposed to cold water in proportion to volume: Whales

33. What are “The Bends” and what are some of the behaviors or adaptations in diving marine mammals to prevent “The Bends”?

“The Bends” is a condition when an animal gets nitrogen bubbles in its blood stream. When the body is exposed to decreased pressure during an ascent to the surface, gases come out of solution. Normally the gases that come out of solution are exhaled. If a gas comes out of solution too quickly from a rapid ascent to the surface bubbles form inside the body and are unable to leave through the lungs. (This is similar to opening a bottle of champagne. When the cork is removed, the pressure inside the bottle decreases rapidly, and bubbles form). This caused joint pain, sensory system failure, paralysis, and death.

34. What is *The Diving Reflex*?

Step 1: **Diving Bradycardia:** A slowing of the heart rate. The heart rate of a northern elephant seal decreased from about 85 beats per minute to 12 beats per minute during an extended dive. This reduces the amount of oxygen needed by the body.

Step 2: Peripheral vasoconstriction. Blood is shut off to the extremities and non-vital organs during deep dives. Since aquatic mammals have 25-30% of their oxygen stored in their muscles they can keep working long after blood flow is shut off.

35. Explain adaptations found in diving mammals, related to the words listed below, that enable them to stay under water for long periods of time.

A. Blood cells (Be specific): Diving marine mammals have a higher volume of blood and a greater number of red blood cells than non-diving mammals. Red blood cells are the cell in the blood that carry oxygen. The more red blood cells and the more blood the animal has the more oxygen it can store in its blood.

The Weddell seal has twice the volume of blood per pound as humans. It can store up to four liters of blood in its spleen. The entire volume of blood found in a human is 4 - 6 liters. Thus the Weddell seal can store as much blood in its spleen as a small person has in their entire body.

B. Hemoglobin: Diving marine mammals has higher levels of hemoglobin in their blood than non-diving mammals. Hemoglobin is the oxygen carrying pigment found in red blood cells. The more hemoglobin an animal has the more oxygen the blood carries.

C. Myoglobin: Myoglobin is the red pigment in muscle cell. It is the red "juice" that oozes out of a medium rare steak. Myoglobin stores oxygen and has a higher affinity for oxygen than hemoglobin. When the blood passes through the muscles myoglobin grabs oxygen from hemoglobin. Marine mammals have very high levels of myoglobin in their muscle tissue. (3 - 10X more than non-diving mammals). This allows them to store lots of oxygen in their muscles.

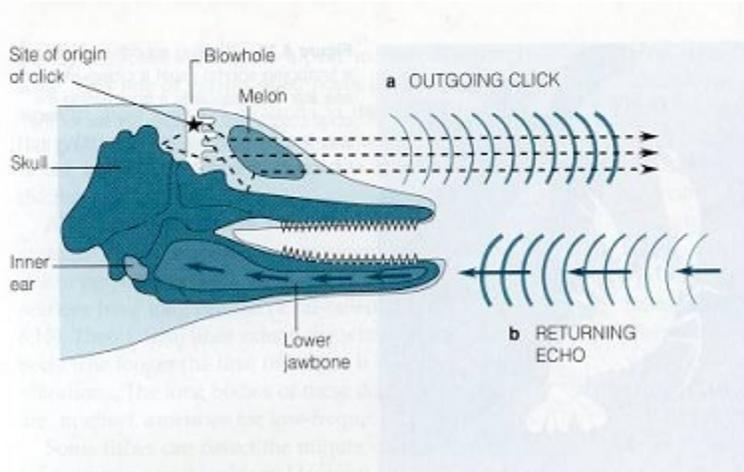
D. The ribs of Odontoceti cetaceans: The ribs of toothed whales collapse during a dive. This forces oxygen out of the lungs and prevents nitrogen from entering the blood from the lungs. This helps the animal prevent decompression sickness or "the bends".

E. The spleen of the Weddell Seal: The Weddell seal has twice the volume of blood per pound as humans. It can store up to four liters of blood in its spleen. The entire volume of blood found in a human is 4 - 6 liters. Thus the Weddell seal can store as much blood in its spleen as a small person has in their entire body

F: Oxygen exchange in the lungs: Marine mammals have very efficient exchange of oxygen between the blood and the lungs. 90% of the oxygen in each breath enters the blood in diving marine mammals. In humans, only 20% of the oxygen in each breath ends up in the blood.

36. Explain the process of echolocation in dolphins.

Clicks emerge from the dolphins forehead. The bony surface of the forehead and the melon act as reflector and lens, respectively. The jaw transmits incoming sounds to the ear.



The clicks are created by squeezing air through the nasal passages. These clicks then bounce off the forehead and are directed through the melon.

The melon of a dolphin directs the sound in a specific direction.

An animal that echo-locates creates a sound that leaves the animal, moves through the water, and hits an object. When the sound hits an object it bounces off of it and creates an "echo". The animal that emitted the sound is able to sense the returning echo. The animal can detect how far the object is by how long it takes for the echo to return. The higher the sound frequency the more detail the animal can interpret in terms of distance and size of the object that creates the echo.

37. Describe the difference between the intestine of herbivores and carnivores.

Herbivores have very long intestines since they ingest a lot of indigestible material. Carnivores have very short intestines. (Think of the intestine of a shark). Omnivores, which eat both meat and plant material, have intestines of intermediate length.