Protein Synthesis

Chapter 9
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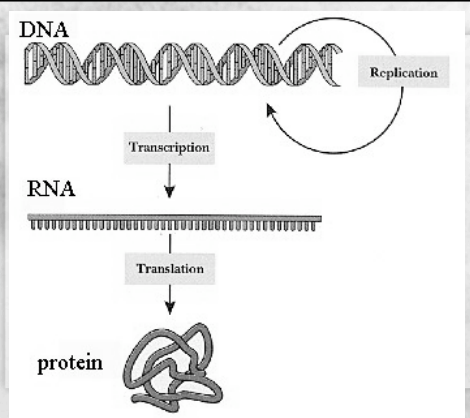
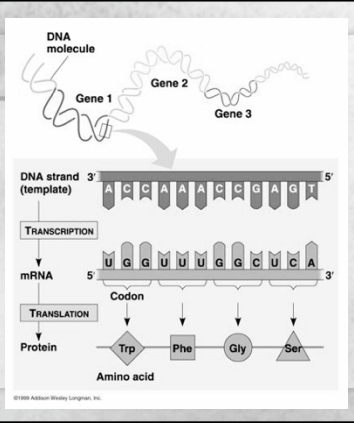
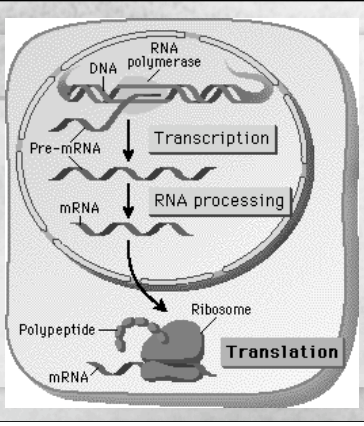
Protein Synthesis

- Gene- segment of DNA that codes for a protein.
- Gene Expression/ Protein Synthesis is the process of using DNA's genetic code to make proteins.
  - Transcription- RNA is written from the code of DNA in the nucleus.
  - Translation- Amino Acids are ordered in the proper sequence to form a polypeptide chains in the cytoplasm of the cell. Nucleic Acid is converted to an amino acid sequence.



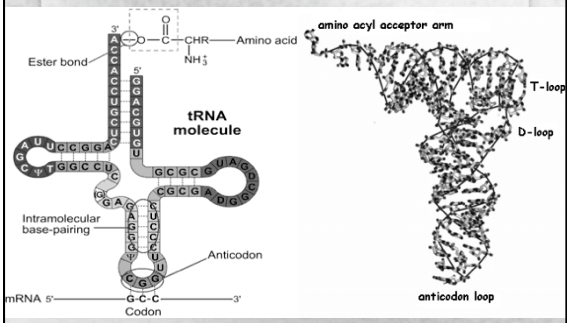




RNA

- RNA- Ribonucleic Acid
  - Sugar is Ribose
  - Single stranded
  - Adenine, Uracil, Guanine, Cytosine are bases
- mRNA- messenger RNA- temporary copy of a gene that encodes a protein.
- tRNA- transfer RNA- cloverleaf shaped molecule that carries amino acids during translation.
- rRNA- ribosomal RNA- with other proteins make up a ribosome, formed in the nucleolus.
- snRNA- small nuclear RNA- interact with specific protein during RNA processing in eukaryotes.

tRNA structure



Genetic Code

- Sequence of bases of DNA or RNA that code for Amino Acids.
- Codon- three base sequence of **mRNA** that codes for an amino acid.
- Anticodon- three base sequence of **tRNA** that is complimentary to a mRNA codon. Directs the sequence of Amino Acids.
- Types of Proteins made during Protein Synthesis
  - Structural
  - Antibodies
  - Hormones
  - Enzymes

Transcription

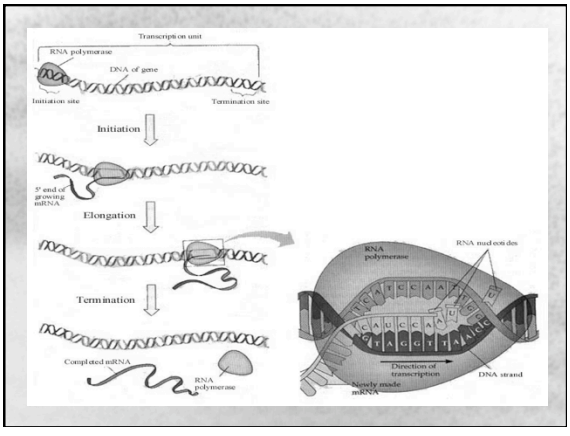
- **In the nucleus**, DNA's code is transcribed into a molecule of RNA by transcription.
- Different types of the enzyme RNA Polymerase will transcibe mRNA, tRNA, and rRNA.
- rRNA and ribosomal proteins are synthesis in the nucleolus.
- A complimentary strand of RNA is made from one strand of DNA.
- RNA are modified in the nucleus then exit through pores in the nuclear membrane.

Transcription

- Only one strand of the DNA- the coding or the template strand, will code for RNA.
- RNA made during transcription will be complimentary to the coding strand from DNA.
- Initiation
  - RNA Polymerase will attach to a section of DNA at the promoter site located just before the segment of DNA to be transcribed.
  - Initiation factor proteins must be present for RNA polymerase to attach to the promoter region.

Transcription

- Elongation
  - RNA Polymerase partially unwinds DNA, exposing coding strand of the gene.
  - RNA polymerase moves along the strand away from the promoter site as it adds complimentary RNA nucleotides to make a primary transcript.
- Termination
  - When RNA polymerase reaches terminator region, RNA polymerase and RNA primary transcript are released.



RNA Processing

- mRNA can last a few minutes to a few days depending on the way it is processed.
- Primary RNA transcript can contain 200,000 nucleotides, post transcription modifications can reduce mature mRNA to 1,000 nucleotides.
- All RNA is processed before it leaves the nucleus.

mRNA Processing

- mRNA post transcription modifications
  - Enzymes add a methyl guanine nucleotide to the starting tail of the mRNA. (mG cap)
  - Enzymes replace part of the opposite tail with 100-200 Adenine nucleotides. (poly-A tail)
  - The mG cap and poly-A tail protect mRNA from enzymes that would break down nucleic acids. (The longer the poly-A tail- the longer the lifespan of the mRNA)
  - Poly-A tail helps transport the RNA out of the nucleus.

mRNA Processing

- Segments of mRNA that do not code for proteins are removed.
- Intron- internal segment of mRNA that does not code for protein.
- Exon- Segments of mRNA that code for proteins remain after splicing.
- Splicing- removal of introns and rejoining of cut exons.
- Splicing enzymes recognize GU at one end of an intron and AG at the other end.

tRNA and rRNA processing

- tRNA processing
  - Nucleotides are modified and tRNA molecule is folded into a stable cloverleaf shape with an anticodon and amino acid binding site.
- rRNA processing
  - Primary rRNA transcript is spliced and modified into mature rRNA molecules that will bind to proteins to form the 2 subunits of a ribosome.

Translation

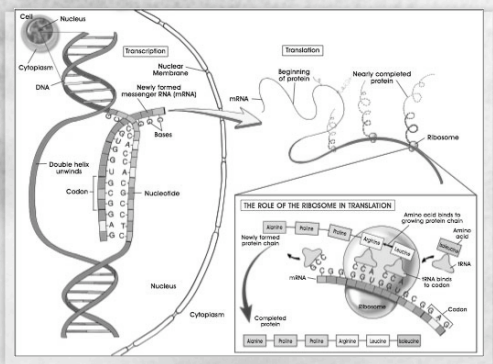
- The codon of mRNA is translated into the amino acid sequence of a protein.
- Step 1- Processed mRNA leaves the nucleus and enters the cytoplasm and joins with 2 ribosome subunits. The mRNA start codon (AUG) signals a tRNA molecule carrying methionine and attaches at the anticodon at the P site.
- Step 2- The next codon at the A site receives a tRNA with the complimentary anticodon which is carrying a specific amino acid.

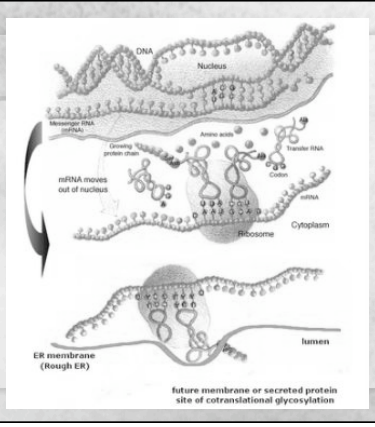
Translation

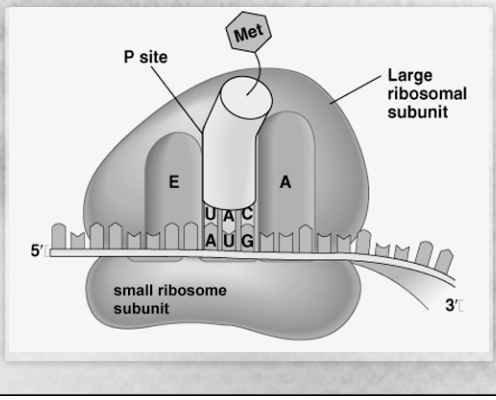
- Step 3- Enzymes in the ribosome form a peptide bond between amino acids.
- Step 4- The ribosome shifts down one codon, the tRNA at the P-site enters the E site and detaches leaving the methionine behind.
- Step 5- The tRNA at the A-site shifts to the P-site, the A-site is unoccupied.
- Step 6- A new tRNA occupies the empty A site. The amino acids are bonded.

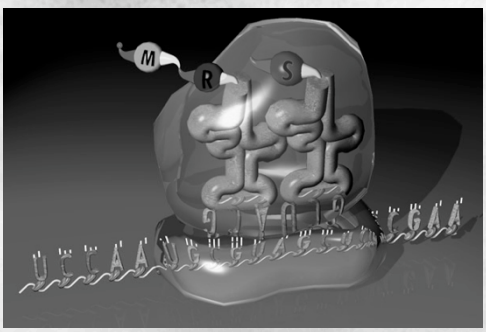
Translation

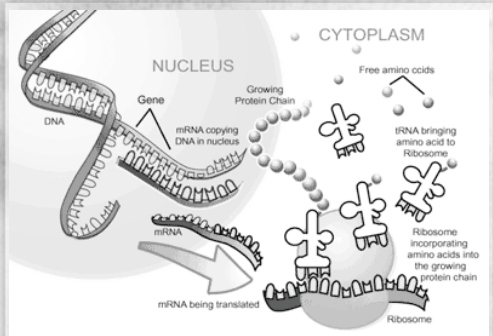
- Step 7- The processes continues until the stop codon reaches the A-site. There is no tRNA with the anticodon for these codons.A releasing factor protein pairs with the stop codon and causes the new polypeptide chain to be released into the cell.











Protein Modifications

- After translation proteins need to be modified to gain a functional structure.
- Proteins will fold to obtain tertiary structure.
- Sugars can be added to polypeptide- glycoprotein.
- Proteins can be transported by E.R.
  - Amino acid signal sequence binds to an E.R. receptor during translation allowing proteins in.
  - After the signal sequence is removed and sugars are added, the protein is transported to the plasma membrane or Golgi apparatus via vesicles.

Translation Errors

- Starting point of a reading frame can be off by one or two bases during Translation.
- Mutations- changes in DNA
  - Point mutation- substitution of one base can cause the change in one amino acid (missense), a premature stop codon (nonsense), or no change at all (silent).
  - Frameshift mutation- an insertion or deletion of bases in the DNA sequence that will change every subsequent codon. (splicing error, loss of base)

Viruses

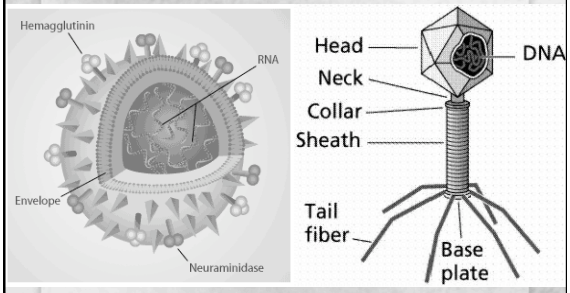
- Tiny, non-cellular particles that depend on host cells for respiration, gene expression, and reproduction.
- Viruses are constructed of
  - Protein or lipid membrane coating
  - Small amount of DNA or RNA
  - Some enzymes

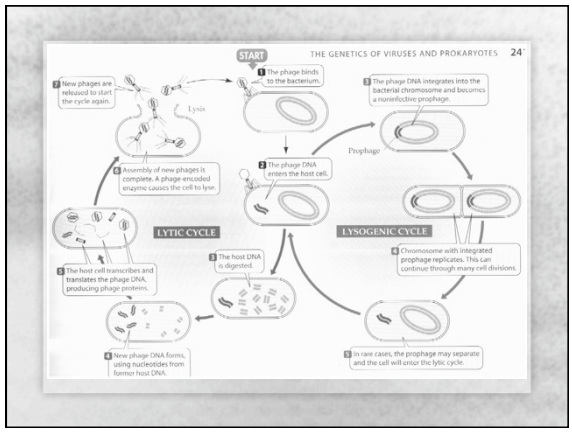
Virus Reproduction

- Lytic reproduction- host cell enzymes and ribosomes replicate transcribe, and translate the viral DNA or RNA to make new viruses which cause the cell to lyse.
- Lysogenic reproduction- viral DNA (or copy of viral RNA) is inserted into the host cell's DNA and is replicated when the cell divides.
  - Viral particles wrapped in the the host cell's plasma membrane may be given off.
  - Stress on the host cell can activate a lytic cycle.

Viruses

- Bacteriophage- type of virus that attacks bacteria.
- Retrovirus- virus with RNA, uses process of reverse transcription to turn the viral RNA into DNA that can join the host cell's DNA
  - RNA is turned into DNA by enzyme reverse transcriptase.
- Antibiotics don't cure viruses.
- Weakened viruses are used for vaccines.
- Disarmed viruses can be used to deliver DNA for gene therapy and genetic engineering




START
THE GENETICS OF VIRUSES AND PROKARYOTES 24
1 The phage binds to the bacterium.
2 The phage DNA enters the host cell.
3 The phage DNA integrates into the bacterial chromosome and becomes a noninfective prophage.
Prophage
4 Chromosome with integrated prophage replicates. This can continue through many cell divisions.
5 In rare cases, the prophage may separate and the cell will enter the lytic cycle.
LYSOGENIC CYCLE
LYTIC CYCLE
3 The host DNA is digested.
5 The host cell transcribes and translates the phage DNA, producing phage proteins.
6 New phage DNA forms, using nucleotides from former host DNA.
6 Assembly of new phages is complete. A phage-encoded enzyme causes the cell to lyse.
7 New phages are released to start the cycle again.
Lysis