

HOMEWORK PROBLEMS SET 1

INTRO TO LIFE ON EARTH

Qu. 1) Extremophile organisms of the genus *Halobacterium* live in extremely salty water containing over 5 moles/liter of potassium ions (K^+). These Archaea also have a high concentration of K^+ ions in their cytoplasm. Because of the extreme concentration of K^+ ions, many proteins of *Halobacterium* are enriched in two specific amino acids compared to mesophile prokaryotes that do not live in very salty water. Which amino acids are enriched in *Halobacterium* and why? [Hint: concentrated K^+ creates a cumulative positive charge. However, natural solutions are electroneutral; for example, you do not get an electric shock when you take a dip in the ocean or when you drink a glass of water]. [3 pts]

Qu. 2) (a) DNA consists of two strands in a double helix. Exposure to high temperatures can cause the strands of DNA to separate, although the strands themselves are left intact. This process of separating of the strands by heating up the DNA is known as **denaturing**. Of the two pieces of DNA below, which one would you expect to denature at a lower temperature and why?

1. GCATTGCCAATGC
2. TTAGCCTATCGG

[3 pts]

(b) The sequence of a strand of DNA is 5'-AGTCGACGA-3'. (Take note: The 5-prime and 3-prime numbers specify the direction in which the DNA runs). What would be the 5' to 3' sequence of the complementary strand of DNA in the double helix?

[2 pts]

Qu. 3) Review the structure of DNA. Describing the basis for your decision, is DNA positively charged, neutral, or negatively charged? [2 pts]

Qu. 4)

(a) The genetic code uses four nucleotide bases, denoted A, T, C and G. These are arranged into codons of three bases, each of which specifies the manufacture of a particular amino acid. The codon can be represented as XXX where X can be any one of the nucleotides containing bases A, T, C or G. Considering all the possible combinations, how many amino acids could in theory be specified by a three letter codon comprised of four nucleotide bases? Considering that the genetic code translation behaves a bit like software instructions, why is the number of genetically coded amino acids likely to be less than this theoretical maximum? [2 pts]

(b) On an inhabited extrasolar planet, extraterrestrial creatures have a genetic code with only two nucleotide bases, which we will denote A and B. If the aliens have proteins consisting of 30 genetically coded amino acids, what is the minimum number of nucleotides in an alien codon? [1 pt]

Qu. 5) Is the following molecule chiral or not? Justify your choice. [2 pts]

