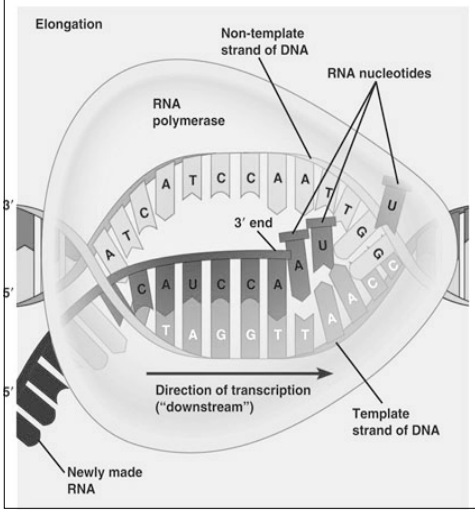
Transcription & Translation

or “Making Proteins”

A. Transcription

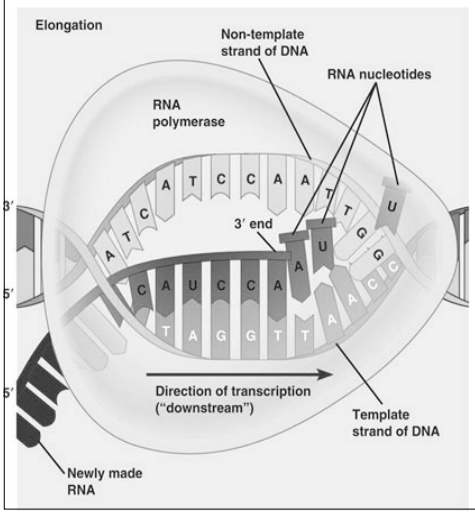
(in prokaryotes)



1. RNA polymerase
   a. attaches to the promoter region
   b. splits DNA into 2 strands
      - The template is called the “<u>antisense strand</u>” (it is complementary to the mRNA)
      - The other DNA strand is called the “<u>sense strand</u>” (it matches the mRNA strand - except T instead of U)

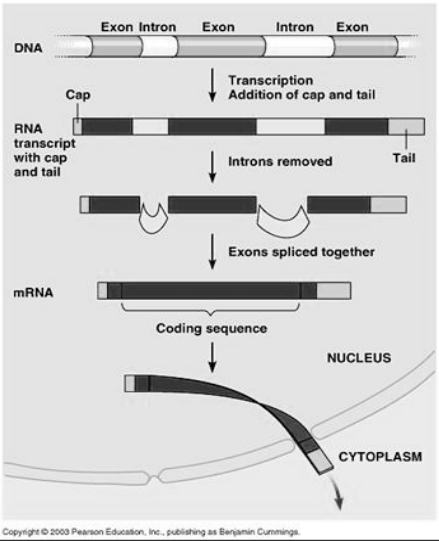
A. Transcription (cont'd)

(in prokaryotes)



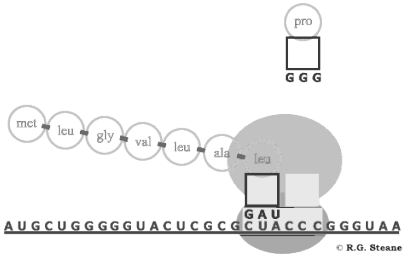
1. RNA polymerase (cont'd)
   c. makes the mRNA
      - Free nucleoside triphosphates used to extend the mRNA
      - -OH on C_2 make it ribo (not deoxyribo)
      - 2 phosphate groups removed for energy to drive the reaction
      - Transcription moves in the **5' ---> 3'** direction
   d. rewinds the DNA at the other end
   e. mRNA detaches at the terminator site.

A. Transcription (cont'd)



2. In eukaryotes, the RNA needs the introns removed to form mature mRNA
3. Then the mRNA leaves the nucleus and enters the cytoplasm to do its job - translation.

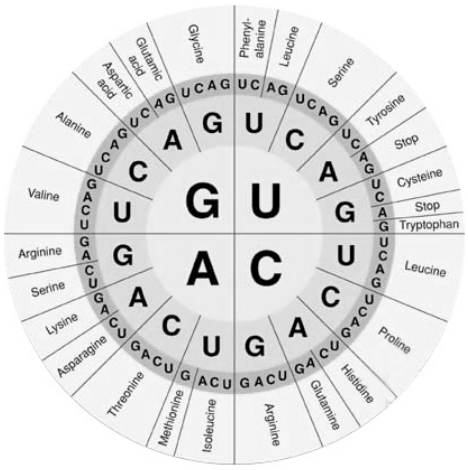
B. Translation



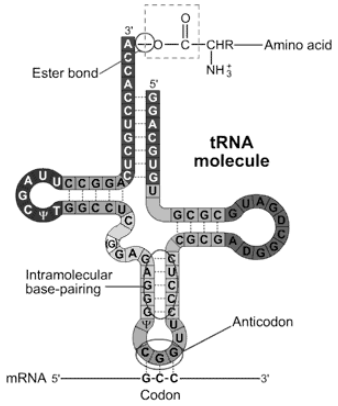
1. General
   - Ribosomes, mRNA, and tRNA, with their amino acids, make protein
   - Free ribosomes make protein for use in the cell
   - ER-bound ribosomes make proteins for export
     - Export (secretion)
     - Lysosomes.

B. Translation (cont'd)

2. Genetic Code used by mRNA:
   - Triplet code = three bases code for one amino acid
   - Codon = three bases
   - Degenerate code = all 64 codons are used for 20 amino acids
   - Universal = virtually ALL living things and viruses use this code.

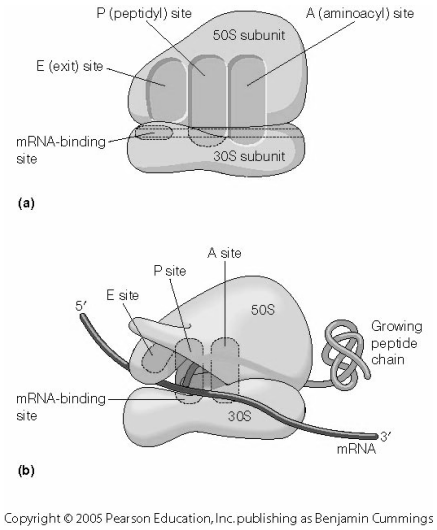


B. Translation (cont'd)



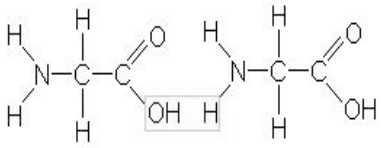
3. tRNA
   - Note the tRNA structure
   - 20 different amino acids means 20 different tRNA-activating enzymes
   - tRNA-activating enzyme catalyzes amino acid attachment:
     - Amino acid reacts with ATP and becomes activated (ATP energy used)
       - tRNA + amino acid +ATP (tRNA activating enzyme)---> activated tRNA-amino acid complex + AMP
     - Activated amino acid binds to the acceptor stem of the tRNA (3' end)
   - CCA end forms a covalent bond with the a.a. by dehydration synthesis (condensation reaction).

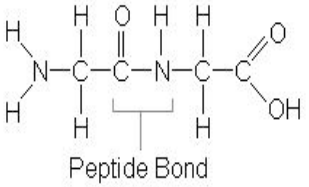
B. Translation (cont'd)



4. Ribosomes:
   - 1000's in each cell
   - When many are working on the same mRNA, they are called <u>polysomes</u>
   - Structure:
     - Proteins & rRNA
     - Two subunits - one large and one small
     - Three binding sites for tRNA called A, P, and E sites (large subunit)
     - 1 binding site for mRNA (small subunit).

B. Translation (cont'd)





A molecule of water is removed from two glycine amino acids to form a peptide bond.

5. Peptide Bond
   a. Dehydration synthesis reaction (condensation reaction)
      - Takes out water
      - Makes peptide bond
      - Joins 2 amino acids
   b. Reaction catalyst:
      - rRNA itself?
      - Peptidyl transferase?

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B. Translation (cont'd)

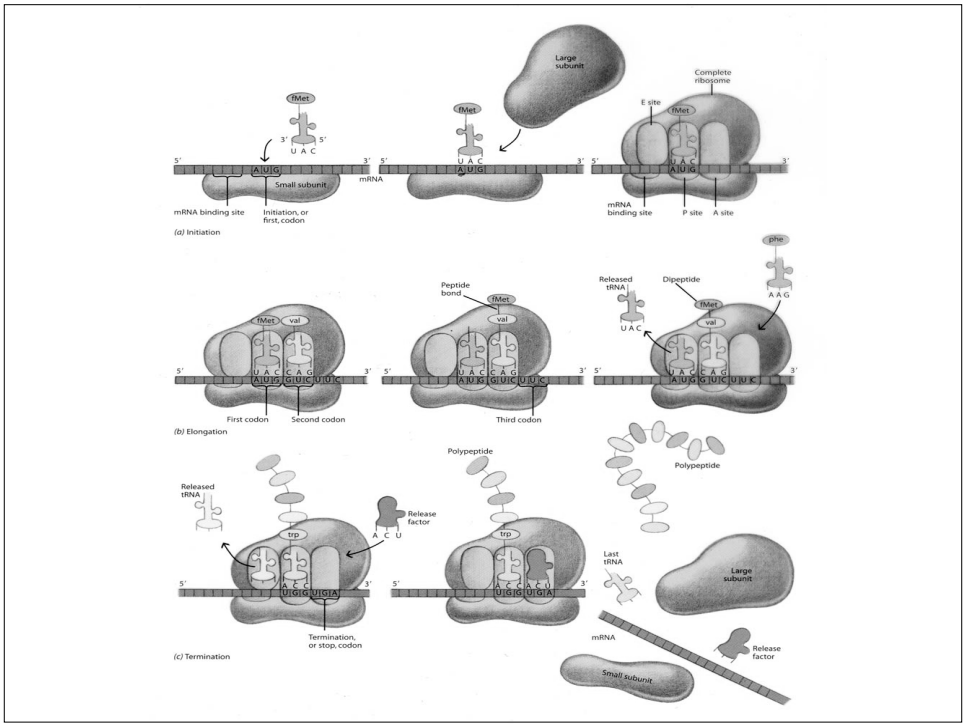
6. The Process
   1) Initiation
      a. Start codon on mRNA is AUG
      b. Activated tRNA (with methionine) binds to P-site base on small subunit with help of ATPase
      c. Small subunit with tRNA binds to ribosomal binding site at 5' end of mRNA
      d. Small subunit slides along mRNA (5' ---> 3' direction)
      e. When P reaches start codon, the large subunit joins the complex.

B. Translation (cont'd)

6. The Process (cont'd)
   2) Elongation & Translocation-
      a. Second tRNA (whose anti-codon is complementary to the next mRNA codon) binds to the open A site
      b. Part of the ribosome catalyzes the formation of the peptide bond between the two amino acids
      c. The ribosome moves over 3 bases in the 5' ---> 3' direction (translocation)
      d. Now the first tRNA is in the E site, the second tRNA is in the P site, and the A-site is open
      e. The first tRNA detaches

B. Translation (cont'd)

6. The Process (cont'd)
   3) Termination -
      a. Stop codons are found near the 3' end of mRNA
      b. When the A-site moves over a stop codon, this is the signal to stop
      c. There are no tRNA with anti-codons complementary to the stop codons
      d. The bond between the polypeptide chain and the last tRNA id broken by hydrolysis
      e. The polypeptide is released
      f. tRNA released and the large subunit, small subunit, and mRNA all separate.


fMet
Small subunit
mRNA binding site
Initiation, or first, codon
(a) Initiation
Large subunit
mRNA
Complete ribosome
E site
P site
A site
mRNA binding site
fMet
val
First codon
Second codon
Third codon
(b) Elongation
Peptide bond
Released tRNA
Dipeptide
phe
trp
Release factor
Termination, or stop, codon
(c) Termination
Polypeptide
Last tRNA