

Agronomy 405/505  
Spring 2009  
Problem Set 11  
Due Tuesday, April 14, 2009

Assigned April 11, 2007

- 12.1 in Campbell and Norman. Assume  $M = 40 \text{ W m}^{-2}$  for both a human and a mouse. Assume  $g_v = g_{vs}$ , where  $g_v$  is the total water vapor conductance, and  $g_{vs}$  is the skin water vapor conductance. Assume that both a human and a mouse have body and surface temperatures of  $37^\circ\text{C}$ .
2. Consider the following equation that relates metabolism ( $M$ ), latent heat flux ( $\lambda E$ ), and internal body temperature ( $T_b$ ) to the operative temperature ( $T_e$ ) through the boundary layer ( $g_{Ha}$ ), radiative ( $g_r$ ), tissue ( $g_{Ht}$ ), and coat ( $g_{Hc}$ ) conductances (represented by  $g_{Hr}$  and  $g_{Hb}$ ).

$$(M - \lambda E) = \frac{g_{Hr}}{1 + \frac{g_{Hr}}{g_{Hb}}} c_p (T_b - T_e) = g c_p (T_b - T_e) \quad (1)$$

- Draw a diagram that represents how  $g_{Ha}$ ,  $g_r$ ,  $g_{Ht}$ , and  $g_{Hc}$  are “connected” in terms of the flow path for heat leaving the body core and indicating which conductances are in series or in parallel.
  - What is the total conductance  $g$  if  $g_{Ha}$ ,  $g_r$ ,  $g_{Ht}$ , and  $g_{Hc}$  are all  $1 \text{ mol m}^{-2} \text{ s}^{-1}$ ?
  - Which conductance should be  $0.1 \text{ mol m}^{-2} \text{ s}^{-1}$  to *maximize*  $g$  if the other three are  $1 \text{ mol m}^{-2} \text{ s}^{-1}$ ?
  - Which conductance should be  $0.1 \text{ mol m}^{-2} \text{ s}^{-1}$  to *minimize*  $g$  if the other three are  $1 \text{ mol m}^{-2} \text{ s}^{-1}$ ?
- 12.3 in Campbell and Norman. Assume a tissue conductance of  $1 \text{ mol m}^{-2} \text{ s}^{-1}$ . Estimate coat conductance from Figure 12.4 in the text.
  - Read the *Science* article “The Heartbreak of Adapting to Global Warming,” doi: 10.1126/science.1137359.
    - Why is it difficult to establish a direct relationship between environmental temperature and species distribution patterns?

- (b) Define “viviparous.”
  - (c) What is “venous blood?”
  - (d) Define “aerobic scope.”
  - (e) A negative correlation between estimated population and summer water temperatures has been found for the viviparous eelpout by Pörtner and Kunst. What is their hypothesis?
5. Read the *Science* article “Life, the Universe, and Body Temperature,” doi:10.1126/science.1135375.
- (a) Where are “cutaneous blood vessels?”
  - (b) What is “thermogenesis” and how is ATP used in thermogenesis?
  - (c) How did Conti *et al.* “dial down” the temperature of mice?
  - (d) What did Conti *et al.* find for the hypothermic transgenic mice in terms of food intake, physical activity, and body weight, and what is their hypothesis that would explain the cause of these changes?
  - (e) How did the life span of the hypothermic transgenic mice change, and why was this surprising?
  - (f) How might this change in life span in mice translate to humans?
  - (g) What do you think: should this treatment be considered for humans?