Week 1 – Questions – Membranes and Ion channels

Membranes

1. What is the plasma membrane made of?

2. How thick is the plasma membrane?

3. Why are ions not permeable across the plasma membrane?

Ion channels

4. What is the protein structure of a typical ion channel?

5. How can ions rapidly and selectively permeate ion channels?

6. What is the Nernst equation?

Reversal potential

7. Calculate the reversal potential of a potassium selective conductance at 37 Celsius if $[K^+]_i$ = 200 mM and $[K^+]_o$ = 20 mM.

8. Calculate the reversal potential of a sodium selective conductance at 37 Celsius if $[Na^+]_i$ = 10 mM and $[Na^+]_o$ = 150 mM.

9. Calculate the reversal potential of a calcium selective conductance at 37 Celsius if $[Ca^{+2}]_i$ = 1 uM and $[Ca^{+2}]_o$ = 2 mM.

10. Calculate the reversal potential of a chloride selective conductance at 37 Celsius if $[Cl^-]_i$ = 5 mM and $[Cl^-]_o$ = 150 mM.

Membrane potential

11. What would be the resting membrane potential for a cell with permeability ratio for K^+ : Na^+ : Cl^- = 1 : 0.1 : 0.5 at 37 Celsius with $[K^+]_i$ = 200 mM; $[K^+]_o$ = 20 mM; $[Na^+]_i$ = 10 mM; $[Na^+]_o$ = 100 mM; $[Cl^-]_i$ = 5 mM and $[Cl^-]_o$ = 150 mM?

12. Calculate the number of monovalent ions needed to change the membrane potential by 50 mV, if the capacitance of the cell is 50 pF.

13. If the cell has a volume of 10 pL, then what fraction of Na^+ or K^+ ions in the cell would need to move across the membrane in order to change membrane potential by 50 mV in this 50 pF cell?

14. What happens if you inject a square current pulse into a cell? How can you measure the membrane resistance and capacitance? What is meant by the membrane time-constant? How do these aspects depend upon the location of the recording / current injection across the extended processes (axons and dendrites) of a neuron?