Homework One

Please hand in the solutions to the following problems on Tuesday, September 16, 2014. Hand in a hard copy (required) and a CD (optional) or USB flash drive (optional) containing your solutions.

Problem 1 Problems from the textbook – Chapter One

1) What is one of the key challenges facing biology today?
2) What is the main role of DNA?
3) What is a nucleotide?
4) A) Which DNA base is sometimes methylated?
   B) What effect does it have on certain genes?
5) We know that errors occur during DNA replication.
   A) What is the error rate?
   B) Why is it so low?
6) A) What is nucleic acid hybridization?
   B) Give 3 applications in which it is used.
7) What are the main working components of organisms that play the major role in almost all the key processes of life?
8) What part of DNA determines whether a gene is active (a protein is produced) or inactive?
9) What is the name of the RNA transcribed from a protein-coding gene?
10) What is meant by "a gene is expressed"?

11) Name one method for measuring the expression of many genes in a cell.
12) In which direction is the mRNA produced during transcription? Give the direction with respect to the mRNA itself.
13) A) Where do overlapping genes most commonly occur?
    B) Do they also occur in humans?
14) What does it mean that the "genetic code is degenerate"?
15) Which amino acid is often subsequently removed from newly synthesized proteins?
16) How many possible ways are there to translate a given DNA sequence?
17) What is meant by an "open reading frame"?
18) A) What are RNAs mainly involved in?
    B) The 3 main classes of RNAs are: rRNA, mRNA, and tRNA.
       What is each one involved in?

19) A) What molecule is the physical link between the mRNA and the growing protein chain?

B) Where does this molecule bind to?

20) What does the regulation of many processes that interpret the information contained in a DNA sequence rely on?

Problem 2

A) The nucleotide sequence of one DNA strand of a double helix is given. Write the complementary sequence found on the other strand. Notice that the new sequence you will write is on the lower strand. Do not forget to label the ends of your sequence.

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5' --- CACTGTCATGGCTTTTGATCAAAAAAA --- 3'
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B) Search the Web for an on-line tool that will find the complement of a DNA sequence. Write down the URL.

C) Suppose that the DNA molecule from part a) is transcribed and the lower strand (from 3' to 5') is used as the template strand. What is the RNA sequence obtained from the transcription? Label the 5' and 3' ends of the molecule.

D) What is the difference between the RNA molecule you obtained and the given sequence of part a)?

Problem 3

A) The following is a sequence of bases within a segment of a RNA molecule.

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5'--- CACUGUCACGGCUUUAGAUCAAAAAAA --- 3'
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Write the amino acid sequence that would exist in the corresponding segment of the encoded polypeptide molecule. Assume that translation has been initiated and that this sequence is in the proper reading frame (first reading frame).

B) Find an on-line RNA translation tool. Write down its URL.

C) Write all six possible reading frames from 5' to 3' of the following sequence:

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5' --- GCACTAGTCATGGCTTTTGAC --- 3'
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Problem 4

A) Complete the following table. Assume that
- the reading is from left to right
- the columns represent transcriptional and translational alignments

C									DNA double helix
					T	C	A		
	C	A			A				mRNA transcribed
						G	C	A	Appropriate tRNA anticodon
	Trp (W)								Amino acids incorporated into protein

B) Label 5' and 3' ends of DNA and RNA, as well as the amino and carboxyl ends of proteins. [*Introduction to Genetic Analysis* by Griffiths et al., 2005]

Problem 5

Consider the following segment of DNA:

        5' – GCTTCCCAA – 3'
        3' – CGAAGGGTT – 5'

Assume that the top strand is the template strand used by the RNA polymerase.

    A) Draw the RNA transcript.
    B) Label its 5' and 3' ends.
    C) Draw the corresponding amino acid chain.
    D) Label its amino and carboxyl ends.
    E) Repeat, assuming the bottom strand to be the template strand.

            [*Introduction to Genetic Analysis* by Griffiths et al., 2005]

Problem 6   True or False:

    A) It is possible for an RNA polymerase molecule and a ribosome to be attached to a eukaryotic mRNA simultaneously.
    B) At no time during protein synthesis does an amino acid make direct contact with the mRNA being translated.

C) Because the two strands of DNA are complementary, the mRNA of a given gene can be synthesized using either strand as a template.

Problem 7

A) In how many cases in the genetic code would you fail to know the amino acid specified by a codon if you knew only the first two nucleotides of the codon?

B) In how many cases would you fail to know the first two nucleotides of the codon if you knew which amino acid is specified by it?

Problem 8

NCBI has a sample GenBank record at:

http://www.ncbi.nlm.nih.gov/Sitemap/samplerecord.html

Please go to that site, read the example and answer the following questions:

A) What does CDS stand for? Explain.

B) There are three occurrences of "CDS" under "Features". Consider the first occurrence of "CDS". One of its subfields is "/translation".

Explain why "/translation" starts with the specific sequence of amino acids: SSIYN.