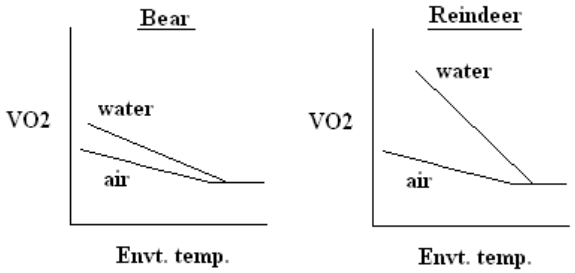
Name: _____ Fall 05 Principles of Physiology Exam III

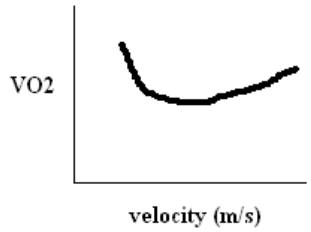
1. List the main avenues for the loss/gain of water and salt from a saltwater fish, including how the fish fights this. (note the direction water/salt moves) (8)

2. Weightlifters sometimes eat protein-rich diets in order to build their muscles. This can be helpful, but it doesn't always work. If you eat a lot of protein on a day that you are building muscles, the high protein diet may help. On the other hand, you can't eat a massive amount of protein one day and count on the extra protein being available all week. The day after the meal, you may have no excess amino acids left from the previous day, even if no protein synthesis occurred on that day. Why would this be true? (8)

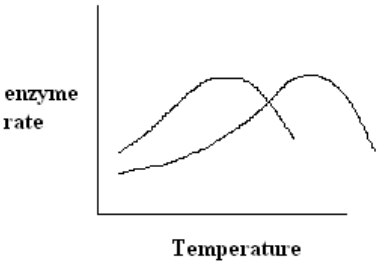
3. The following figure shows the metabolic rate of a small polar bear and a reindeer, both in air and in the water. Assume the animals are roughly the same size. Explain why the air and water curves are different, and why the reindeer's curve for water is different from the bear's. (10)



4. Consider the following graph of metabolic rate for a flying bird.
   A) Is the cost per meter the same at all speeds? (3) (no explanation necessary)
   B) How could you determine the speed at which the bird would stop flying and begin to walk? (5)



5. The following graph shows the relationship between temperature and enzyme activity for a mitochondrial enzyme taken from one species of turtle. Each curve shows the results from an enzyme extracted at one time in the year and then tested at different temperatures in the laboratory. There are two curves, because the test was repeated at two different times of year. Explain the most likely reason why the two curves are different (both the rising and falling regions). Your answer should explain why it's a useful adaptation for turtles. (8)



6. A) Why is fat the preferred method of energy storage in most mammals? (4)
   B) Why is bile important for digestion? (4)

7. Anaerobic symbionts in the guts of ruminants help digest cellulose. These symbionts digest ***and*** metabolize the cellulose first.

A) How can the ruminant get enough energy from the end-products of symbiont metabolism? (4)

B) The ruminants digest some symbionts for protein. Where do the symbionts get protein from, since their diet is primarily cellulose? (4)

8. Freeze tolerant frogs usually trigger ice crystal formation in their extracellular space and break down massive amounts of starch to glucose within the cells. Explain how both of these actions help the animals survive freezing. (10)

9. The ability to absorb sugars from the foods that you eat can vary. Some animals can absorb certain sugars better than others. Also, many animals (humans included) have a sugar absorption capacity that changes from day to day. Specifically, if they eat a lot of carbohydrates, their capacity to absorb sugar increases, but if they go a few days without carbohydrates, they decrease their capacity to absorb it.

A) At the molecular level, what would be the reason you could absorb some sugars and not others? (4)

B) At the molecular level, what would account for changes in absorption capacity? (4)

10. The structure of lipids in the legs of arctic mammals can change as they get further from the body. The net result of this is that, near the body, the lipids tend to be fairly viscous or even solid when tested at room temperature (~20° C). Near the feet, the lipids tend to be fairly fluid when tested at room temperature. Explain the adaptive significance of this, given what you know about conditions inside the limbs of mammals living in very cold environments. (8)

11. People do urine tests for drugs, because most drugs are small molecules that are foreign to the body. Why are they so likely to be present in the urine? (your answer should refer to the major process involved in kidney function, and should address why their size **and** foreignness matters) (8)

12. If the second part of the loop of Henle (the ascending limb) was freely permeable to water, how would that affect kidney function in mammals? (8)

Name: _____ Fall 2001 Physiology Exam III

A) Explain why bile is necessary for digestion of some nutrients. Include in your answer a brief description of how bile works. (8)

B) Why are lipids transported in the blood in the form of lipoproteins? (4)

The symbionts in a ruminant's gut not only digest, but also metabolize cellulose.

A) Why are the end products of this metabolism still useful to the ruminant? (4)

B) The end products of symbiont metabolism place a specific physiological stress on the rumen. What is this and how do ruminants deal with it? (4)

What is one advantage and one disadvantage of using ethanol-based metabolism instead of lactic acid? (8)

How come bears don't "truly" hibernate, and squirrels and smaller animals do? (8)

Horses run much faster than hippos, so their metabolic rate while running is probably higher. Nevertheless, metabolic rate is not the best way to measure how efficiently they transport themselves.

A) Why? (4)

B) What measure, related to metabolic rate, is more informative? (4)

Changing body temperature can kill an organism.

A) What is one way that a decrease of ten degrees or more would be lethal? (4)

B) Suppose the body temperature dropped below zero. What is one reason that such a decrease would be lethal? (be specific as to the cause of death) (4)

C) Describe in detail one way of surviving sub-zero body temperatures. (6)

I don't know if this has been studied, but I would bet that seals and other diving mammals have larger glycogen stores (in their liver and muscles) than non-diving mammals. What is one reason that their glycogen stores would be larger? (6)

If your glycogen (starch) supplies were low, your sprinting performance might be poor. This is probably one reason that it is hard for a distance runner to really sprint to the finish (they've used up a lot of their glycogen). Why would low glycogen supplies affect sprinting? (8)

In heat stroke, people who have been exposed to high environmental temperatures for too long ultimately stop sweating and their body temperature rises rapidly.

A) Why would they stop sweating? The body is made of 70% water, so we know that there is water available. In other words, what is one risk involved in losing more water? (4)

B) As their *body* temperature rises, their metabolic rate will increase. What causes this increase in metabolic rate and why is it dangerous (be specific)? (10)

Adding urea or ammonia to a cow's diet can increase the cow's growth.

A) Explain how this works. (6)

B) How would you test that the urea was incorporated into the structural components of the cow's tissues? (6)

C) Describe two experimental tests that you would do to prove that the protozoan symbionts in the cow's gut were responsible for the above phenomena. (6)

Suppose you wanted to design a diet pill that allowed people to eat a lot of either sugar or fat (choose one) without gaining weight or without adding to their fat stores. This drug could bind to and inactivate a protein. Identify *two* types of protein that you would target. Be as specific as possible. Also, these two proteins should have different effects (ie. don't choose two variants of the same thing). Explain how inactivating these proteins will have the desired effect. (8)

If you had a fever, you may be able to reduce your body temperature by placing a hot pack on the back of your head, so that it warmed the hypothalamus. Why would this reduce your body temperature? (6)

Two of the mechanisms for surviving body temperatures below 0° C are freeze tolerance and antifreeze proteins. Unlike supercooling, both mechanisms allow ice crystals to form. With regards to the ice and not the solute concentration, what do you see as the major differences between the two methods?

Name: _____ Animal Physiology Exam III Fall 2006

1. In diabetes, cells cannot take sugar from the blood to use as a source of energy. This has two main effects: 1) the blood sugar becomes very high because the intestines continue to absorb sugar but the cells of the body do not remove it from the blood, 2) the cells must turn to other sources of energy besides sugar. These two effects lead to the phenomena mentioned in part A and B of this question. (*answer each part in one or two sentences*)

A) One result is that the blood becomes more acidic. Why would this happen? (4)

B) Another result is that sugar usually shows up in the urine. Why does this happen? (4)

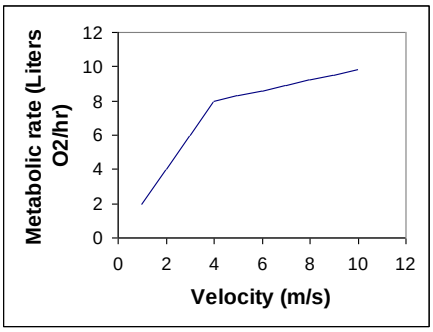
C) If the liver was able to transport the sugar from the blood, you might see an increase in the amount of very

low density lipoproteins (vLDL) released by the liver. Why? (4)

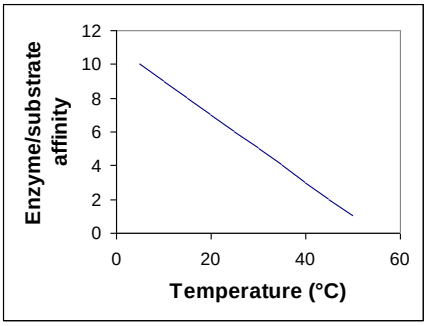
2. A) Describe the process of protein digestion by the stomach and intestine in one or two sentences. (6)
B) Is this more similar to fat digestion or carbohydrate digestion? Explain in one sentence. (4)

3. A) What is special about the symbionts found in the gut of ruminants that allows them to digest cellulose? (4)
B) Ruminants add bicarbonate (HCO_3^-) to the rumen. What would happen to the rate of cellulose digestion if bicarbonate wasn't present? Explain. (4)

4. Consider the following graph showing the metabolic cost of locomotion for an animal.
Is this similar or different from the results you typically see for most animals, and what does it suggest regarding gaits and efficiency? (8)



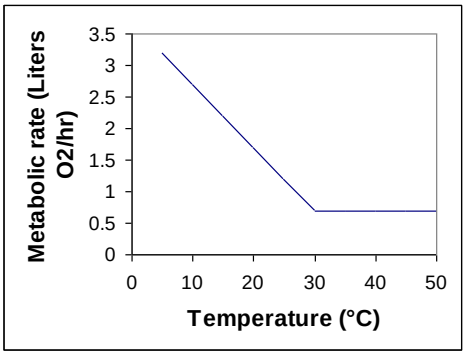
5. Consider the following graph showing the typical relationship between temperature and enzyme-substrate affinity. Ectotherms that live in the Northeast US see warm summer temperatures, but must also be active in the cold temperatures of early spring. Why does this pose a problem, and how might the ectotherm deal with the problem? (be as specific as possible) (8)



6. Northern frogs that freeze and desert frogs that suffer severe dehydration have some similar adaptations to deal with these stresses. Identify one major similarity, and explain why they are similar in this way. (8)

7. Describe how you would experimentally test (with a control) whether or not fever is a useful defense mechanism against infection. (8)

8. Human body temperature is about 37° C. Based on the adjacent graph, we would probably begin to sweat once the environmental temperature reached 30° C or higher.
A) Explain why you would predict that we would begin to sweat at exactly that temperature, being precise and referring to the accompanying graph, heat loss and heat gain. (6)



B) Would it make a difference if the air was the same temperature but it was sunnier? Explain, being specific about modes of heat transfer. (4)

9. Compare the water/salt balance in saltwater fish to a desert mammal such as a rat. What are the major avenues for water and salt loss or gain? (10)

10. How is sugar reabsorption in the kidneys similar to sugar absorption in the small intestine? (6)

11. Suppose you are studying the kidney function of a newly discovered animal. It is a vertebrate, so you might expect that its kidney generally works the way you would expect for most vertebrates, but there may be some differences. To study the kidneys, you inject a known concentration of inulin into the animal's blood. This is a small oligosaccharide that is not recognized by any enzymes or transport proteins in the body.

A) What would it mean if there was no inulin in the urine? (4)

B) What would it mean if the inulin concentration of the urine was 50x greater than the inulin concentration of the blood, but the total solute concentration of the urine was the same as that of the blood? Explain, making direct reference to the action of different parts of the nephron. (8)