Question Set 5

Membrane biophysics

Note that it is not necessary to read the papers beyond what is indicated by the questions and what is covered by the lecture notes.

Remember to draw figures to explain your answers. This is often more efficient than just using words.

If you have any questions feel free to send an email: diogo.volpati@ftf.lth.se

Questions for Cell membranes models & paper (Brogden and Singer & Nicolson)

1. Describe the evolution of Cell Membrane Models until our currently most accepted model proposed by Singer & Nicolson.
2. Antimicrobial peptides can be considered an alternative for conventional antibiotics. Please, describe their three proposed mechanism of action to form pores into membrane bilayers.
3. What is the difference between a lipid molecule and detergent molecule? How would the structure of a lipid molecule need to change to make it detergent?
4. Lipid molecules exchange places with their lipid neighbor every 10^{-7} sec. A lipid molecule diffuses from one end in a 2μm long bacterial cell to another in about 1 second. Are these two number in agreement (assume that a lipid head group is about 0.5 nm)? If not, can you think of a reason for the difference?
5. To get an appreciation for the speed of molecular motions, assume a lipid head group is about a size of ping-pong ball (4cm diameter) and that the floor of your living room (6 m x 6 m) is covered wall to wall with these balls. If two neighboring balls exchange position every 10^{-7} sec, what would be the speed in kilometers per hour? How long would take a ball to move from one end of the room to another?
6. What role does water play in determining the molecular organization of cell membranes?
7. How are vesicles formed? How can we define their size?
8. What are the main differences between Langmuir and Langmuir-Blodgett membranes?

Questions for Probing Membrane Models at molecular Level

1. What are the main differences between FTIR and Raman Spectroscopies techniques? Fundamentally, what are the processes involved in both methods since they can probe exactly the same information (defined frequencies of the molecular vibrations)?

2. Describe what are the selection rules for a vibrational mode be active in FTIR spectroscopy. Also, describe the same selection rules for Raman Spectroscopy.
3. The vibrational frequency of a harmonic oscillator formed by two spheres of mass *m* can be calculated by $\upsilon_m = \frac{1}{2\pi}\sqrt{\frac{\kappa}{\mu}}$ where $\mu = \frac{m_1 m_2}{m_1+m_2}$. Please explain how we can use these equations to understand how different molecules like H_2, O_2, CO, HF have their well-defined and unique fundamental frequencies of vibration. Remember to consider the strength of the bonding between the atoms.
4. Given the phospholipid 1,2-Dipalmitoyl-sn-glycero-3-phosphocholine (DPPC), please find some of the fundamental vibrations associated with (a) PO_x group, (b) NH_3, CH_3 and CH_3. State your answers in cm^{-1} and then convert it to eV.

Questions for sensing with SPR and QCM

1. What is a plasmon? Which metals are most commonly used to support Plasmon's? Which characteristics of these metals are essential?
2. In the paper J. Am. Chem. Soc. 2000, 122, 4177-4184, please describe how phospholipid vesicles were used to build a SPR sensing unit to monitor the amount of PLA2 which bound to these vesicles. Please, describe the main strategy of the authors, and not the details.

References

i. *The Fluid Mosaic Model of the Structure of Cell Membranes*, S. J. Singer and Garth L. Nicolson, Science, **175**(4023), 720-731 (1972)

ii. *Antimicrobial Peptides: Pore Formers Or Metabolic Inhibitors In Bacteria?*, Kim A. Brogden, Nature Reviews Microbiology volume **3**, 238–250 (2005)

iii. *Surface Plasmon Resonance Sensors for Detection of Chemical and Biological Species*, Jiří Homola, Chem. Rev. **108**(2), 462-493 (2008)

iv. *Quantification of Tight Binding to Surface-Immobilized Phospholipid Vesicles Using Surface Plasmon Resonance: Binding Constant of Phospholipase A2*, Linda S. Jung et al. J. Am. Chem. Soc. **122**, 4177-4184 (2000)