Chapter 13

How Proteins Are Made

From Genes to Proteins

- Traits are determined by specific proteins
- Proteins are built from instructions in DNA
- Proteins are not built directly from DNA
- Use this website to help you!
- http://207.207.4.198/pub/flash/26/transmenu_s.swf

RNA

- A type of nucleic acid
- Single strand of nucleotides rather than a double helix (DNA)
- Ribose sugar instead of Deoxyribose Sugar
- No thymine, replaced by uracil

Making a Protein

- Coded in the genes
- Instructions for proteins are transferred from a genes to RNA
- This process is called Transcription
- This RNA is then decoded into a protein
- This process is called Translation
- Whole process is called Protein Synthesis

Transcription

- The process wherein a molecule of messenger RNA (mRNA) is synthesized along a template strand of DNA
- Happens in the nucleolus
- Occurs in 4 Stages: Initiation, Elongation, Termination, mRNA Processing

Initiation

- Promoter site signals where transcription begins
- RNA Polymerase binds to this site
- In eukaryotes, promoter site consists of a TATA Box

- 1st, transcription factors attach to the TATA Box
- They are proteins that help RNA Polymerase bind to promoter site
- RNA Polymerase then binds to the promoter
- RNA Polymerase is the enzyme that makes the pre-mRNA strand

- RNA Polymerase begins to unwind the double helix

Elongation

- Using the base pairing rules, RNA Polymerase reads the template strand and creates the pre-mRNA strand
- Thymine is replaced by uracil
- A pairs with U
- As RNA polymerase moves along the template, the mRNA strand separates from the template

- The double helix closes up behind the RNA Polymerase

Termination

- When the RNA Polymerase reaches a terminator (signal to stop)
- RNA Polymerase transcribes the terminator and a few nucleotides after that
- The pre-mRNA strand releases

RNA Processing

- Before the mRNA strand leaves the nucleus, it must be altered
- The ends of the strand are “capped” to prevent damage from enzymes in the cytoplasm
- Also a signal for attachment of ribosome

- Non-coding segments called Introns are removed
- Exons are coding sequences
- Introns are removed and exons are attached by splicosomes
- mRNA is now ready to leave the nucleus

Translation

- Translation is the synthesis of a polypeptide strand using the information of the mRNA molecule
- Occurs at ribosomes outside the nucleus
- Ribosomes are made of subunits composed of proteins and rRNA (Ribosomal RNA)
- mRNA leaves through pores
- Occurs in 3 main steps: Initiation, Elongation, Termination

Initiation

- When mRNA strand attaches to a ribosome, a tRNA molecule carries the 1st amino acid of the polypeptide chain
- tRNA stands for transfer RNA
- tRNA attaches to the start codon AUG
- Always the start codon
- Ribosome has 3 attachment sites: E, P, A

Elongation

- Every 3 nucleotides represents a codon
- Codons code for a specific amino acid
- Incoming tRNA molecules have an anticodon which pairs with a specific codon

- A tRNA molecule attaches at the A site
- The amino acid carried is attached to the 1st amino acid by a peptide bond
- The tRNA molecules then slide down one site
- The used tRNA exits at the E site
- Then the process repeats

Termination

- Terminates when a stop codon is reached
- At this point, the polypeptide chain is released
- The ribosome breaks apart and releases the mRNA strand

- Multiple ribosomes travel along the mRNA strand

Gene Regulation

- Control of genes is different in prokaryotes and eukaryotes
- While different, both can control this process with different approaches

Prokaryote Gene Regulation

- Well studied example found in E. coli bacteria
- Three different enzymes required to break down lactose into glucose and galactose
- Each enzyme is coded for by three different genes

- All three genes are located next to each other
- Controlled by the same promoter site
- When lactose is available, the genes are switched on and turned off when not available

- The switch is called an operator
- An operator is a segment of DNA that overlaps the promoter site
- It controls RNA Polymerase's access to the promoter site
- All together, the operator, promoter site, and genes are called an operon

- The operon that controls the metabolism of lactose is called the lac-operon
- Repressors are proteins that bind to the operator and block RNA Polymerase (Off Switch)

Gene Regulation in Eukaryotes

- Have much more DNA
- Operons not found very often
- When transcription factors, RNA Polymerase, and Activators come together they initiate transcription

Mutations

- Mutations that change just one or a few nucleotides are caused point mutations
- Substitution Mutation (Wrong Nucleotide)
- Insertion Mutation (Extra Nucleotide)
- Deletion Mutation (Remove Nucleotide)