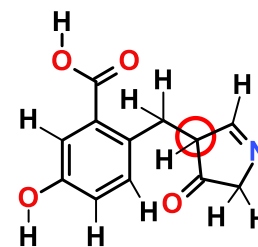


Problem Set 1:

You should be able to answer these questions based on the suggested reading from the openstax text (see syllabus). Feel free to use any resource outside of the text or the lecture.

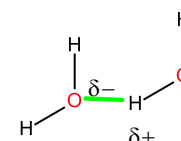
1. Add the correct hydrogen atoms to the drawing on the right, briefly justify your answer.

Hydrogens are added to carbon such that carbon has four bonds.



2. What type of favorable interaction can occur between two water molecules? Hint: Think of the partial charges on each atom.

Favorable interactions form due to the partial negative charge on the oxygen and the partial positive charge on the hydrogen, due to the difference in electronegativity. This type of interaction is called a **hydrogen bond**.



3. What is an enantiomer? Does an enantiomer exist for the compound on the right?

Enantiomers are compounds that contain one or more chiral centers and are mirror images of each other. Amino acids are an example, the alpha carbon is chiral and there are D- and L-amino acids. In the above compound the carbon that is circled is chiral, therefore this compound has a mirror image or an enantiomer.

4. How much does the proton (hydrogen ion) concentration increase if the pH of a solution is changed from 6 to 5?

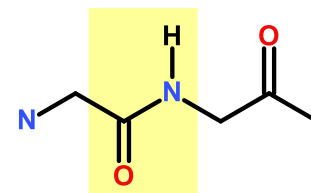
10 fold, since $\text{pH} = -\log [\text{H}^+]$

5. What would happen if ribosomes were inhibited in cells? What could the cell not do?

The cell could not make protein.

6. In the openstax text, what is incorrect about figure 3.24?

The peptide bond is shown in the less favorable cis form. The more stable trans form is shown on the right.



7. What is the difference between a purine and a pyrimidine? What are the common features of a A-T and a G-C basepair?

- A purine is a nucleobase with two rings, a pyrimidine has one.
- Both are held together with hydrogen bonds (2 for AT and 3 for GC)
- Both have a purine and a pyrimidine

8. Compare and contrast prokaryotic to eukaryotic cells. What major features do they have in common, how do they differ?

- The common features are a cell membrane, DNA as the genetic material, and ribosomes to make proteins.
- A major difference is the presence of membrane bound organelles in eukaryotic cells. The organelles have specific functions, e.g. mitochondria are involved in ATP production.

9. What organelles does a protein transit through if it is to be secreted by a eukaryotic cell?

The rough ER, then the golgi.

10. What is the role of the lysosome in a eukaryotic cell?

To degrade unwanted proteins

11. What is the role of topoisomerases in DNA replication?

When DNA is unwound during replication it will become overtwisted. The overtwists will eventually halt replication. Topoisomerases remove the overtwists, allowing replication to continue.

12. What is the most significant difference between prokaryotic and eukaryotic DNA replication?

In eukaryotic cells the linear ends of the chromosomes must be replicated by telomerase. This enzyme uses an RNA template to extend the chromosome until it can be replicated by the normal replication machinery.

13. What is a promoter and what part of the prokaryotic RNA polymerase binds to the promoter?

The promoter is a DNA sequence that recruits RNA polymerase to start the process of transcription.

In prokaryotic cells, the sigma factor of RNA polymerase binds to the promoter. Eukaryotic cells also have promoters, but they are recognized by a number of proteins.

14. In a mRNA, how many bases code for one amino acid?

Three bases code for one amino acid. The coding is unique in that a single three base sequence only codes for one amino acid. However, more than one sequence can code for the same amino acid. For example, both TTT and TTC both code for the amino acid phenylalanine.

15. Compare and contrast exons and introns.

- Both are regions of an RNA molecule.
- Introns are removed during processing of the RNA, causing the exons to be joined together.

16. What three key processing steps happen to mRNA molecules in eukaryotic cells, after the mRNAs are generated by RNA polymerase by transcription?

The mRNA is spliced, the exons are joined together and the introns are removed.

The 5' end is modified with a methyl-G cap

The 3' end has A residues attached (poly A)