Plasma Glucose Regulation Problems

Physiology – Biology 390

1. Assume that a person ingests 50g of glucose and that all of it enters the blood and none is metabolized or excreted. Calculate the concentration (in mg glucose/dl plasma) in that person's plasma if:

plasma concentration prior to ingestion was 80 mg/dl plasma
plasma volume = 3500 cc

2. Given the data below, calculate how many times a person could climb the spiral staircase outside the science library to the math department. Before they would completely deplete their plasma glucose. Assume that the only fuel they have available is their plasma glucose and that glucose is only used for the work of the muscles. Make the following simplifying assumption: calculate only work that needs to be done against gravity, ignore friction and transverse movement.

Height of the stairs = 10 m
person's mass = 60 kg
acceleration due to gravity = 9.8 m/s^2
plasma glucose concentration = 100 mg/dl plasma
plasma volume = 3.5 liters
aggregate efficiency of climbing = 20%
1 g glucose contains 3.76 kcal
1 cal = 4.184 J

3. Effects of exercise -- the way we exercise in the lab.
One excellent means of quantifying exercise is to use some sort of a bicycle ergometer. We will use a special form of ergometer called a **wind trainer**. This is a device that that not only simulates the effects of riding against different gravitational loads (as would be experienced by going up different grades) but it also takes into account the fact that wind resistance increases as the square of the velocity of the rider (since
$e = 0.5 * m * v^2$ where m is mass and v is velocity).
The wind trainer we have in lab is calibrated to read the actual power output (P_O) in watts of a rider depending on (1) the wind resistance (which is a function of the square of the speed); (2) road resistance (assumed to be a minimal, constant value -- if we used under-inflated tires our actual road resistance would be greater than the constant used, therefore it is important that we fully inflate the tires!) and (3) gravity, as determined by grade.

Suppose that a rider adjusts her speed so that her P_O is 100 watts (i.e., 100 J/s). Based on your calculation in problem #2 of the amount of glucose present in blood (3500 ml of plasma with a plasma glucose concentration of 100 mg/dl, how long (in seconds) would she need to ride to, in theory, completely deplete her plasma glucose? Assume that she is 20% efficient in turning the chemical energy of glucose into the motion of the bicycle wheel and that she utilizes only plasma glucose to fuel her riding. Also, assume that she does not use glucose for anything but powering the ride.