Answer Key - Quantitative Question from Lecture #5

Quantitive Question: If a representative mammalian cell has an average diameter of 20 μm, and up to 25% of its total surface area can be occupied by receptor molecules, and the exocellular aspect of a typical receptor has a diameter of 100 Å, calculate:

(a) What is the maximum (total) number of receptors that can be displayed on the surface of the plasma membrane? [Assume, for the sake of this question, that the mammalian cell in question is roughly spherical in shape and the extracellular face of any type of receptor is roughy circular.]

The surface area of a sphere (the cell) = $4 \pi r^2 = 4 (3.14159265) (10 \mu m)^2 = 1{,}257 \mu m^2$

The area of a circle (the receptor) = $\pi r^2 = (3.14159265) (5 nm)^2 = 78.5 nm^2$, where 1 Å = 0.1 nm and 1 nm = 10^{-3} μm.

Thus, $0.25 \times 1{,}257 \mu m^2 / 78.5 nm^2 = 314 \mu m^2 / 78.5 \times 10^{-6} \mu m^2 =$

4×10^6 receptors total can be displayed on the cell surface

(b) Assuming that any given receptor type (say, β2AR or the EGF receptor) is present at ~10^5 per cell, what does the number you calculated in (a) suggest about the maximum number of different receptor types that can be displayed on the surface of a mammalian cell at any given time?

$4 \times 10^6 / 1 \times 10^5 =$

~40 different classes of receptors displayed by a given cell type