Animal Physiology
Practice Exam I

1. How does the elasticity of the arteries affect exchange at the capillaries? (8)

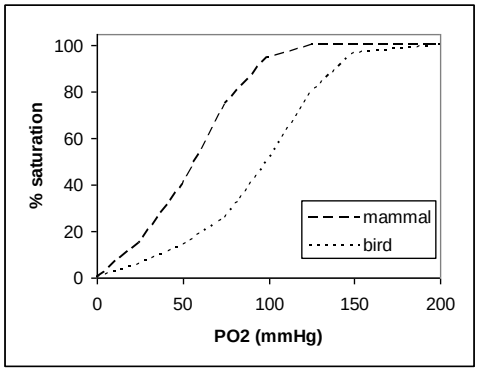
2. When you stand up for a long period of time, leakage from capillaries in your feet can cause swelling. Why do they leak more when you stand up? (8)

3. When you do a lot of endurance exercise, your body responds by adding more capillary beds per arterial branch. This shortens the distance that oxygen must diffuse to reach any muscle cell. It also means that blood will move more slowly through each capillary.
   A) Why will the blood move more slowly? (4)
   B) Is this a good thing, or a bad thing? Explain. (4)

4. If you want to shunt blood away from the gut, is it more effective to constrict the arterioles leading to the capillary beds of the gut, or the major arteries leading to those arterioles, or does it not make a difference? Explain. (8)

5. Why would a puncture wound in the chest wall make breathing difficult for mammals? (8)

6. Consider the following two oxygen dissociation curves.
   A) Describe the functional significance of the differences between the two curves. (4)
   B) One of the curves was for a bird, and one was for a mammal. You could hypothesize that the bird's curve is an adaptation to take advantage of its unidirectional flow and corresponding lack of a residual volume.
   - Explain what a residual volume is and why having a residual volume is a disadvantage. (4)
   - Explain why the birds curve is better suited to their system, given the lack of a residual volume. (4)



7. Massive fluid loss, as during excessive sweating and heat stroke, can cause low blood pressure.
   A) How does this cause low blood pressure? (4)
   B) Why is low blood pressure bad? (4)
   C) List two ways (short of replacing lost fluids) the body responds to low blood pressure. (4)

8. Whales and water snakes can both spend large amounts of time underwater without using their lungs. Given their huge difference in size, which do you think is more likely to supplement its oxygen supply by breathing through its skin? Explain. (8)

9. Keeping hemoglobin in cells rather than loose in the plasma has a number of important consequences.
   A) Explain what would happen to fluid exchange across the capillary membrane if all that protein was loose in the plasma rather than confined to cells. (4)
   B) List two features of the environment within the cell that affect hemoglobin's function. (4)

10. In some animals, when the arterial blood gives up oxygen to active cells, it's possible for the oxygen pressure in the muscle to rise from 10 to 95 mmHg, while the oxygen pressure in the plasma may only fall from 100 to 95 mmHg. Explain how this can happen. (8)

11. Compare the carbon dioxide content of water and air in general terms (you don't need numbers). Explain why there is a difference. (8)

Principles of Physiology

1. Why is surfactant necessary for lung function? (10)

2. A) Active muscle can extract more oxygen from the blood than inactive muscle. Part of this is because the oxygen pressure in the active muscle is much lower. Explain how this affects oxygen delivery, with reference to an oxygen dissociation curve (sketch a curve) (6)

B) The metabolic products of aerobic and anaerobic metabolism can also affect oxygen delivery. Discuss how *two* metabolic products or byproducts affect oxygen delivery. (4)

3. A) Capillaries are very small and have thin walls. How come they don't rupture due to the large pressures they see? (6)

B) Why is rupturing not a problem for veins? (4)

4. Many animals respond to low oxygen environments by producing more red blood cells (thus more hemoglobin to carry O_2).

A) One side effect of this is high blood pressure. Why would this occur? (6)

B) Another possible response to low oxygen is to adjust the conditions inside red blood cells so that hemoglobin has a higher oxygen affinity. What is the drawback to this? (4)

5. A) Suppose you measure the diameter of the major arteries in a number of species and find that more active animals have wider aortas. A colleague suggests to you that this would significantly decrease vascular resistance, thus there will be greater blood flow and oxygen delivery. In reality, it wouldn't change the resistance of the circulatory system much. Why? (4)

B) Even if a wider aorta doesn't noticeably affect the volume/time of blood passing to the tissues, it may cause slower blood velocities in the aorta. Explain. (4)

C) Will that affect blood velocity elsewhere? (2)

6. Some insects can hold their breath for hours. An adaptation to allow this is that they have good buffering capacity in their blood. This means that they have molecules that bind to H+, so extra H+ can't change the pH. How would this affect the ability of an insect to hold its breath? (8)

7. When platelets run into the exposed connective tissue of a ruptured vessel, they do three things. What are two of those things and what effect do they have? (8)

8. A) People who stand a lot without moving much, such as cashiers, are prone to varicose veins. In this situation, the veins of the lower leg become so distended that the valves don't come together properly. Explain why this is more common in people who spend a lot of time on their feet. (4)

B) Why does activity prevent this? (4)

9. A) When we sprint, pumping air in and out of our lungs can become a substantial energy cost. For fish, moving water across their gills when they are sprinting is no more difficult than when they swim easily. Explain why this is true. (4)

B) You would normally predict that moving water across the gills would be more difficult than moving air through the lungs. Why? (4)

10. Describe how you could measure the plasma volume of an animal. (10)

Practice exam III

1) Choose either smooth muscle or cardiac muscle and describe two ways the muscle's performance or behavior differs from that of skeletal muscle. Briefly describe the cellular basis for these differences. (8)

2) How are movements of the diaphragm and chest wall physically linked to expansion of the lungs? (5)

3) Within the red blood cells, there is an enzyme that speeds the reaction between carbon dioxide and water, and a transport protein that removes one of its main products, the bicarbonate ion (HCO_3^-). Considering the full equation for this reaction, how do these adaptations affect oxygen delivery? (6)

4) A) Even after air has been in our lungs for a while, it never becomes fully deoxygenated. In fact, the oxygen pressure doesn't drop much below 100 mmHg. How come the blood cannot extract all the oxygen? (3)

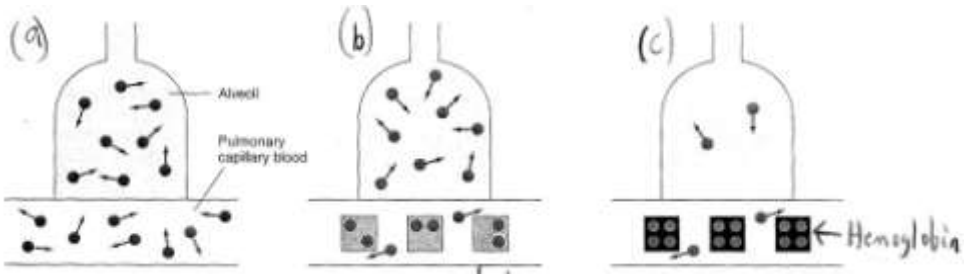
B) With unidirectional flow, fish can arrange the blood flow in their gills so that they can extract all the oxygen from the water they inhale. Explain how. (6)

C) List one other advantage to using unidirectional flow. (2)

5) Consider the following diagram – taken from a standard human physiology text (amazingly enough!). There are two serious misrepresentations in this figure.

A) Compare the concentration of oxygen molecules (moving dots) in the lungs and plasma of part (a). This is an inaccurate representation of the equilibrium. Explain why. (4)

B) Compare the ratio of oxygen in the plasma to oxygen bound to hemoglobin (squares) in parts (b) and (c). Is this possible? Refer to an oxygen equilibrium curve. (6)



6) Vessel damage triggers the release of factors that simultaneously activate plasminogen and prothrombin.

A) How do each of these enzymes affect fibrinogen, or the product of fibrinogen activity? (6)

B) Why do the relative rates of activity of these enzymes matter? (4)

7) A) Is the combined flow (volume/time) through all the capillaries greater than, equal to, or less than the flow through the main artery from the heart (the aorta)? (2)

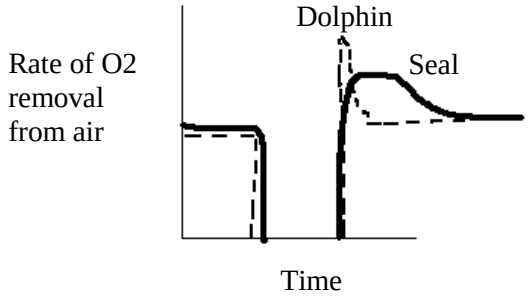
B) How does the fact that capillaries are very small affect the **flow** (volume/time)? Explain in one sentence. (4)

C) How would increasing the number of capillaries affect blood **velocity**? Explain in one sentence. (4)

8) Suppose you measured the rate of oxygen removal from air by a seal and a dolphin when diving, and got the following data.

A) Which animal maintains a higher rate of oxygen use while diving? How can you tell? (4)

B) From these data, can you determine which animal is likely to have a higher hemoglobin concentration in their blood? Explain. (6)



9) A) Athletes typically have lower resting heart rates than non-athletes. Does this necessarily mean that they have a lower oxygen delivery to their tissues at rest? Explain in one sentence. (4)

B) Suppose someone argued to you that high blood pressure was good because it led to increased blood flow. This is a flawed argument though; high blood pressure is not necessarily associated with increased blood flow. Explain in one sentence. (4)

10) Fick's principle considers the major factors that affect the amount of oxygen delivered by the blood. You can do almost exactly the same kind of analysis for the amount of oxygen delivered by the lungs using very similar variables.

A) Explain how, using the approach we used in class to derive Fick's principle. In other words, using a format analogous to Fick's equation, identify the measurable components of breathing that determine the amount of oxygen delivered by the lungs. (6)

B) How does the amount of oxygen delivered by the lungs compare to the amount of oxygen delivered to the tissues by the blood? (2)

11) Many animals have a reflex that triggers the heart to beat harder (produce a higher pressure) when they stand up after lying down.

A) Explain why it would be a problem for most animals if they did not have this reflex. (6)

B) Would this reflex be as crucial for very short animals like mice? Explain in one sentence. (3)

12) Large animals tend to have much more complex lungs (in terms of branching to create many more tiny subdivisions) than small animals. Why would this need to be true? (5)