***Last name**, first name (neatly please!)*_____

Biology 462 Midterm I 20 October 2004

IMPORTANT NOTE: IN 2004, WE HAD SEVERAL LECTURES ON TEMPERATURE PRIOR TO THE FIRST EXAM, SO YOU SHOULDN'T BE CONCERNED IF YOU CAN'T ANSWER MANY OF THE QUESTIONS BELOW.

CALCULATORS OF ANY KIND ARE NEITHER NECESSARY NOR ALLOWED.

1. Fill in the blanks. (@ 1 points, total = 20 points).

The low T_b at which the righting response is lost is called_____.

_____was the French scientist who figured out metabolic reactions

One watt is a _____SI unit and is defined as _____.

Animals with variable T_b are often called _____.

_____is the name for dormancy during hot or dry seasons.

Field metabolic rates are often _____times higher than lab rates (give a number).

The primary cause of heat death is probably_____.

If an animal's speed is 30 cm/s at 25°C and is 15 cm/s at 30°C, its Q_{10} is _____.

Mass-specific food intake should scale approximately to the _____power in herbivorous mammals.

Temperature refers to the _____ of a system.

Some animals tolerate being partially frozen, but they restrict freezing to their

_____.

Heat transfer by the movement of warm blood is called _____.

The respiratory exchange ratio helps indicate what an animal is _____.

The mass-specific metabolic rate of brain tissue is high because of the cost of

_____.

The body temperature selected by an ectotherm in a thermal gradient is called its

_____.

A _____experiment is one in which the person gathering data is unaware of the treatment group of the individuals being measured

The warmer the skin of an animal, the _____ the amount of radiation emitted and the _____the average wavelength

_____ is a compound some animals produce in winter to lower their freezing point.

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2. On Experimental Design. (10 points)

Here is an actual experimental design used in a NASA experiment on shuttle astronauts. The scientists measured neuromuscular coordination **before** a shuttle flight, **during** the flight, and again **after** the flight. They were attempting to determine whether coordination was influenced by the flight itself, and whether there were any post-flight effects as well. If you were a reviewer for the NASA grant officers, would you recommend funding "as is" or would you recommend modifying the experimental design? Justify your answer

3. On Metabolism and "Caloric Equivalents" (10 points)

You are the lucky Staff Physiologist on an expedition to Planet X, and your task is to study the physiology of "ergs," a novel type of organism. You study the metabolism of these creatures and find that they metabolize chemical F as a fuel and use gases G1, G2, and G3 as oxidizing agents, which react with F to produce a gas G3 plus STP (a high energy compound that is apparently equivalent to ATP), and some heat. Using a bomb calorimeter, you find tha the reaction for the "oxidation" of 1 mole of F is as follows:

1 *mole* F1 + 2 *liters* G1 + 1 *liter* G2 $\Rightarrow$ 3 *liters* G3 + STP + 60 kJ

what are the energy equivalents (="caloric" equivalents) for the gases G1, G2, and G3 (specify the units and show how you arrived at your answer!) @ 2 points

G1 =

G2 =

G3 =

Assume that you also find that these beasts can alternatively metabolize a different fuel (F2), and here is the reaction. Which gas or gases would be the most reliable index of metabolic rate in this creatures? Briefly your answer (4 points)

1 mole F2 + 5 *liters* G1 + 5 *liters* G2 $\Rightarrow$ 5 *liters* G3 + STP + 100 kJ

4. Explain this physiological paradox (5 points)

A 10°C rise in Tb increases the average kinetic energy of the system by only 2 or 3 %, yet rates of physiological reactions usually double or triple. Why are physiological rates so sensitive to temperature? A graphical answer (properly labeled) will suffice.

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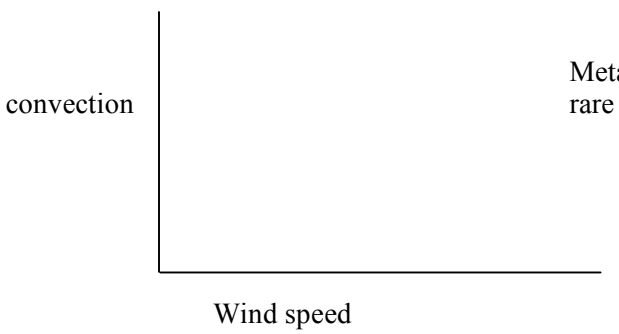
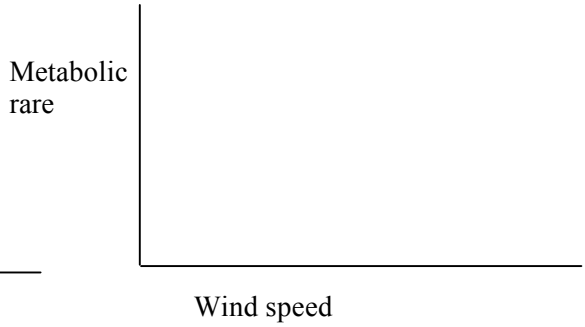
5) Briefly describe three DIFFERENT ways that temperature experienced during development is important to animals

Imagine that the resting metabolic rate of salamanders scales as 0.3 $M^{.75}$ and of mammals as 4.3 $M^{.76}$. What is the resting and mass-specific metabolic rate of a 1 g salamander and a 1 g mammal?

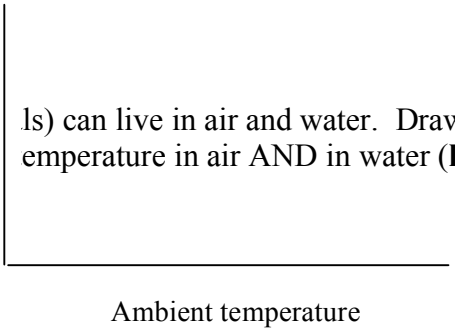
Salamander rest = mass-specific =
Mammal rest = mass-specific =

3. Draw a graph (left) showing how convection changes with wind speed. Then show how 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. @ 4 points

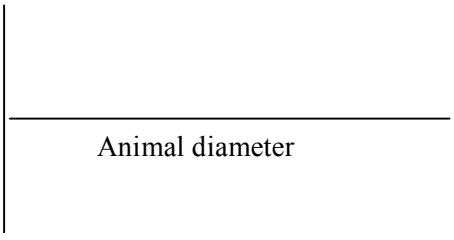




4. Some mam metabolic rate ls) can live in air and water. Draw how the metabolic rate of a seal is affecte emperature in air AND in water (**label** both curves). (6 points)



5. Plot how th h_c coefficient changes as a function of animal diameter. (4 points)



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Experimental design (5 points). Here is the actual experimental design used for a NASA experiment on shuttle astronauts. Doctors measured neuromuscular coordination BEFORE a shuttle flight, DURING the flight, and immediately AFTER the astronauts returned to earth. The doctors were attempting to determine whether coordination was influenced by space flight. If you were a reviewer for a NASA granting agency, would you (& if so, how?) recommend funding or would you recommend modifying the experimental design? Justify your answer.

7. Suppose a baby lizard (2 g), which started out with a body temperature of 15°C, started basking on a rock *in a desert*. You measured various avenues of heat gain an loss. 8 points

Radiation	+ 5 calories
Conduction	- 1 calories
Convection	- 3 calories
Metabolism	+2 calories
Evaporation	-2 calories

What would be its new temperature at equilibrium? °C

If a frog of the same size and color joined the lizard on the rock, would its equilibrium temperature be higher, the same, or lower than the lizard? Briefly justify your answer.

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9. Heat flux and thermoregulation (20 points total)

Metabolic heat production increases directly with a mammal's activity level, and becomes a challenge to its heat balance. Write down a basic heat balance equation showing the main **sources** of heat gain (e.g., metabolism) or heat loss. For each indicate whether the flux is ("+") (heat gain only), "-" (heat loss only), OR ("±") (either heat gain OR loss). (2 pts.)

With reference to the above equation, name TWO different ways a terrestrial mammal can use to balance its high metabolic heat production during activity and thus maintain a constant body temperature. (4 pts).

Is heat production from activity *less* likely (or *more* likely) to be a thermoregulatory problem for an ectotherm (working at 4X its resting metabolic rate) than for an endotherm of equivalent size (also working at 4X its resting rate). (4 points)

Consider a proposal to have military recruits undergo basic training (high activity levels) in the southern US during summer, when air temperature and humidity would be high. If you were a physiologist providing advice to the military, would you support or fight this proposal? Explain your position. If spot a physiological concern with this proposal, suggest some modification of the training routine that might reduce that concern. (6 points)

Flying birds -- and long-distance runners -- often allow their body temperature to increase a few degrees. Why might this be advantageous to them in terms of water balance? (4 points)

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