Sierra College Name _____

DNA, RNA and Protein Synthesis

The **nucleus** (eukaryotic cells) or **nucleoid** (prokaryotic cells) is considered to be the control center (sometimes called the "brain") of the cell, because it contains the genetic information that determines what metabolic processes the cell can run, i.e., what **enzymes** and **ribozymes** the cell can make. This genetic information is stored within molecules of **deoxyribonucleic acid** (DNA) in the form of nucleotide (base) sequences. In order for DNA to be passed on to successive generations, it must be reproduced prior to cell division. The process by which this occurs within cells is called _____, is a **semi-conservative** process, and requires several different types of enzymes. An enzyme called _____ can catalyze the formation of **phosphodiester bonds** attaching DNA-type nucleotides to the free, 3' ends of growing nucleotide strands, and an enzyme called _____ is used to catalyze reactions binding together (joining) the many small segments of DNA called _____ fragments, that make up the lagging strand.

Cellular DNA molecules contain two nucleotide strands joined to one another by relatively weak **hydrogen bonds**. The two strands are **antiparallel** (up-side-down relative to one another) and **complementary**. If one strand of the DNA double helix contains the base sequence shown below, what will be the base sequence of the complementary strand?

DNA base sequence = TACTAGTTGAAAGTCCATGAGCCCGGGTTTATT
Complementary sequence = _____

Ribonucleic acid (RNA) is also formed when DNA is reproduced. Each of the "fragments" named above begins with a short sequence of RNA, and the proteins involved in the production of these are called _____ enzymes. RNA molecules (t-RNA, m-RNA, r-RNA, etc.) are made through a process called _____ that occurs within the nucleus or nucleoid because it requires DNA as a pattern or template. This process requires a type of enzyme called _____, that in prokaryotic cells is a complex containing five proteins. One important component of this enzyme complex is a protein called _____ that recognizes and binds with a specific portion of DNA known as the _____ site. Once this has occurred, the core enzyme can bind and begin the building process. In prokaryotic cells the synthesis of RNA molecules is said to be _____ because each m-RNA molecule produced is a copy of multiple structural genes (cistrons).

If the DNA base sequence **TYPED** above were used as the template for building m-RNA, the base sequence in the m-RNA would be _____.
Messenger-RNA molecules (m-RNA) carry the information telling cells what types of poly-peptides to make, and the process involved is called _____ (also called protein synthesis, although the polypeptide made may not be a complete protein). Protein synthesis occurs in association with _____ in all types of cells, because these bodies contain the catalyst (called _____) required for **peptide bond** formation. This catalyst is actually a type of **ribosomal-RNA** (r-RNA) molecule, so is actually a _____ rather than an enzyme.

If a polypeptide were constructed using the m-RNA sequence **WRITTEN** above, the amino acid sequence would be _____.

Does this polypeptide contain the same number of **amino acids** as there are **codons** in the m-RNA? _____ Explain why or why not below.

Individual amino acids are carried to ribosomes by another type of RNA molecule called **transfer-RNA** (t-RNA). Each t-RNA picks up a specific type of amino acid (from the 20-plus possible types available within cells) because the "picking up" requires the activity of another type of catalyst. This is a type of enzyme called _____, and each one can catalyze a reaction between a specific type of t-RNA and a specific amino acid. The nucleotide sequences of t-RNA molecules differ from one another in their **anti-codon** regions, and this is essential to protein synthesis because each anti-codon can form _____ bonds with a complementary codon on the m-RNA molecule being translated.

The synthesis reactions associated with **replication**, **transcription** and **translation** are endergonic, i.e., require energy, so cost the cell in terms of energy expenditure. The energy required for replication and transcription is provided by _____, while the energy required for peptide bond formation is provided by alternate (and less obvious) sources.

In prokaryotic cells metabolic processes are often regulated at the gene level through the interactions of proteins with regions of DNA called _____. Each of these contains a series of structural genes, and one or more "control elements", i.e., regions of DNA involved in regulating the transcription of those genes. The promoter site (as described above) is where sigma factor binds to initiate transcription. Beyond or "down stream of" the promoter is a region of DNA called the _____ site, that serves as a sort of "on/off switch". Constitutive proteins called _____ proteins can bind to this site and block transcription, but only if they are active. In the case of the tryptophan biosynthesis operon, the repressor protein is inactive until it has formed a complex with _____ (an amino acid and the end-product of the tryptophan biosynthesis pathway). Thus, this operon is said to be _____, i.e., transcription is "on" (will continue), unless it is "turned off" (is repressed), and repression occurs only when intracellular levels of tryptophan have increased to a certain level. In the case of the lactose utilization operon, the repressor protein is active alone, so will block (repress) transcription unless it is inactivated. This requires an _____ (a sugar called allolactose). Because transcription of the lactose utilization genes is repressed unless allolactose is available, this operon is _____ (is "off", but can be turned "on"). The enzymes involved in **glycolysis** are essential to the function of many cells, so are _____, i.e., always being made in those cells. If glucose is available, these cells are better off (in terms of energy conservation) to use it, rather than making the enzymes required to utilize an alternative **catabolite** such as lactose. In *E. coli* cells, glucose up-take inhibits the production of a nucleotide called _____ by blocking the activity of an enzyme called adenylate cyclase. This regulatory nucleotide when bound to a catabolite activating protein can enhance the promoter sites of inducible operons (i.e., make them more attractive to sigma factor). Thus, glucose availability can prevent the activation of inducible operons. This regulatory mechanism is called _____.