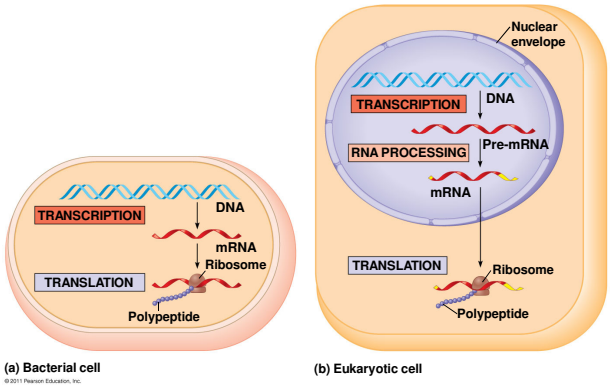
TRANSLATION



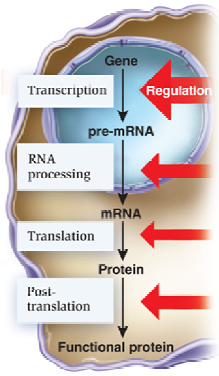
Learning outcomes

(f) Explain translation in protein synthesis.

(g) Describe the stages involved:
- i. Initiation
- ii. Elongation (codon recognition, peptide bond formation and translocation)
- iii. Termination

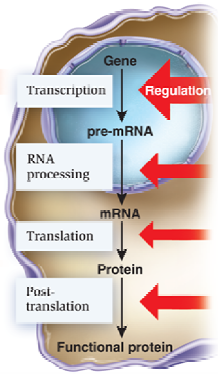
TRANSLATION

- In a eukaryotic cell, mRNA is synthesized in the nucleus and translated on ribosomes in the cytoplasm
- Gene is transcribed into a pre-mRNA
- Pre-mRNA is processed into a mature mRNA



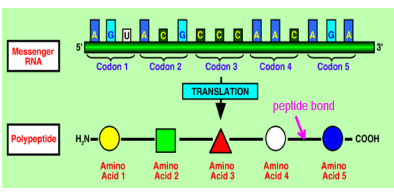
TRANSLATION

- mRNA exits the nucleus
- mRNA is translated on ribosomes to produce the polypeptide chain.

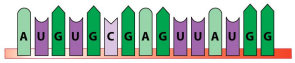


DEFINITION OF TRANSLATION

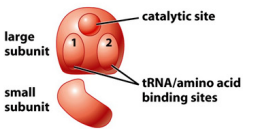
The process in living cells in which the genetic information encoded in messenger RNA (mRNA) in the form of sequence of nucleotide triplets (codon) is translated into a sequence of amino acid in a polypeptide chain during protein synthesis

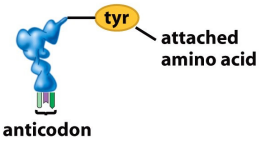


Molecular component in translation



1) mRNA
2) Ribosome
3) tRNA with amino acid





Types of RNA and their functions

1) mRNA - carries information specifying amino acid sequences of proteins from DNA to ribosomes

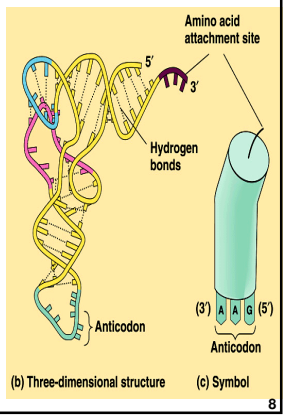
2) rRNA - is part of the structure of ribosome and plays catalytic roles and structural roles in ribosmes

3) tRNA - serves as translator melecule in protein synthesis; translates mRNA codons into amino acids

7

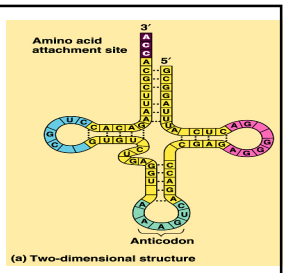
tRNA

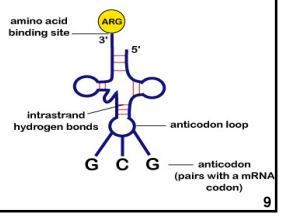
- tRNAs bring amino acids to the ribosomes during translation to be assembled into polypeptide chains
- tRNAs are encoded by tRNA genes
- All tRNA molecules are similar in size and shape



8

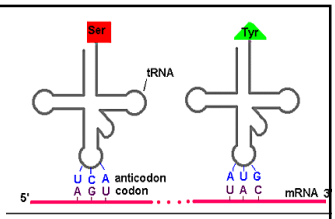
- All tRNAs have CCA (triplet bases) at the 3' end to which the amino acid attaches
- Each tRNA arriving at the ribosome carries a specific amino acid at one end and has a specific nucleotide triplet, an anticodon, at the other.

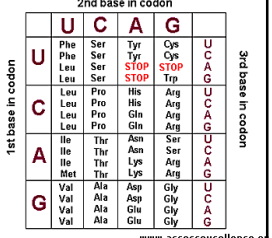




9

- The anticodon base pairs with a complementary codon on mRNA
- If the codon on mRNA is AGU, a tRNA with an UCA anticodon and carrying serine will bind to it





The Genetic Code www.accessexcellence.org/AB/GG/genetic.html

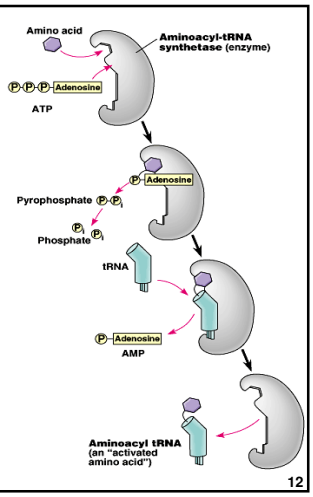
10

Activation of amino acids for attachment to tRNA

- Before tRNAs bring amino acids to the ribosomes during translation, each amino acid is joined to the correct tRNA by aminoacyl-tRNA synthetase
- The 20 different synthetases match the 20 different amino acids

11

- Each has active sites for only a specific tRNA and amino acid combination
- The synthetase catalyzes a covalent bond between tRNA and amino acid forming aminoacyl-tRNA
- This process driven by hydrolysis of ATP



12

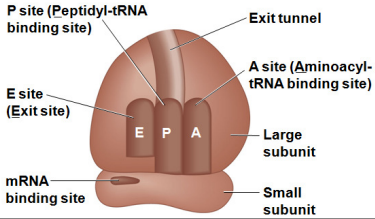
Ribosome binding sites

P site (Peptidyl site)

- Holds the tRNA carrying the growing polypeptide chain.

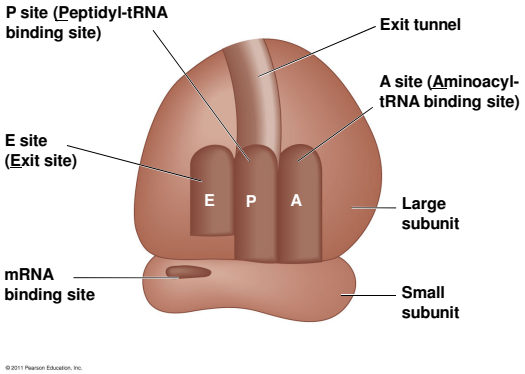
A site (Amino acyl site)

- Holds the tRNA carrying the next amino acid to be added to the chain.



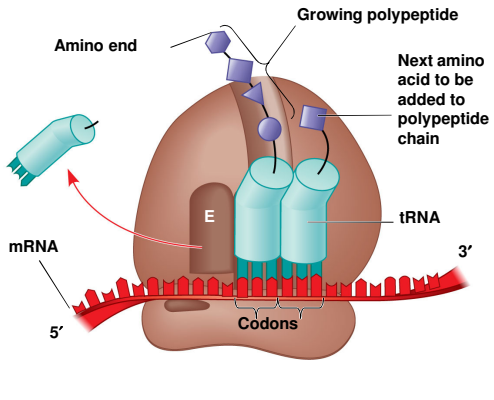
13

Schematic model showing binding sites



14

Schematic model with mRNA and tRNA



15

3 steps of translation process; synthesis of a polypeptide chain:

1) Initiation

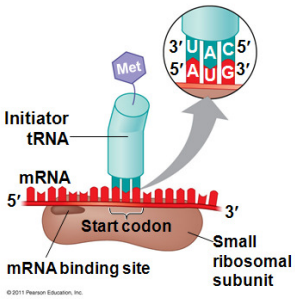
2) Elongation
   i. Codon recognition
   ii. Peptide bond formation
   iii. Translocation

3) Termination

16

1. The initiation of translation

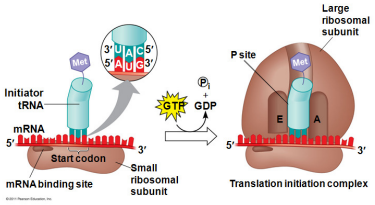
- A **small** ribosomal subunit binds to a molecule of mRNA.
- The mRNA binding site this subunit recognizes a specific nucleotide sequence on the mRNA just upstream of the **start codon**.
- An initiator tRNA, with the **anticodon UAC**, base-pairs with the start codon, AUG.
  - This tRNA carries the amino acid **methionine** (Met).



17

1. The initiation of translation

- The arrival of a **large** ribosomal subunit completes the initiation complex. Proteins called initiation factors (not shown) are required to bring all the translation components together.
- **GTP** provides the energy for the assembly.
- The initiator tRNA is in the **P** site; the **A** site is available to the tRNA bearing the next amino acid.

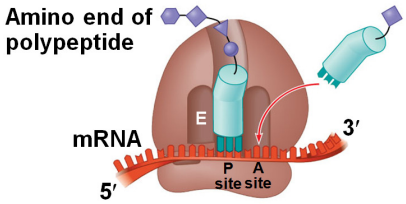


18

2. The elongation cycle of translation

i. Codon recognition.

- The **anticodon** of an incoming aminoacyl tRNA base-pairs with the **complementary** mRNA codon in the **A** site.
- Hydrolysis of GTP increases the accuracy and efficiency of this step.

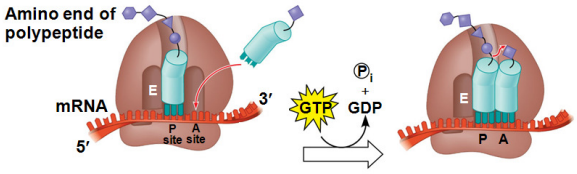


19

2. The elongation cycle of translation

ii. Peptide bond formation.

- An rRNA molecule of the large subunit catalyzes the formation of a **peptide bond** between the first amino acid with the new amino acid in the **A** site at the **carboxyl end** of the growing polypeptide in the **P site**.
- This step attaches the polypeptide to the tRNA in the **A** site

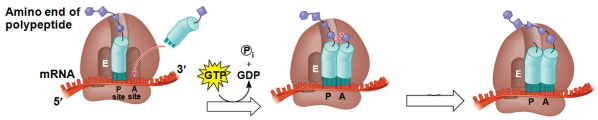


20

2. The elongation cycle of translation

iii. Translocation.

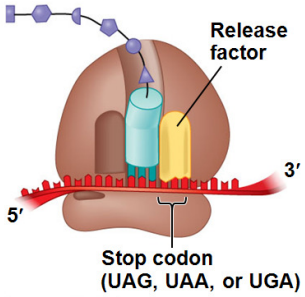
- The ribosome **translocates** the tRNA in the A site to the P site.
- The **empty tRNA** in the P site is moved to the **E** site, where it is released.
- The mRNA moves along with its bound tRNAs, bringing the next codon to be translated into the A site.



21

3. The termination of translation

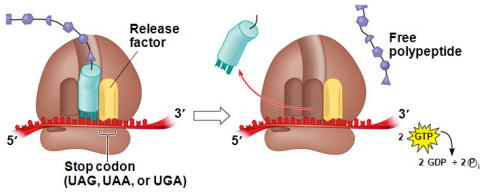
- When a ribosome reaches a stop codon on mRNA, the A site of the ribosome accepts a protein called a **release factor** instead of tRNA.



22

3. The termination of translation

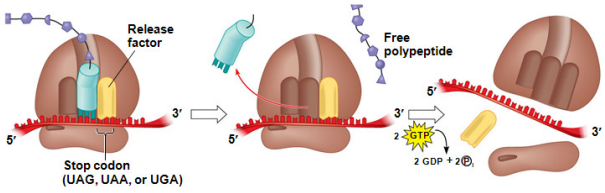
- The **release factor** hydrolyzes the bond between the **tRNA** in the P site and the **last amino acid** of the polypeptide chain.
- The polypeptide is thus freed from the ribosome.



23

3. The termination of translation

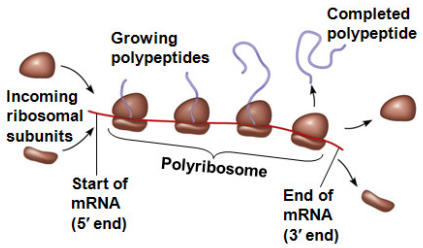
- The two ribosomal subunits and the other components of the assembly **dissociate**.



24

Polyribosomes

- A number of ribosomes can translate a single mRNA simultaneously, forming a **polyribosome** (or **polysome**)
- Polyribosomes enable a cell to make many copies of a polypeptide very quickly



25