***Last** name, First name*_____

Please PRINT neatly _____

Last name ----------first name----------

Score exam 2 (100 pts) _____

NOTE

Exam worth 92 pts
20 pts page 1
20 pts page 2
25 points page 3
27 points page 4
TOTAL = 92

Exam 2

Biology 462

November 14, 2005

Ray Huey / Mary Pat Wenderoth

***Last** name, First name*_____

1. Answer the following questions. (@ 1 point, total = 10 points).

The ____HYPOTHALAMUS_____ is the central T_b sensor in the brain of mammals & lizards.

_ARGENINE PHOSPHATE_is the source ATP used by most *invertebrates* at the beginning of activity.

If VO_2 is 10 watts, and VO_{2max} is 1200 watts, the animal's aerobic scope is ___1190_____ , its factorial scope is _____120_____, and the animal itself is probably _____AN INSECT_____ (name a group of animals).

The *equation* for net radiation exchange between an animal and the environment is _____T^4 skin- T^4 env_____.

The equilibrium body temperature of an ectotherm that is PREDICTED from a biophysical model is called the_____operative environmental temperature_____.

Heat, ATP, and _____lactate_____ are produced by anaerobic glycolysis.

____brown adipose tissue or brown fat____ is the special tissue of neonatal mammals to produce heat.

Leucocytes produce compounds called___ pyrogens____, which change thermoregulatory set-points.

2. Answer both questions (@ 5 points, total = 10 points)

Oxygen debt (what is it? What physiological activities are taking place during the O2 debt)

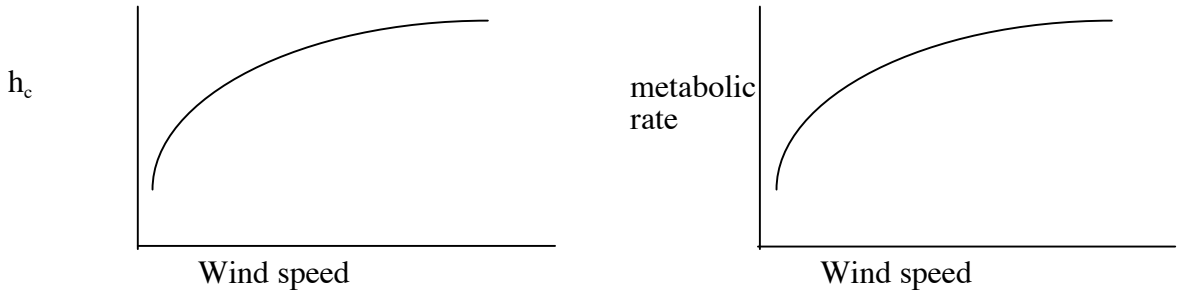
Period when O2 remains high after exercise ceases
Or use of O2 to repay costs of activity

1) resynthesis of glycogen from lactate.
2) resynthesis of creatine phosphate

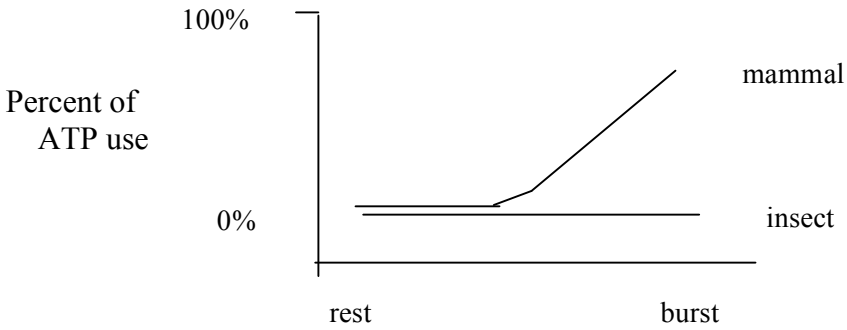
Nutrient insufficiency hypothesis (What does it do? What are the two steps involved, and why are both required?)

Kills fever causing bacteria
Steps
1) increase body temp (Tb), raises metabolism of bacteria
2) decrease free iron levels, a key nutrient for bacterial reproduction
therefore a one-two punch. Increases demand and reduces supply. (Increasing Tb only actually increases growth of bacteria)

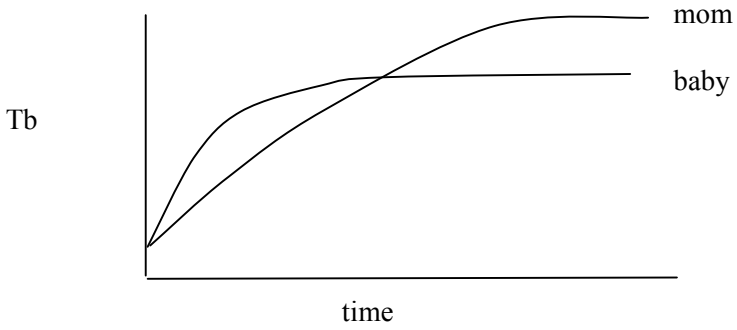
3. Graph how how h_c changes with wind speed and then the ***metabolic rate*** of an endotherm changes as a function of wind speed. Assume that T_a is BELOW the endotherm's thermal neutral zone. 6 points



4. Draw TWO curves indicating the proportion of 1) a mammal's **AND** 2) an insect's ATP use that comes from **anaerobic glycolysis** as a function of activity.*(label the curves).* (6 points)



5. A mother lizard and her baby oversleep and emerge mid-morning from a cold burrow and begin basking in bright sunlight. Plot the T_b both, assuming that both stayed in the sun until reaching their equilibrium T_b. (8 points)



Of course, they would seek shade before reaching their equilibrium T_b.. Assuming that both have the same thermal preferences, which will seek shade sooner. Briefly justify your answer.

__baby____seeks shade sooner because it heats faster (this assumes that its thermal preference is set below the equilibrium Tb. Otherwise, the baby will never seek shade.)

6. What are 3 characteristics of an effective respiratory membrane that will MAXIMIZE the rate of diffusion across that membrane and give an example from a different animal that typifies each..

THIN (T)– skin of planaria, frogs, earthworm, lungs of mammals, etc.—a short diffusion distance will allow a rate rapid of diffusion

Large surface area (A) gills of fish have a lot of evaginations (gill filaments and lamella) that increase surface area.

Provide for a large or at least a constant gradient for gas exchange (P1-P2). Best example is countercurrent flow of water and blood in the fish gill.

Could also mention that respiratory membrane must interface outside world (P2) with inside world (P1) : any reasonable example works for this
[*answer needs to address the variables in the equation for diffusion of gases*
Diffusion rate = surface area (P1-P2)/ thickness]

7. Each of the following physiological parameters is homeostatically maintained by most vertebrates .
Why is it critical for the animal to maintain this physiological parameter?

a) blood temperature	b) blood glucose
Blood temperature will determine temperature of cells (because heat will always move down its gradient) and the temperature of the cells will determine the rate of enzyme reactions- specifically the enzymes of metabolism. [if enzyme reactions slow down than ATP production drops, at high temperatures enzymes could unfold and lose their enzymatic activity]	*Glucose in the blood will diffuse into the cells and provide the substrate for cellular metabolism,* *Glucose + O2 --- CO2 + H2O + ATP + heat* *Low blood glucose levels will lead to decrease in ATP production and cell death.*

8. Size is critical. .As a respiratory physiologist, state why a moth could never grow to be as large as an airplane and still be able to fly(monster moth!).
***Flying requires a large increase in metabolic rate** to supply ATP as rapidly as flight muscle require. To met this demand **oxygen must be delivered to the mitochondria of flight muscles, rapidly**.*
*The **major oxygen delivery system in moths is the tracheal system** [network of tubes that is a conduit of air to each cell] and the **driving force for movement of oxygen through these tubes [from spiracle to cell] is predominately diffusion**. There are some instances of bulk flow of air in tracheal systems but the bulk flow is only an auxillary system of air movement.*
*Because diffusion is the main driving force for oxygen movement and diffusion is slow over large distances as a **moth grew in size, the rate of oxygen diffusion would be too slow to meet the metabolic demands of its cells**.*

9. What is the PO_2 in the hemolymph of a manduca caterpillar found in a laboratory in Hitchcock Hall. Give a value and give your reasoning for selecting this value.

The hemolymph is in contact with the cells of the animals so the PO2 of the hemolymph should be in equilibrium with the PO2 of the cells. The cells of the animal are metabolizing [consuming oxygen] so the PO2 of the cytoplasm of the cells should be considerably lower than the room air [PO2=160mmHg] but higher than the mitochondria. A good estimate is between 20-80 mmHg.

Oxygen does not diffuse out of the tracheal system along its length because the walls are impermeable to gas.

10. What is the driving force for movement of a molecule of oxygen from the spiracle on the outer surface of that caterpillar to a working muscle cell inside the animal.
Partial pressure gradient of oxygen from outside (PO2=160) to cell (PO2= 40mmHg)

What is the driving force for movement of a molecule of oxygen from the mouth of a dog to its lungs.
Atmospheric pressure gradient – outside 760 mmHg inside lung less than 760, about 758 mmHg

11. List 4 factors that would DECREASE the oxygen CONTENT of a body of water. (8 pts)

1.decrease PO2 *2. increase temperature*

3. Increase solute concentration *4. decrease plant life, increase decomposers, increase density of animal life*

-- must state the parameter (i.e. heat, solutes, other) and whether an increase or decrease will cause the decrease in oxygen content. 1 pt for parameter, 1 point for indicating increase or decrease)

12. List 3 factors that make the work of ventilation more costly for a fish than for a dog and BRIEFLY explain why they are more energetically costly. (6 pts—2 each)

1. *Water is more dense (1pt): 1 ml of water is heavier than 1 ml of air, so to move a heavier substance the same distance requires more work, more energy expenditure (1pt)*
2. *water is more viscous—this increases the resistance to movement, to overcome this resistance more energy must be expended by the animal.*
3. water has a lower Oxygen content—therefore fish must move MORE water to get the required oxygen for its metabolism. (V/Q ratio for fish is 15:1 because of low oxygen content of water.)

What physiological/anatomical features help to minimize this cost for the fish. And briefly explain how this feature minimizes the cost. (3pts-- one pt each)

*Gills have a **large surface area** to facilitate gas exchange from a low Oxygen environment.*

*Fish have **unidirectional ventialtion**. Water is heavy and viscous- one way flow minimizes energy expenditure (in tidal ventilation water would move into gills, decelerate, stop and reverse course)*

*Fish have **countercurrent flow of blood** and water which maintains a small but constant gradient along entire length of gill surface thus allow fish to get maximal amount of oxygen from water.*

13. Give a physiological explanation for the shape of the curve marked LUNG on figure 1.13 on the next page. (4 pts.)

*You see O2 uptake from lungs increase during spring and summer months. Would indicate that **metabolic rate of animal increases** due to **mating season, warmer temperatures** (animal is ectotherm) **and rate of O2 uptake via the skin is insufficient** to meet this higher demand **so lungs supplement**.*

14. On graph (a)—on next page what determines the distance between the lines marked air and blood. That is, why are the lines this far apart and not closer together? (2 pts)

*The **thickness of the barrier** (skin) determines how close these two lines can get to each other—the thicker the membrane, the greater the resistance, the slower the rate of diffusion the further apart the lines will be.*

Use graphs on back page--Is the crosscurrent system (d) of birds more or less effective than the countercurrent system (b)of fish—defend your answer by using information depicted on the graph. (4 pts)

*The cross-current system of birds is **LESS effective** than countercurrent. (1 pt)*
The PO2 of media entering gills or lungs is the samae = PO2= 160 yet when you compare the PO2 of the blood leaving the respiratory surface you see that the PO2 of blood leaving gills is greater than the PO2 of blood leaving lungs! So fish got more out of water. (3 pts)