Biology 3550
Physical Principles in Biology
Fall Semester 2016

Quiz 1
2 September 2016

Please write your name on each page.
Be sure to show your work and include correct units in all of your answers!
25 points total.

1. The cells of the human body vary tremendously in size. The neurons of the sciatic nerve are among the largest. These neurons originate in the lower spine, and the axons (thin cylindrical projections) of some reach the feet. For the following, consider just the axon of one of these neurons and assume that it has a length of $1\,\text{m}$ and a diameter of $15\,\mu\text{m}$.

   (a) (4 pts.) Calculate the volume of this single axon, in units of μm^3.

   (b) (4 pts) Calculate the volume of the sciatic axon defined above in units of mL.

(c) (3 pts) The interior of an axon contains, among other things, sodium ions at a concentration of approximately $12\,\text{mM}$. Calculate the number of moles of sodium ions in axon describe in part a.

2. (4 pts.) The sciatic nerve is a bundle of neurons that divides into branches as it descends from the spine to the lower extremities. The undivided sciatic nerve has a diameter of about $10\,\text{mm}$. From this information and that given in problem 1 for a typical axon, estimate the number of individual axons in the sciatic nerve. Be sure to state any additional assumptions that you make in this calculation.

Hint: Consider the cross section of the nerve.

3. On an American roulette wheel, there are 38 pockets into which the ball can fall. Two of these pockets are green, 18 are red, and 18 are black. The pockets are also numbered, but ignore that for this problem. For this problem define the outcomes of a single spin by the colors of the pockets the ball can fall into, so that there are three possible outcomes, green (G), red (R) and black (B).

   (a) (4 pts.) Assuming that the ball is equally likely to fall into any of the 38 pockets, Calculate the probabilities of the three outcomes for a single spin and show that these probabilities sum to 1.

   (b) (3 pts.) Consider a sequence of three spins of the roulette wheel. For the three spins, define the outcomes in the sample set as the ordered colors arising from each spin, such as (G, B, R), (R, G, B) and so on. How many elements are there in the sample set for three spins?

   (c) (3 pts) Calculate the probability of the outcome (B, G, B).