

1 Heat Balance (10pts total)

a. (2pts) The resting metabolic rate of a mouse (100 g) is 8.2 kJ/hr (in its burrow with an air temperature of 20°C). It is losing 5.1 kJ/hr to conduction/convection and 3.1 kJ/hr to evaporation from respiratory surfaces. Negligible heat is lost or gained by radiation. Is the mouse in heat balance? Is its body temperature increasing, decreasing or staying the same?

b. (3pts) Now the mouse leaves its burrow to go forage for seeds. It is a cool and sunny day. The outside temperature is 0°C. The active metabolic rate of the mouse is 21 kJ/hr. It is losing 10.4 kJ/hr to conduction/convection, losing 5.2 kJ/hr to evaporation, and gaining 2.8 kJ/hr from the sunlight. Recalculate the heat balance equation. Is the mouse now in heat balance? Is its body temperature increasing, decreasing or staying the same? Why did H_c and H_e go up?

c. (3pts) The mouse accidentally falls in a lake and cannot get out immediately (the lake is also 0°C). AMR is the same, but conduction goes up to 260 kJ/hr, and evaporation and radiation go to zero. Is the mouse in heat balance? Is its body temperature increasing, decreasing or staying the same? Why did H_c go up by so much? Name mechanisms.

d. (2pts) Now the mouse gets out of the water. It is still in trouble, however, because it is wet. It is still losing heat to the environment. Estimate (make up) some numbers for the heat equation which show that it is still losing heat.

2 Heart rate and body temperature (3pts)

Iguanas are introduced to Miami, FL. When it first wakes in the morning, the body temperature of an iguana is 15°C and its heart rate is 3 beats/min. After an hour of basking in the sun, its body temperature is 27°C. What is the approximate heart rate at this higher temperature? (assume a Q_{10} of 2.5).

3 Body temperature and metabolic rate of an ectotherm (11 pts)

Use the iterative method to calculate the H_m (= SMR) of a 50 kg tortoise at 25°C. How much higher than the ambient temperature is the body temperature of the tortoise?

4 Marine iguana heat gain (6pts)

A calorie is the amount of heat required to raise the temp of 1 gram of water by 1°C (1 cal = 4 J). A marine iguana from the Galapagos Islands weighs about 2.5 kg. It is basking on a rock. Its metabolic rate is 6 kJ/hr, it is gaining about 17 kJ/hr from the warm air (both conduction and convection) and it is gaining 31 kJ/hr from the sunlight. Its skin is dry, and heat loss by evaporation from the respiratory system is small.

- How much heat is it gaining per hour?
- How long will it take for it to warm up by 10°C? (Assume that iguana tissue is essentially all water).

5 Extra Credit 2pts

Watch the marine iguana video and identify all of the potential heat gain and heat loss opportunities: Give the behavior or situation and name the type of heat gain/loss (e.g., conduction, convection, radiative, evaporative (CEWL or REWL)). The marine iguana video is on website or at https://youtu.be/Qd-1_CjgGCQ.