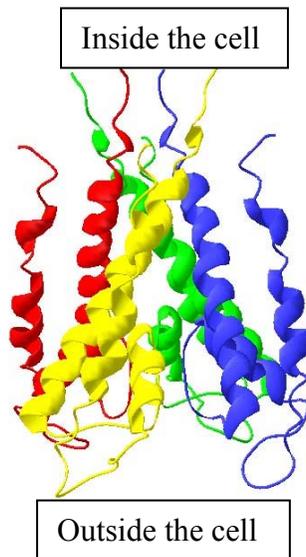
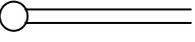


Question 1 (36 points)

Below is a ribbon representation of the K^+ channel, a membrane spanning protein made up of four copies of a single polypeptide. The K^+ channel allows K^+ ions to be shuttled through the membrane.



- a) What protein secondary structure is part of the K^+ channel protein as shown above?
- b) Does the K^+ channel have quaternary structure? If yes, describe it.
- c) Using  as a schematic of a phospholipid, draw a cross-section of the membrane around the K^+ channel shown above.
- d) What type(s) of amino acids do you expect to find on the K^+ channel polypeptides

i) next to the tails of the membrane lipids? (Circle all that apply)

Polar

Nonpolar

Positively charged

Negatively charged

Why?

ii) next to the heads of the membrane lipids? (Circle all that apply)

Polar

Nonpolar

Positively charged

Negatively charged

Why?

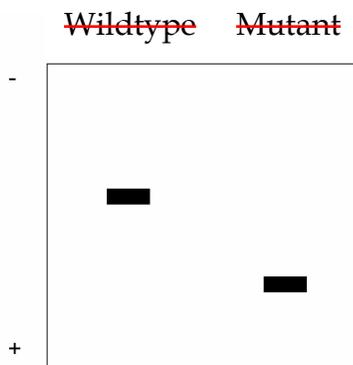
Question 1, continued

- e) If you were trying to estimate the volume occupied by this protein, would the picture above provide all the information you need? Why or why not?

The positively charged K^+ ion is a very small soluble molecule.

- f) Explain why K^+ cannot come across the membrane without a channel protein.

~~You isolate a mutant of the K^+ channel that transports less K^+ than normal. You run both the wild-type and mutant proteins on a denaturing gel and get the following result:~~



- ~~g) From the gel data we can conclude that (circle all that apply):~~

~~shorter than~~

- ~~i) Each subunit of the mutant protein is the same length as in the wild-type protein.~~

~~longer than~~

~~Justify your answer(s)~~

~~primary~~

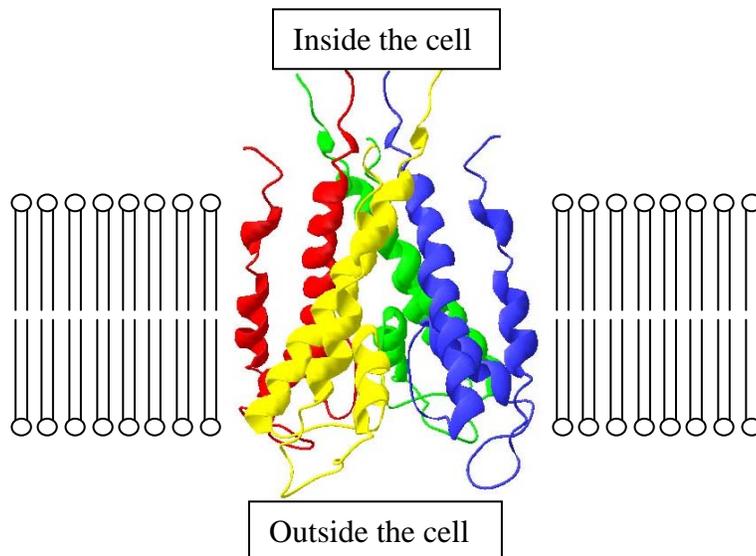
- ~~ii) The mutant and wild-type proteins could differ in their secondary structure.~~

~~tertiary~~

~~Justify your answer(s)~~

Question 1 (36 points)

Below is a ribbon representation of the K⁺ channel, a membrane spanning protein made up of four copies of a single polypeptide. The K⁺ channel allows K⁺ ions to be shuttled through the membrane.

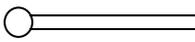


a) What protein secondary structure is part of the K⁺ channel protein as shown above?

K⁺ channel contains only α -helices.

b) Does the K⁺ channel have quaternary structure? If yes, describe it.

Yes, the channel has quaternary structure. It consists of four interacting polypeptides. It appears that each polypeptide interacts with its two neighboring polypeptides, such that the overall shape of the channel is a barrel.

c) Using  as a schematic of a phospholipid, draw a cross-section of the membrane around the K⁺ channel shown above.

d) What type(s) of amino acids do you expect to find on the K⁺ channel polypeptides

i) next to the tails of the membrane lipids? (Circle all that apply)

Polar

Nonpolar

Positively charged

Negatively charged

Why?

The tails of the membrane lipids are hydrophobic, and it is energetically favorable for the protein to have hydrophobic amino acids in the hydrophobic environment.

ii) next to the heads of the membrane lipids? (Circle all that apply)

Polar

Nonpolar

Positively charged

Negatively charged

Why?

The heads of the membrane lipids have negatively charged phosphate groups, and it is energetically favorable for the protein to have positively charged amino acids that can form ionic bonds, or polar amino acids that can form hydrogen bonds in that environment.

Question 1, continued

- e) If you were trying to estimate the volume occupied by this protein, would the picture above provide all the information you need? Why or why not?

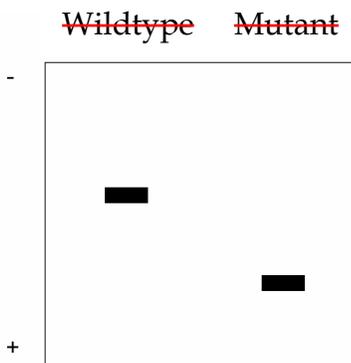
No, the picture above is of a ribbon representation, i.e. backbone trace. It does not show any of the sidechains, and thus does not give us a clear picture of how much space the protein occupies. In addition, for the atoms in the backbone, the vdW radii are not shown.

The positively charged K^+ ion is a very small soluble molecule.

- f) Explain why K^+ cannot come across the membrane without a channel protein.

The tails of the membrane lipids are hydrophobic. It is not energetically favorable for a charged molecule, such as K^+ to be in a hydrophobic environment. Thus, K^+ by itself can not come across the membrane.

~~You isolate a mutant of the K^+ channel that transports less K^+ than normal. You run both the wild type and mutant proteins on a denaturing gel and get the following result:~~



- ~~g) From the gel data we can conclude that (circle all that apply):~~

~~shorter than~~

- ~~i) Each subunit of the mutant protein is the same length as in the wild type protein.~~

~~longer than~~

~~Justify your answer(s)~~

~~The mutant protein shows only one band on the gel, meaning that it consists of only one type of subunit. Denaturing gel separates protein fragments based on their size, with shorter fragments traveling further. Since the mutant subunit travels farther on the gel, we conclude that the mutant subunits are shorter than the wild type ones.~~

~~primary~~

- ~~ii) The mutant and wild-type proteins could differ in their secondary structure.~~

~~tertiary~~

~~Justify your answer(s)~~

~~Because the mutant subunits are shorter than wild-type subunits, it is clear that the primary structure is affected. If the lost fragment is of significant length, tertiary structure will most likely be affected too. And depending on where the fragment the lost in the mutant subunit is located in the wild-type protein, it is possible that the secondary structure would also be altered.~~