Using Chargaff's Rules

Even before the structure of DNA was elucidated, Erwin Chargaff and his coworkers noticed a pattern in the base composition of nucleotides from different organisms: the number of adenine (A) bases roughly equaled the number of thymine (T) bases, and the number of cytosine (C) bases roughly equaled the number of guanine (G) bases. Further, each species they studied had a different balance of A/T and C/G bases. We now know that these consistent ratios are due to complementary base pairing between A and T and between C and G in the DNA double helix, and interspecies differences are due to the unique sequences of bases along a DNA strand. In this exercise, you will apply Chargaff's rules to predict the composition of nucleotide bases in a genome.

In Chargaff's experiments, DNA was extracted from the given organism, denatured, and hydrolyzed to break apart the individual nucleotides before analyzing them chemically. These experiments provided approximate values for each type of nucleotide. Today, the availability of whole-genome sequencing has allowed base composition analysis to be done more precisely directly from the sequence data.

Table 1: Base Percentage for several species

	Base Percentage			
Source of DNA	Adenine	Guanine	Cytosine	Thymine
Sea urchin	32.8	17.7	17.3	32.1
Salmon	29.7	20.8	20.4	29.1
Wheat	28.1	21.8	22.7	
E. coli	24.7	26.0		
Human	30.4			30.1
Ox	29.0			
Average %				

1. Explain how the sea urchin and salmon data demonstrate Chargaff's rules.

2. Use Chargaff's rules to complete the missing values in the table.

If Chargaff's rules are valid, then hypothetically we could extrapolate this to the combined genomes of all species on Earth (as if there were one huge Earth genome). In other words, the total amount of A in every genome on Earth should equal the total amount of T in every genome on Earth. Likewise, the total amount of G in every genome on Earth should equal the total amount of C in every genome on Earth. Calculate the average percentage for each base in your completed table.

3. Do Chargaff's rules still hold true when you consider those six species together?