Name (last, first)________________________________

Zoology 462 19 October 2005

Midterm Exam 1

Please write your name at the top of each page (one bonus point if you do this!).
CALCULATORS ARE NEITHER NECESSARY NOR ALLOWED.
1. Fill in the blanks (answer all @ 1 point, Σ= 18).

critical thermal maximum_ is the upper temperature at which the righting response is lost.
Repeatability (or "precision)_ is the important experimental concept that refers to the reliability of measurements.

Measurement of heat produced by an animal is called direct calorimetry_.

600 joules per minute is the same as __10_ watts.

The ability to remain unfrozen at T_b below the freezing point is called _supercooling

Claude Bernard___ conceived the concept of homeostasis

If resting metabolic rate scales as $7 M^{3/4}$ for a group, the allometric equation for field metabolic rate for that group is probably close to __$21 M^{3/4}$___

Physiologists prefer measuring O_2 consumption over CO_2 production because caloric equivalient for CO_2 is sensitive to fuel being metabolized, whereas O_2 is less sensitive

The range of air temperatures at which metabolic rate of *endotherms* is independent of air temperature is called _thermal neutral zone_.

Heart rate in mammals scales as M to the _-.25__ power (give a "b" value).

Temperature refers to the __average_kinetic energy of a system, but heat content refers to the _total___kinetic energy of a system.

If Y changes as a constant proportion of X, this relationship is called isometry (or linear)_ and the exponent b (in X^b) must have the value of __1____.

The respiratory exchange ratio is measured as CO2 produced: O2 consumed__.

A daily drop in body temperature and metabolism in ectotherms is called_torpor__.

Cell size scales to the __0_power in animals.

A common antifreeze used by animals is _glycoproteins, glycerol etc.__.

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2. Imagine that the resting metabolic rate of turtles scales with the following equation ($E = 0.3M^{.80}$), whereas that for mammals scales as $E = 4\ M^{.74}$), where M is in grams. What is the resting metabolic rate of a representative 1-gram animal of each taxon (calculate a number, ignore the units)? Write the equation for mass-specific metabolic rate for both taxa (Σ = 4 points)

turtles: rest = 0.3 mass specific = $0.3\ M^{-.2}$

mammals: rest = 4 mass specific = $4\ M^{-.26}$

3. Briefly describe the physiological significance all three (@6 points, Σ = 18 points):

Specific dynamic action (define it and explain why it occurs – i.e., its physiological functions)

Increase in metabolic rate following eating
Up regulate digestive enzymes & digestive organs, peristalsis, detoxification

Biological antifreezes (how do they work? Give an example)

Surround growing ice crystals, prevent them from growing
Glycoprotein, protein, peptides, etc.

Strong inference (define it, who conceived it? and give two reasons why it is useful)

Design an experiment that simultaneously tests two or more hypotheses
Platt
Efficient (testing multiple hypotheses simultaneously)

Reduces experimenter bias

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do not write below this line

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5. Endotherms of a given size have much higher mass-specific metabolic rates than do ectotherms of the same size. NAME four physiological or morphological **differences** that enable endotherms to sustain high metabolic rates. ($\Sigma =$ 4 points).

1. bigger hearts, liver, etc

2. mitochondria w/ larger surface area

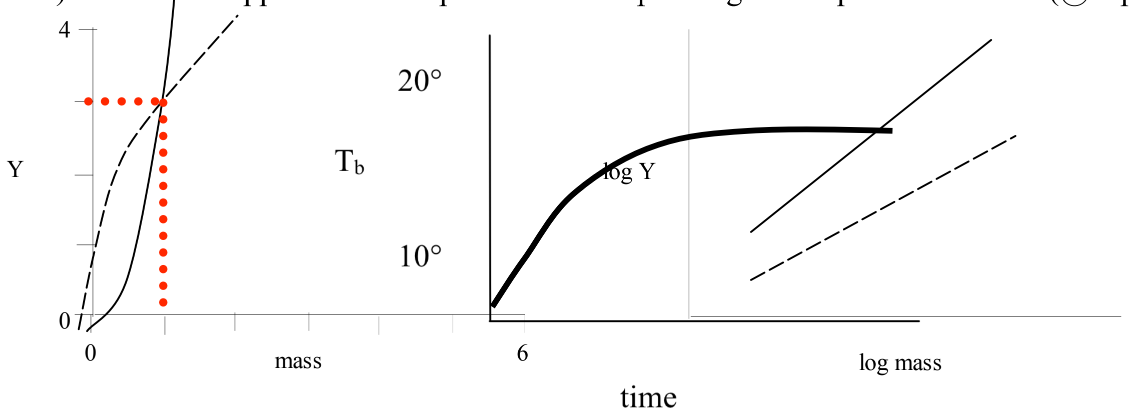
3. higher rates of respiration

4. more food, more enzymes

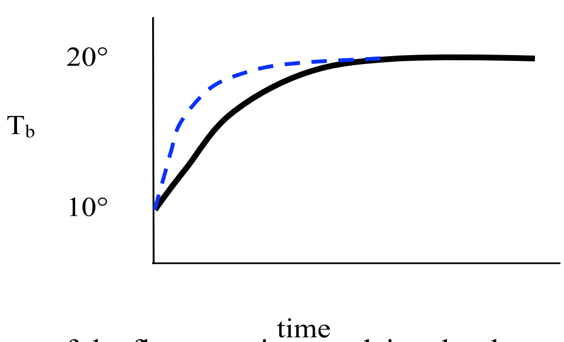
MANY OTHER ANSWERS WERE REASONABLE

6. Draw all of the following graphs:

A. Plot $Y = 3\ M^{1.3}$ on both of the following graphs. ALSO superimpose (*using dashed lines*) on each the approximate shape of the corresponding mass-specific curves. (@ 3 points)



B. Imagine you took a 5-g lizard that started at a body temperature (T_b) of 10°C, you transferred it to an environmental chamber (air) set at 20°C, and monitored its temperature over time. Plot body temperature versus time (solid line). Then add a second line (dashed) for body temperature versus time if you'd placed the lizard into a water bath at 20°C. (8 points)



With reference to terms of the flux equation, explain why the two curves are same or different.

h_c or the "coefficient"

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7. Answer all three questions

a) Some high-latitude ectotherms are remarkably tolerant of freezing. Why don't the ice crystals kill these animals? Briefly explain what physiological adjustments they use to survive freezing. (5 points)

freezing is confined to extracellular fluids, not to intracellular fluids
ECF have lower osmolarity than ICF, so freeze first. This increases osmotic concentration in ECF, which leads to withdrawal of water from ICF, lowering freezing point
NOTE: many students did not answer this question but wrote about supercooling or antifreezes. These help animals survive cold conditions, but are irrelevant to the question asked above.

b) A local biotech firms wants to test the efficacy of a new drug for reducing blood pressure in humans. They know that individual human subjects will vary widely in blood pressure, and that the hormone is likely to have a small (though medically important!) effect. You are asked to develop an experimental design to test the drug, and told to minimize the number of subjects while maximizing the statistical power to detect a significant effect. Describe and justify a specific experimental design. (10 points)

use paired design. Each individual is used as a control and an experimental. For control, need placebo; for experimental, the drug. Randomize the sequence (i.e., some individuals placebo first, then drug; others, drug first, then placebo). This design reduces the impact of between-individual variation in blood pressure.
NOTE: many students proposed a "paired design", in which an individual was measured before and after a drug. This is NOT a paired design, simply because there's no control. (why is this a concern?) You need a placebo, with a randomized sequence of presentation.

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8. You've been asked by the editor of a physiological journal to review a paper submitted for publication. The authors wished to test the hypothesis that *desert mammals have evolved a low metabolic rate*, presumably because this would reduce their food requirements in deserts

So they compared metabolic rates of two rodents – one from a desert, one from a non-desert. Note, however, the two species differed in size; and so a direct comparison of whole-animal metabolic rates (E) would be misleading. So the authors corrected for the differences in body mass by computing mass specific metabolic rates (E/g) to, and they concluded that the data (see table for average values) support their hypothesis – that is, the desert species had a significantly lower E/g than did the non-desert species.

	Mass (g)	E	E/g
Desert	50	71.4	1.4
Non-desert	40	60.4	1.5

Do agree that the authors have adequately corrected for differences in body mass (and thus do you recommend that the study should be accepted for publication)? If not, propose a *specific* mathematical way to correct for size differences and indicate what additional physiological information would be required to implement your correction. (12 points)

NOTE: MOST STUDENTS MISUNDERSTOOD THIS QUESTION, IN PART BECAUSE THE QUESTION WAS (UNFORTUNATELY) POORLY WORDED. SORRY ABOUT THAT! BUT EVEN SO, MOST STUDENTS DID NOT ANSWER THE QUESTIONS ASKED. *ALWAYS READ AND ANSWER THE QUESTION ASKED.*

no. mass-specific metabolic rate is not independent of body mass, as is obvious by dividing both sides of the standard allometric equation

$$E = a M^{.75}$$

$$E/M = a M^{-.25}$$

So E/M changes with M. A better way to do this is to divide the data by M .75, or whatever is the actual scaling relationship for the group in question

$$E = a M^{.75}$$

divide both sized by $M^{.75}$

$E/M^{.75} = a M^{.75} / M^{.75} = a$ thus $E/M^{.75}$ is independent of mass!

Thus $E/M^{.75}$ is a constant, which is exactly what we want when we are trying to correct for size differences. So for our two animals, we'd compute

$$71.4/50^{.75} \text{ and } 60.4/40^{.75}$$

If you actually computed these numbers (*not necessary or even possible without a calculator*), you'd find that the mass CORRECTED metabolic rates were the same. So the authors of the submitted paper were wrong!