Unit 9 Notes: Expressing Genetic Information

I. Transcription

A. In both prokaryotes and eukaryotes, transcription of DNA by RNA polymerase is the beginning of gene expression.

1. Prokaryotes only use one type of RNA polymerase to the various types of RNA.

2. Eukaryotes have three kinds, whose combined efforts make rRNA, mRNA, and tRNA.

a. In the nucleolus, rRNA and proteins are assembled into ribosomal subunits (large & small).

b. mRNA serves as the code to be read by ribosomes.

c. tRNA carries amino acids to ribosomes for translation.

B. Transcription has a beginning, middle, and end.

1. Initiation begins when RNA polymerase is attracted to and binds a promoter region on DNA.

2. In elongation, RNA polymerase unwinds DNA and binds RNA nucleotides based on the DNA's coding strand.

3. When RNA polymerase reaches the terminator region, the enzyme and primary transcript are released.

C. Before leaving the nucleus, all three types of RNA are modified.

1. mRNA is modified in three ways.

a. A methyl-guanine (mG) cap is added to mark the starting end.

b. The other end gets a poly-A tail (100-200 A's) for protection from enzymes.

c. Segments of the mRNA that don't code for its protein (introns) are spliced out, leaving the parts to be expressed (exons).

2. tRNA is spliced, chemically modified, and folded into a stable "cloverleaf" shape with an anticodon and amino acid binding site.

3. rRNA is spliced, modified, and bound to proteins to form the large and small subunits of ribosomes.

II. Translation

A. Protein synthesis translates the codon sequence of mRNA into the amino acid sequence of a protein.

1. In initiation, two ribosomal subunits attach to an mRNA with a mG cap and a tRNA carrying methionine binds at the P site which holds the start codon (AUG).

2. Elongation creates a bond between amino acids.

a. A charged tRNA enters the ribosome's A site.

b. The growing protein (held by a tRNA at the P site) binds to the amino acid at the A site.

c. The uncharged tRNA from the P site leaves via the E site while the tRNA holding the protein at the A site moves to the P site.

3. Termination occurs when a stop codon reaches the A site: a releasing factor (protein) pairs with the stop codon and causes the release of the mRNA.

B. Many proteins must be modified and/or transported.

1. Chemical modification (adding sugars, cutting, etc.) causes the protein to fold into its active tertiary structure.

2. The ER can be used to move proteins.

a. An amino acid signal sequence binds to an ER receptor during translation, allowing the protein in.

b. After the signal sequence is removed and sugars are added, the protein is transported to the plasma membrane or Golgi apparatus (vesicle).

C. Errors in translation can produce nonfunctional proteins.

1. The starting point of the reading frame can be shifted by one or two bases.

2. Mistakes in DNA can cause frame shift errors (splicing error, loss of a base) or partial proteins (new stop codon).

III. Viruses

A. Viruses are tiny, non-cellular particles that depend on other cells for respiration, gene expression, and reproduction.

1. Typically a virus is made of: a protein or lipid membrane coat, a small bit of DNA or RNA, and maybe a few enzymes.

2. Virus reproduction falls into two patterns.

a. In lytic infections, the host cell's enzymes and ribosomes replicate, transcribe, and translate the viral DNA or RNA into new viruses which lyse (break) the cell.

b. Viral DNA (or a copy of viral RNA) is inserted into cellular DNA and is replicated whenever the cell divides – lysogenic.

i. Viral particles wrapped in the host cell's plasma membrane may be given off from time to time.

ii. Stress to the host cell may activate a lytic cycle.

B. Viruses have impacted humanity in a variety of ways.

1. Antibiotics which attack bacterial metabolism don't cure viruses; weakened viruses are used in vaccinations.

2. Rare, deadly viruses may be spread through trading and rapid transit.

3. Disarmed viruses can deliver DNA for biotech. research.