Some Things to Think About In Regards to Temperature Regulation

These are thought questions. I will not post answers. I am willing to discuss them only if it is obvious to me that you have thought about them and tried to answer them. They can be discussed in either class, lab, review sessions, or office hours.

1. Write a general form for all "conductance" equations. What equations have we considered the last few weeks that would be considered conductance equations (list them and show why they are conductance equations)? What is the difference between conductance and insulation? Looking ahead, what do you suppose is the difference between conductance and resistance?

2. With regards to <u>conductance</u> of heat:

- Draw a picture defining the concept of temperature gradient. In defining a temperature gradient, can any distance be used and what is the relationship between the distance used and the temperatures used.
- What is the temperature in the middle of the gradient (spatially) as compared to the two ends?
- Explain why one expects the temperature gradient to decrease with time if there is no convection. Assume that we are talking about heat coming from a small object (such as an endotherm) and that it is moving into an infinitely large sink (the environment).
  - Do we expect equilibrium in this case?
  - What if the heat is diffusing into a small volume -- for instance, one smaller than the animal -- will an approximate thermal equilibrium occur in this case? (give several examples using animals where heat diffuses from the animal to a relatively small volume)?
- In terrestrial endothermic animals, heat diffuses from what is essentially water to air. What value for thermal conductance should be used -- air or water?

3. <u>Convection</u>:

- What is the effect of convection on the rate of conductance? Explain by making reference to your answers in the last question.
- What do you suppose is the main difference between "active" and "passive" convection? Give a couple of examples of each process as they apply to organisms.

4. <u>Radiation</u>: The section in your text book is excellent; I recommend studying it carefully.

- If an animal is at $20^{o}C$ what is the modular wavelength of its electromagnetic emissions.
  - What "band" are these emissions found in? Assume that the environment is also at $20^{o}C$.

    - What are the wavelengths its emissions? If both the environment and the animal are radiating at 20^{o}C, will they heat/cool? Explain.
- The Boltzmann equation is for energy flux. Suppose that two objects (they could be animals) in a typical terrestrial environment have different emissivities in the visible range and are exposed to continuous visible light. Also suppose that both have the same emissivities in the infra-red range.
    - Will both objects eventually get to the same temperature?
    - Will they get there in the same amount of time?
    - Will they reach the same temperature as the light source (i.e., will they come into strict equilibrium with the light source)? If not, why?

5. The effect of evaporative water loss (L*E) on the coefficient of thermal conductance, C:

- At what point should heat loss by evaporation (L*E) reach an approximate minimum? Can you define this point exactly?
- Does L*E occur below T_{LL}?
- What is the effect of relative humidity on the magnitude of L*E?
- Will the TNZ be larger of smaller as relative humidity increases? What will be the effect on the T_{UL}?
- What will be the effect of low humidity on the slope of the metabolism vs. temperature curve above T_{UL}?

6. <u>Newton's law of cooling</u>. If $\dot{Q}$, L*E, and C all remain constant and T_A increases, what happens to T_B?

6. <u>Size and thermal independence</u>.

- All else being equal, what should be the effect of increase in body size on whole animal thermal conductance. What exponent of body mass should C scale to?
- Why don't large animals have higher T_B?
- What does this tell you about the need for additional insulation in small vs. large animals?