Estimations, Dimensions, Units…

1. Estimate the amount of sand at the coastal beaches of the United States. You will have to make assumptions about the typical width and depth of a beach and the amount of coastline in the US which has actual sand (rather than rock).

2. Bacteria reproduce by doubling every 15-20 minutes. (See, e.g., this source.) Assume you are suffering from an infection of MRSA (Methicillin-resistant *Staphylococcus aureus*) and take a new antibiotic to beat it. Alas, it turns out that 0.01% of your bacterial load are also resistant to this new antibiotic! After the new antibiotic has killed of 99.99% of the MRSA in your body, how long would it take for it to double back to the same load as before you took the antibiotic? Note this question is asking in terms of *percentages* not actual numbers.

3. A classic problem presented to physics students is to calculate the speed of light in furlongs per fortnight. Let's at least pretend to make this more biology related. Fast neurons typically reset every 5 ms or so (neuronal firing rate). Imagine a string of neurons, where each neuron is about 100 µm long. How "fast" can changing information be reasonably sent from one end of this string to the other on the basis of a constantly-changing stimulus? Report your answer in µm/ms and in furlongs/fortnight.

4. Draw two horizontal "number lines", one above the other. Line up "273" of the top one with "32" on the bottom one and "373" on the top one with "212" on the bottom. Clearly these are crazy units with a weird conversion. Not only is the size of each unit different, the "origin" is arbitrarily "off" by some weird value. At what value would the two lines "agree"? Why? Can you derive or infer a formula which can give you the value of one line's value based on the other's? What would you "do" to that formula to derive where they are equal through math rather than through lengthy number lines?