STUDY GUIDE TO CHAPTER 10 (*The Structure and Function of DNA*)

1. Discovery of DNA as the genetic material and its structure

The painstaking efforts of three research groups culminated in the conclusion that DNA is the genetic material:

A. Griffith's experiments (1928) with *S. pneumoniae*(non-pathogenic 'R' strain and the pathogenic 'S' strain)led him to the hypothesis that some component of the S strain was the transforming principle.

B. Avery, McCarty, McLeod's work (1944) indicated that nucleic acid, not proteins, is transforming principle.

C. Hershey and Martha Chase (1952) work with ^{32}P- and ^{35}S-labeled phagesconfirmed DNA as genetic material.

Several scientists were involved in the story of DNA's discovery, including the famed James Watson and Francis Crick. Rosalind Franklin – the "dark lady of DNA" – provided the most important piece of scientific data for the eluidation of the structure in 1953.

A. Base pairing and Chargaff's rule B. Dimensions of DNA C. Uniqueness of the structure – implications

2. DNA Replication and Repair

A. How is a DNA molecule duplicated?
   1. First, the two strands of DNA unwind and expose their bases.
      a. Then, unattached nucleotides pair with exposed bases.
      b. Thus, replication results in DNA molecules that consist of one "old" strand and one "new" strand; this is designated _____ .
   2. Several enzymes participate in replication. Identify these.
      a. One kind of enzyme unwinds the two nucleotide strands: _____
      b. Another attaches free nucleotides to the growing strand: _____
      c. Yet another seals new short stretches of nucleotides into one continuous strand: _____

B. How is DNA repaired?
   DNA polymerases "proofread" the new bases for mismatched pairs, which are replaced with correct bases.

C. How does the end of a linear chromosome pose a problem for replication? How is this problem overcome?
   The ends of eukaryotic chromosomes have structures called *telomeres* that prevent information loss.

Shown below is the snapshot of a DNA strand that is being replicated. The primers *X, Y* and *Z* are indicated as *******.

3'---------- 5'
5'----------*** X***----------***Y***----------***Z***---------- 3'

(a) Which of the three RNA primers would first be incorporated as part of Okazaki fragment? Explain.

(b) Which of the three primers will be the first to be removed, and why?

3. How Is RNA Transcribed From DNA?

A. It takes three classes of RNA to synthesize proteins.
   1. _____ carries the "blueprint" to the ribosome.
   2. _____ combines with proteins to form ribosomes upon which polypeptides are assembled.
   3. _____ brings the correct amino acid to the ribosome and pairs up with an mRNA code for that amino acid.

B. The Nature of Transcription
   1. Transcription differs from DNA replication in three ways.
      a. Only one region of one DNA strand is used as a template.
      b. The enzyme used is different: _____ vs. _____.
      c. The result of transcription is a single-stranded RNA.
   2. Transcription begins when RNA polymerase binds to a _____ (a base sequence at the start of a gene) and then moves along to the end of a gene; an RNA transcript is the result.

C. Finishing Touches on mRNA Transcripts
   1. Newly formed mRNA is an unfinished molecule, not yet ready for use.
   2. mRNA transcripts are modified before leaving the nucleus.
      a. The 5' end is *capped* with a special nucleotide that serves as a "start" signal for translation.
      b. A "poly-A tail" of about 100–200 molecules of adenylic acid is added to the 3′ end.
      c. Noncoding portions called _____ are snipped out, and actual coding regions called _____ are brought together to produce the mature mRNA. This process is called _____.

4. Deciphering mRNA Transcripts

A. The Genetic Code

1. Every three bases (a triplet) specifies an amino acid to be included into a growing polypeptide chain; the complete set of triplets is called the *genetic code.*
   a. Each base triplet in RNA is called a _____.
   b. The genetic code consists of sixty-one triplets that specify amino acids and three (called _____) that serve to stop protein synthesis. Which are the three?
   c. _____ is the start codon and specifies the amino acid _____.
   d. With few exceptions, the genetic code is universal for all forms of life.

B. The Other RNAs

1. Each kind of tRNA has an _____ that is complementary to an mRNA codon; each tRNA also carries at its 3′ end one specific _____.
2. After the mRNA arrives in the _____, an anticodon on a _____ bonds to the codon on the _____, and thus a correct amino acid is brought into place.
3. A ribosome has two subunits that perform function together only during translation.

For the peptide *Met – Trp – Gly – Met – Ser*, what is the:
(a) number of possible unique mRNA sequences that encode it, assuming the stop codon is the same.

(b) sequence of any one mRNA that encodes it?

(c) sequence of the coding strand corresponding to (b)?

5. Translating mRNA into Protein

A. Translation proceeds through three stages.

1. In _____ , a complex forms in this sequence: initiator tRNA + small ribosomal subunit + mRNA + large ribosomal subunit.
2. In _____ , a start codon on mRNA defines the reading frame; a series of tRNAs deliver amino acids in sequence by codon–anticodon matching; a peptide bond joins each amino acid to the next in sequence.
3. In_____ , a stop codon is reached and the polypeptide chain is released into the cytoplasm or enters the endomembrane system for further processing.

6. Mutated Genes and Their Protein Products

A. A gene mutation is a change in one to several bases in the nucleotide sequence of DNA, which *can* result in a change in the protein synthesized.

B. Common Mutations

1. Spontaneous mutation can cause sickle-cell anemia, which is the result of a single "base pair substitution," which places _____ as the sixth amino acid in the hemoglobin chain instead of _____. The corresponding change in DNA is from: _____ to _____ .
2. In a "frameshift mutation," there may be an insertion or deletion of several base pairs, causing a misreading of the mRNA during translation.

C. How Do Mutations Arise?

1. Mutations are rare, chance events, but fortunately special enzymes correct most of the mistakes.
2. Mutations can be caused by _____ such as ionizing radiation (gamma and X-rays), ultraviolet radiation, and chemicals such as alkylating agents, which act as carcinogens.

D. The Proof is in the Protein

1. If a mutation arises in a somatic cell, it will affect only the owner of that cell and will not be passed on to offspring.
2. If however, the mutation arises in a gamete, it may be passed on and thus enter the evolutionary arena.
3. Either kind of mutation may prove to be harmful, beneficial, or neutral in its effects.

A point mutation changes a peptide sequence from *Met – Asn – Trp – Ser – Gly* to *Met – Thr – Gly – Val* . Write out the sequence of the portion of mRNA that corresponds to the original pentapeptide.