Translation

A) Components

- mRNA - conveys the genetic code to site of protein synthesis
- Ribosomes - organelles where protein synthesis occurs
  a. two parts - large and small subunits that are characterized by "s" values
  b. bacterial ribosomes are typically 70s when the two components are combined; the small subunit is 30 s and the large 50 s when measured apart.
  c. ribosomes in eukaryotic cytoplasm are slightly larger; 80s overall with 35s and 60 s subunits
  d. each component has a long piece of RNA (rRNA) that serves as a scaffolding for 20 or more proteins
    - bacterial rRNAs are 16s and 23s while those in eukaryotic ribosomes are 18s and 28s in the Large and Small subunits, respectively
    - there is also a small 5s rRNA that helps link the subunits
  e. rRNA is coded by multiple genes in the genome
    - the genes are randomly arrayed, one after the other with a short spacer between
    - each rRNA gene is transcribed into one long pre-rRNA that contains all three subunits
    - the large, small, and 5s rRNA fragments are released from the pre rRNA by specific enzymes

- tRNAs transfer amino acids to the ribosome
  - each tRNA-amino acid combination requires a different activation enzyme
  - the energy comes from ATP
  a. each tRNA is a single strand about 77 bases in length but folds back on itself by hydrogen bonding into a "cloverleaf" structure
b. the 3 bases at the end of the middle leaf are called "anticodons"; they form base pairs with the code words (codons) in the mRNA.

c. "charged tRNA" carrying histidine (anticodon)

d.) tRNAs are also coded by DNA, with several copies per genome.

1. B) Mechanism (recall that translation takes the information from a chain of nucleotides to make a chain of amino acids)

1. • Initiation

1. The 5' leader of the message attaches to the small subunit of a ribosome (in prokaryotes, base pairing between the mRNA leader and an exposed section of the 16s rRNA is enough).

2. In the presence of "initiation factors" the large subunit is added, which aligns the first AUG in the message with a P site of the ribosome.

3. A tRNA called f-met-tRNA is positioned on the ribosome so that it's anticodon pairs with the AUG in the mRNA.

   • in prokaryotes, the tRNA carries a modified methionine that has a C=O attached to its amino group
   • In eukaryotes, the f-met tRNA is used to start but does not carry any amino acid.

4. The next tRNA with an anticodon complementary to the next codon in the message is positioned in the A site.

  • [http://www.sp.uconn.edu/~bi107vc/fa99/terry/images/tliniani.gif](http://www.sp.uconn.edu/~bi107vc/fa99/terry/images/tliniani.gif)

• elongation
1. the high energy bond holding the growing chain of amino acids in the P site is used to make a new peptide bond by linking to the amino group of the amino acid on the tRNA in the A site.

2. the now-uncharged tRNA in the P site is released for re-use

3. the peptide bond is formed by an enzyme called peptidyl synthase which includes both protein and RNA from the large subunit, making it a "ribozyme"

4. the tRNA with the now-longer chain of amino acids moves from the A site to the P site

5. the energy needed to break the H-bonds for moving tRNAs and for inching the message along the ribosome comes from GTP, not ATP

6. once enough of the message has been read, another ribosome can attach through the initiation process and start translating the same message

http://www.sp.uconn.edu/~bi107vc/fa99/terry/images/tlelonga.gif

• termination
  • whenever one of 3 codons, UAG, UUA, UGA enters the A-site of the ribosome, translation will end
    • there are no tRNAs with corresponding anticodons
    • a release factor enters the A site and triggers the peptidyl synthase, releasing the polypeptide chain
    • the ribosome disassembles and can be used over and over
  • these 3 codons are called stop codons for their effect on translation, or nonsense codons since they do not call for amino acids

http://www.sp.uconn.edu/~bi107vc/fa99/terry/images/tilterman.gif