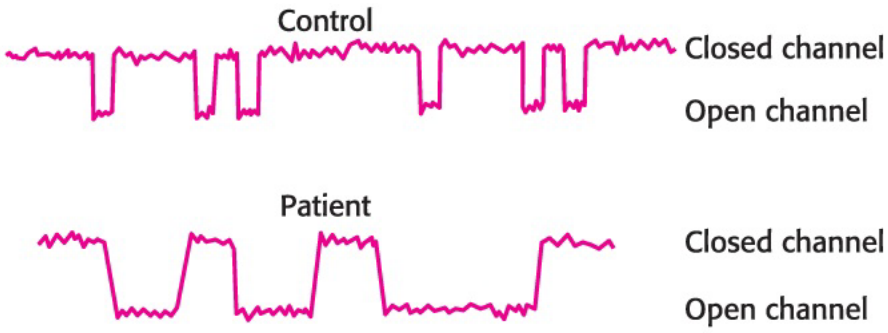
1. Some cells take up glucose by a symporter powered by simultaneous entry of Na^+. The entry of Na^+ provides free energy input of 10.8 kJ/mol under typical cellular conditions like external $[Na^+]$ = 143 mM; internal $[Na^+]$ = 14 mM; membrane potential = -50 mV; How large a concentration gradient of glucose at 310 K can be generated by this free energy.

2. The Na^+ and K^+ channel have similar structures and are arranged in similar orientation in the membrane. Explain how Na^+ channel allows Na^+ to flow inside the cell, while K^+ channel allows K^+ to flow outside the cell.

3. Digitalis inhibits the Na^+-K^+ ATPase pump. Explain how this inhibition leads to increased contraction of heart muscle.

4. Consider a neuronal cell with volume 10,000 μm^3 and a surface area of 10,000 μm^2. If during opening of Na^+ channel, 100,000 Na^+ ions flow inside the cell per ms per μm^2 area, calculate by what percentage does the Na^+ ion intracellular concentration change in 1 ms due to action potential.

5. Mutation in the β-subunit of acetylcholine receptor channel causes muscle weakness and rapid fatigue. Acetyl choline generated currents through acetylcholine receptor channels for both control and patient carrying mutation are shown below. What is the effect of mutation on channel function.



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6. Calculate the equilibrium membrane potential
   a. For Na^+ ($[Na^+]_{in}$ = 14 mM; $[Na^+]_{out}$ = 143 mM;)
   b. For K^+ ($[K^+]_{in}$ = 157 mM; $[K^+]_{out}$ = 4 mM;)