1. (5 pts) The drug camptothecin inhibits topisomerases, which are the mammalian form of the bacterial gyrase. What disease do you think this drug would be useful to treat? [Hint: What is the role of gyrase in a cell?]

2. (10 pts) Discuss the similarities and differences between DNA replication in a cell versus a PCR reaction in a laboratory.



3. (8 pts) Which of the following molecules are monosaccharides? For those which are not, explain why.

4. (12 pts) Bacterial resistance to penicillin is due to the production of an enzyme called β-lactase by the bacteria. This enzyme breaks open the 4 atom ring in penicillin, inactivating the antibiotic. The other piece of information that you need to know to solve this problem is that the salt concentration inside bacterial cells is 0.15 Molar (moles/L) and that the normal media to grow bacteria is low in salt concentration, much less than 0.15 M.

A culture of bacterial cells is split in four, as indicated in the table below. After incubation of the culture for 1 hour the number of living cells is determined for each of the four conditions. The number of cells is shown in the second row of the table.

|  |  |  |  |
| --- | --- | --- | --- |
| No addition | + NaCl 0.15m | Penicillin | Penicillin + 0.15M NaCl |
| 100 | 100 | 0 | 100 |

The first column is the experimental control. Explain the experimental data for the other three conditions, i.e. why did the cells die or not die. Hint: You want to consider how penicillin works and the permeability properties of the lipid bilayer membrane. At equilibrium the concentration of the water will be the same on both sides of the cell membrane. Water can move across the membrane, but can sodium and chloride ions?

5. (10 pts) Many bacteria that cause disease have become resistant to penicillin (or the similar drug ampicillin). Consequently, patients with bacterial infections are often given the drug augmentin instead. How does augmentin overcome the resistance to penicillin. Please cite your source (Please use the web).

6. (5 pts) What will happen if there is a mutation in the LDL receptor that *increases* binding and uptake of LDL by the liver? How will this affect the properties of the cell membranes throughout the body?

7. (10 pts) The gene for the light chain of an antibody consists of three exons, as shown on the right.



i) List the steps involved in the assembly of an antibody in the rough endoplasmic reticulum, beginning with the DNA. Your answer should include any alterations that occur to both the mRNA and protein during this process (6 pts).

ii) The light chain protein does not contain a membrane anchor sequence. What is a membrane anchor sequence and why is it not required (or desirable) for the light chain (4 pts).

8. (5 pts) A mutation has occurred in the G-protein that recognizes the glucagon receptor. This mutation causes the G-protein to bind to GTP all of the time. How will this affect:

i) the levels of protein phosphorylation in the liver cell.

ii) the release of glucose by the liver.

9. (8 pts) View the Jmol structure of bacteriorhodopsin. Determine the location of non-polar, charged, and polar residues. How does the location of these residues differ with respect to soluble proteins. Why does this difference make sense when considering the environment of this integral membrane protein?