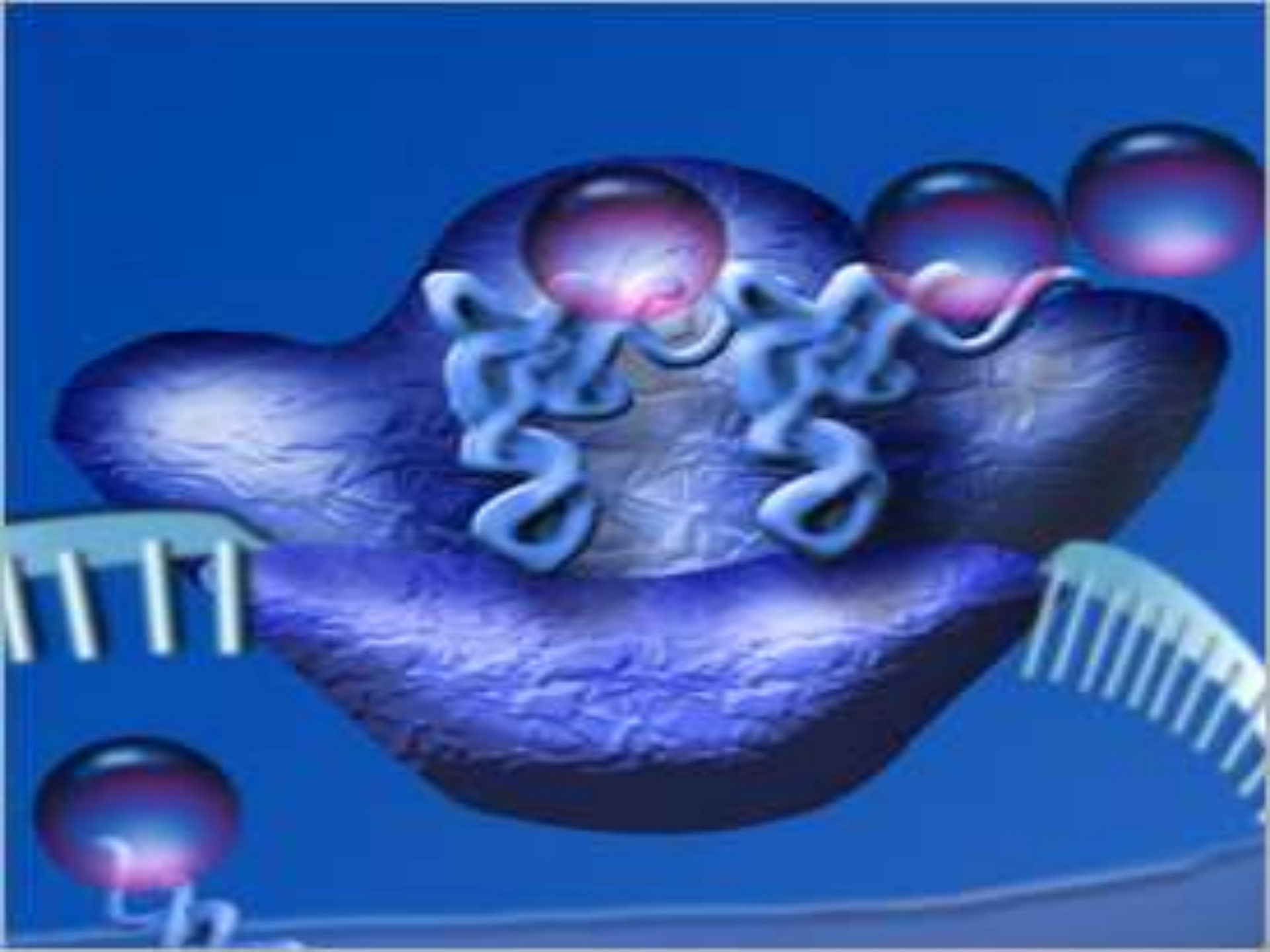

بسم الله الرحمن الرحيم



RIBOSOMES

SCHEME

- Introduction
- Definition
- Discovery
- Structure
- Function

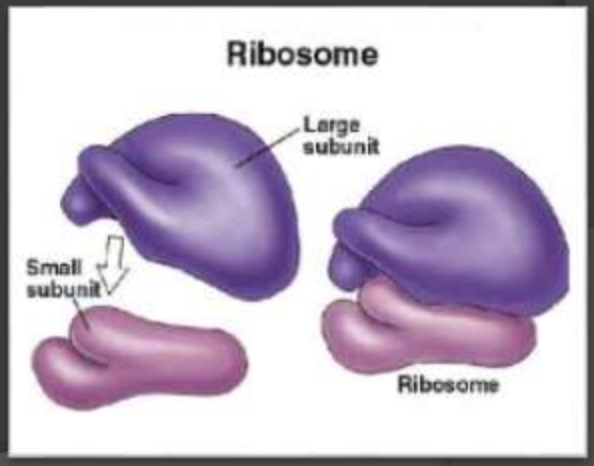
Introduction

- Ribosome are small organelles found in each type of cell i.e.,
  - Prokaryotic
  - Eukaryotic
- They are the only organelle found in prokaryotic cell
- They are not membrane bounded

Definition

- Cell organelle consisting of proteins and RNA and function as protein synthesizer.

  A ribosome complex is made up of different ribosomal subunits



Discovery

- Discovered in 1950 by a Romanian cell biologist George Palade
- Appeared under microscope as dense granules
- Can be seen through electron microscope

Structure

- A ribosome has two main constituent elements
- Protein = 25-40%
- RNA = 37-62%

- Two main subunits are present i.e.,
- A larger subunit
- A smaller subunit

Structure

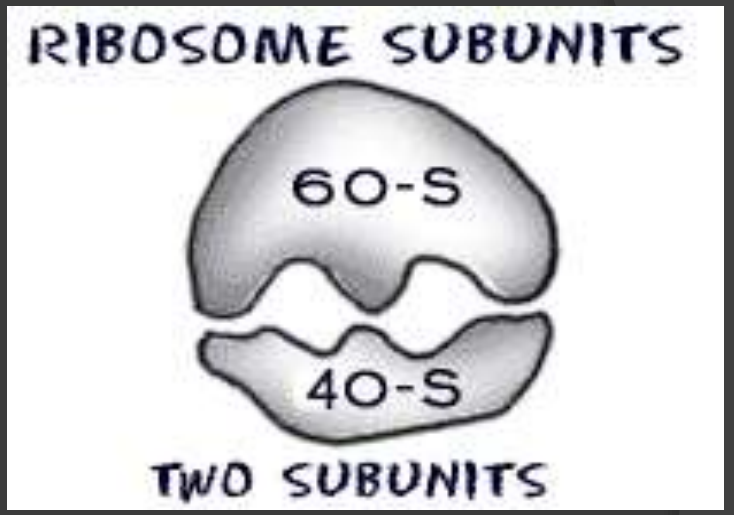
PROKARYOTIC SUBUNITS:

- larger subunit = 50 S
- smaller subunit = 30 S
- Total ribosomal complex = 70 S

Bacterial 70S ribosome from electron microscopy
[models from James Lake, University of California]

Structure

EUKARYOTIC SUBUNITS:



- Larger subunit = 60S
- Smaller subunit = 40 S
- Total ribosomal complex = 80 S
- Eukaryotic cell has almost 78 proteins

Ribosome Source	Whole Ribosome	Small Subunit	Large Subunit
E. coli	70S	30S 16S RNA 21 proteins	50S 23S & 5S RNAs 31 proteins
Rat cytoplasm	80S	40S 18S RNA 33 proteins	60S 28S, 5.8S, &5S RNAs 49 proteins

Structure

- SVEDBERG:

It is the centrifugal unit depending on the density of the object (and in the cage of cell, organelles) determining that how quickly they sink to the depth when centrifuged

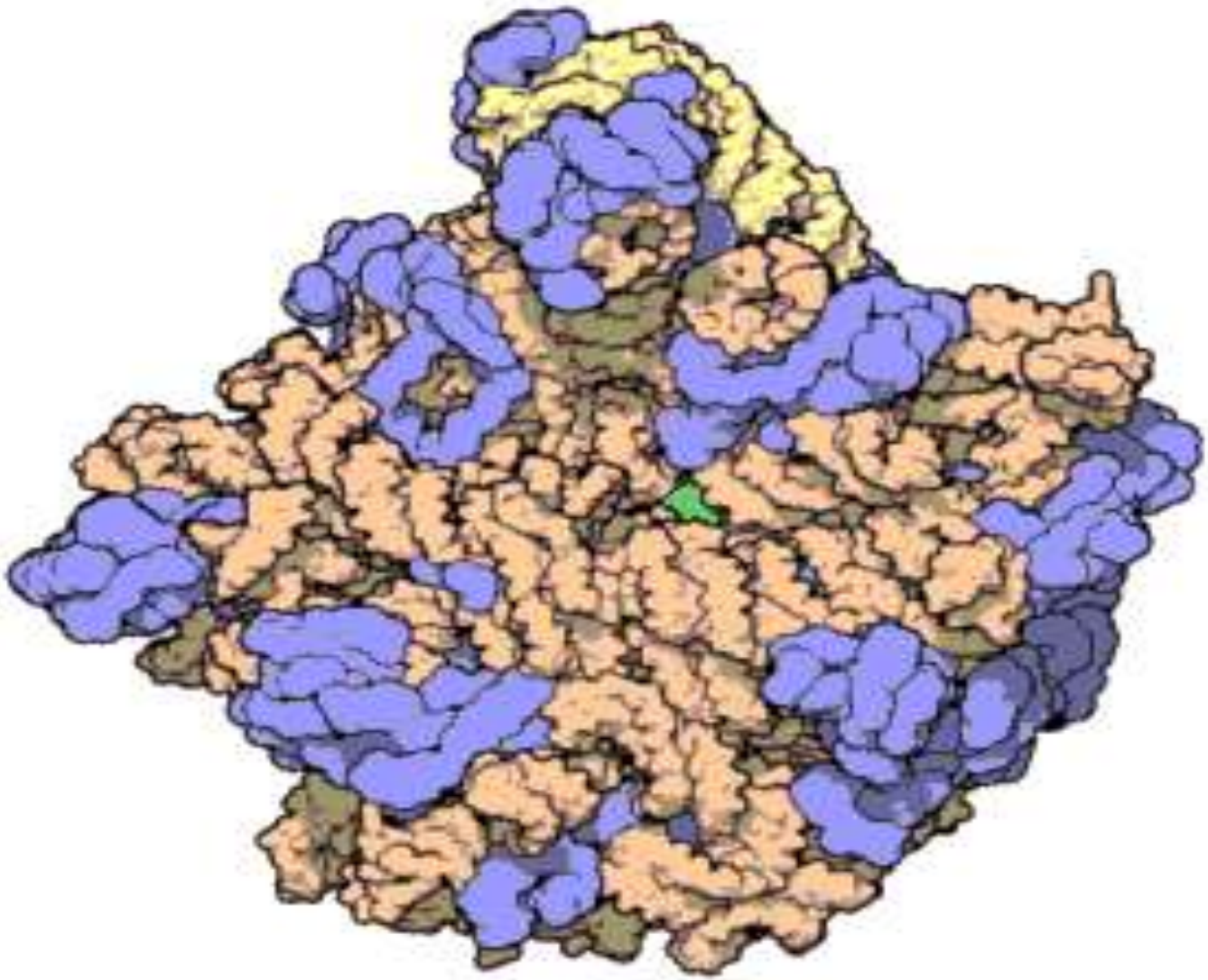
Quantity:

- Quantity of ribosomes vary depend upon the type of cell e.g.,
- Bacteria = 20,000
- Yeast = 200,000
- Quantity depends upon the physiological ability of cell to produce proteins

Structure

LARGER SUBUNIT:

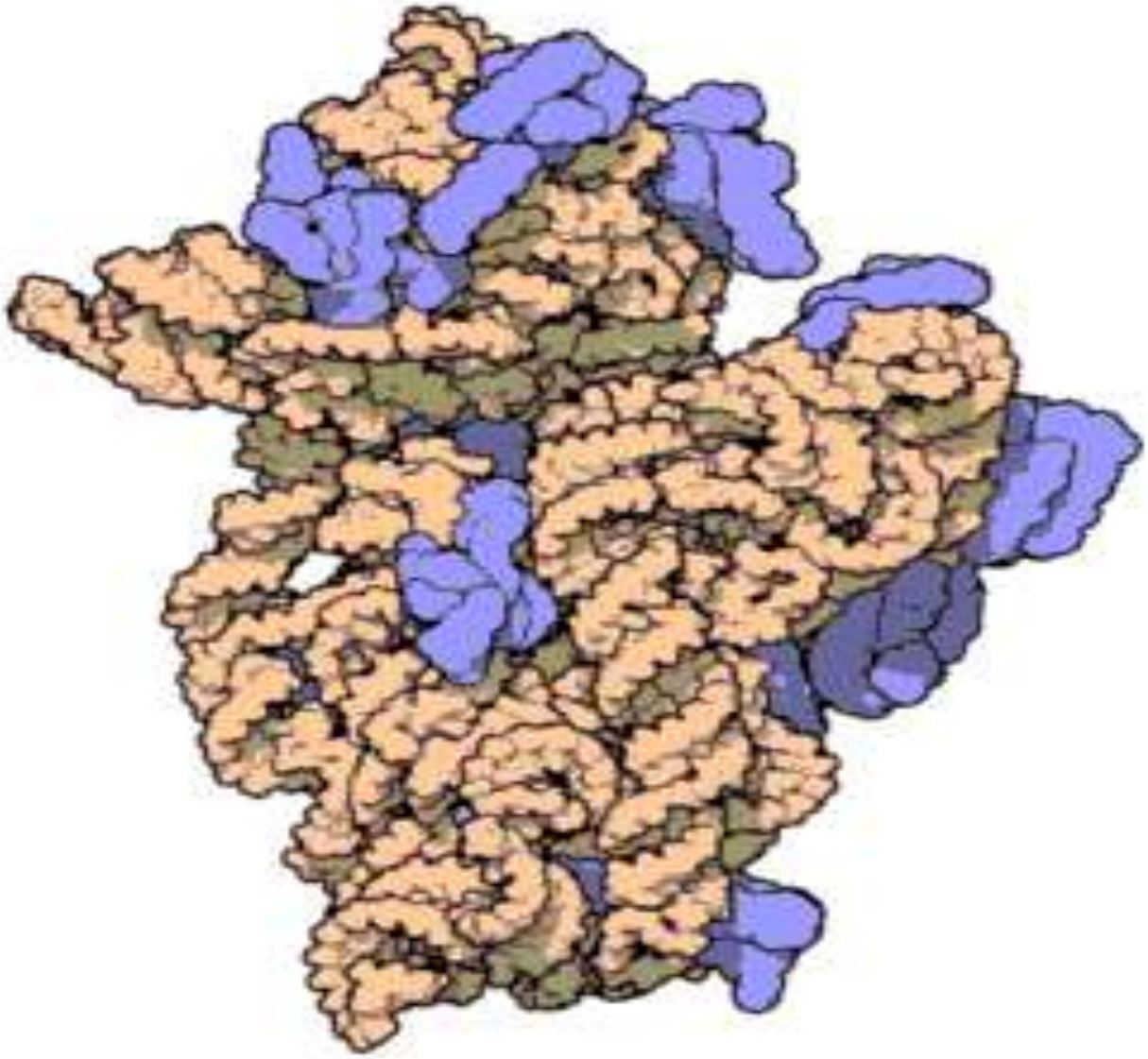
- Consists of two RNA strands
- A longer and a shorter strand wrap upon each other
- Strands are dotted with protein coats
- Proteins often glue RNA strands in their characteristic shape



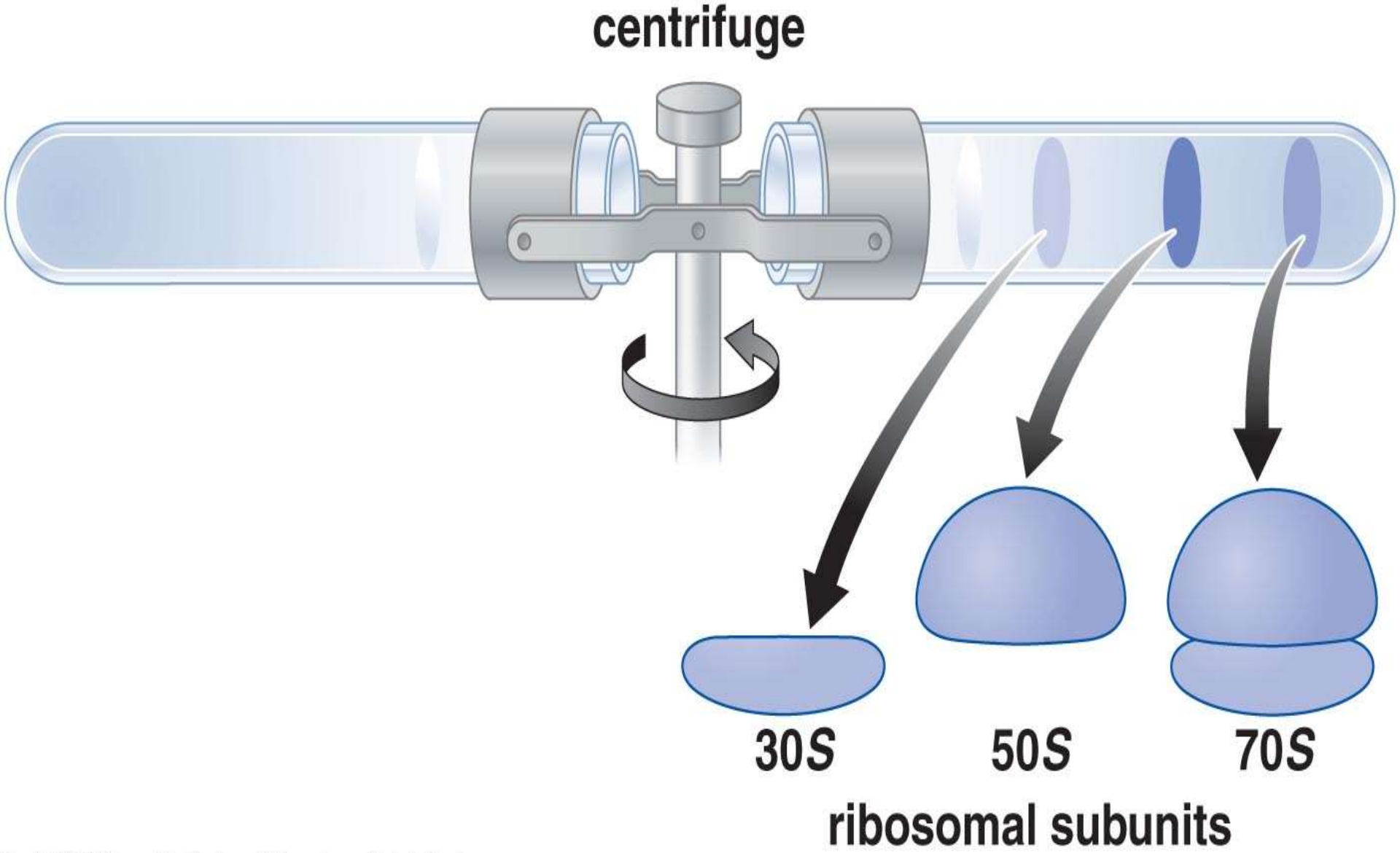
Structure

SMALLER SUBUNIT:

- Consists of a single RNA strand
- It is also covered with a protein coat
- Smaller subunit though smaller than the larger subunit, is quite enormous than the normal proteins



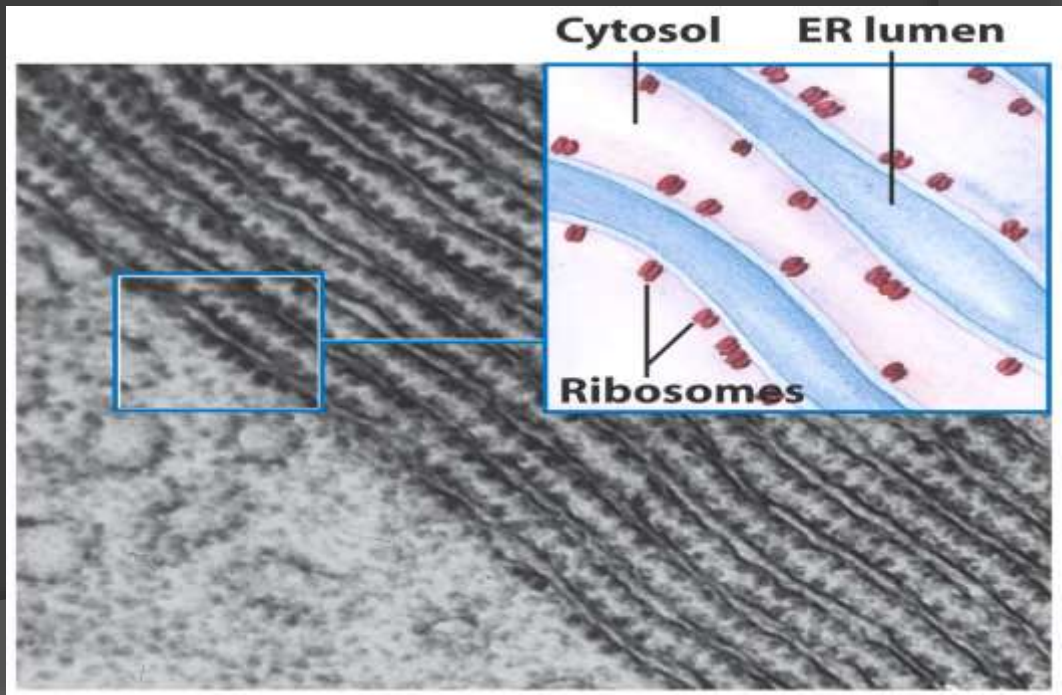
Ribosomal subunits:



Location:

Ribosomes can be found either:

- Dispersed freely in the cytosol
- Attatched to the surface of Endoplasmic Reticulum



Location:

- On the basis of location ribosomes are divided into two types:
  - Free ribosomes
  - Bounded ribosomes

Free Ribosomes

- These ribosomes are found freely dispersed in the cytosol
- They are involved in the synthesis of proteins that work inside the cytosol
- They vary in number depending upon the functionality of the cell types and its need to synthesize proteins

Bounded Ribosomes:

- They are found attached to the surface of Endoplasmic reticulum making them "**Rough Endoplasmic Reticulum**"

- The proteins assembled in these ribosomes are either transported to the outside of the cell or are included in the cell membrane

Function:

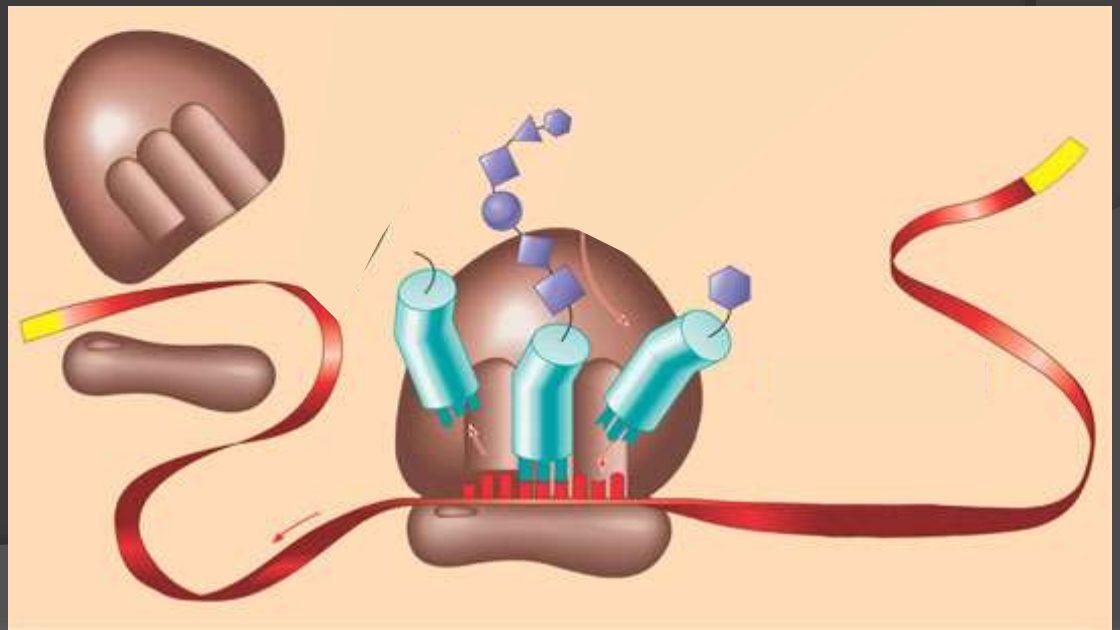
- Main function of ribosomes is the translation of genetic information encoded in nucleotide bases of DNA into amino acid sequence of proteins.

- This is also known as “gene expression”

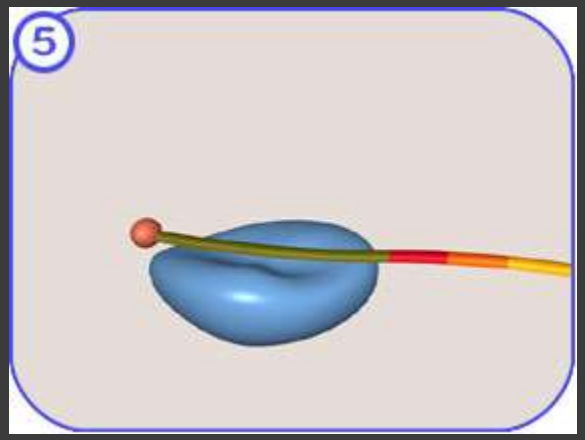
Translation

- The two ribosomal subunits join to translate the mRNA into proteins

- Following are the steps of translation:
  - Initiation
  - Elongation
  - Termination

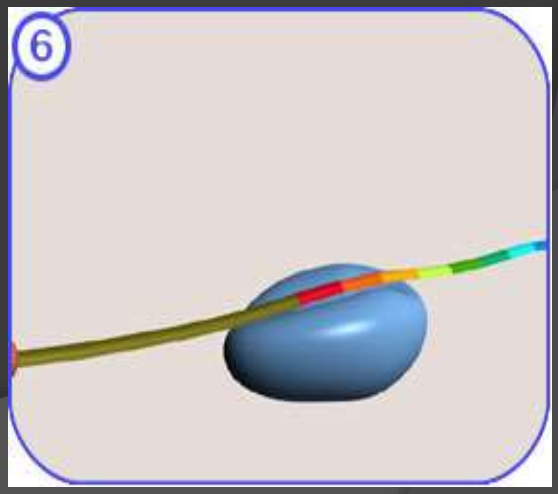


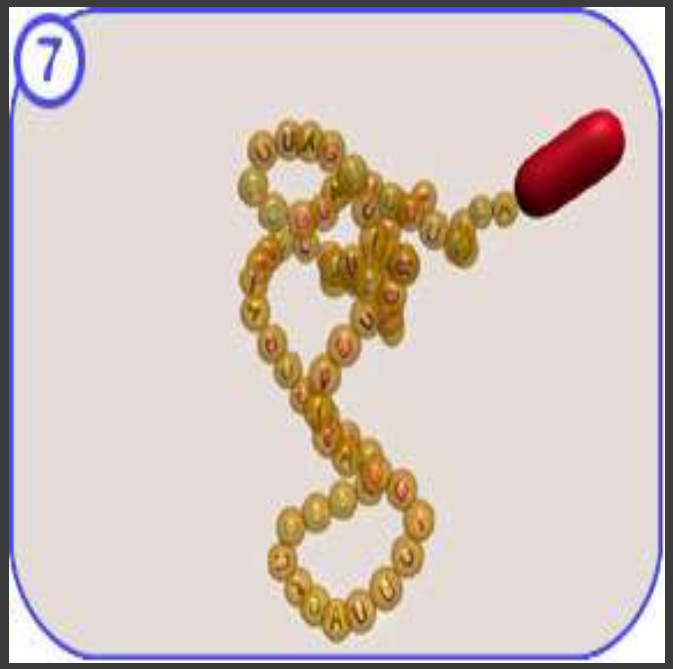
Initiation



To begin initiation, the small subunit of a ribosome attaches to the mRNA.

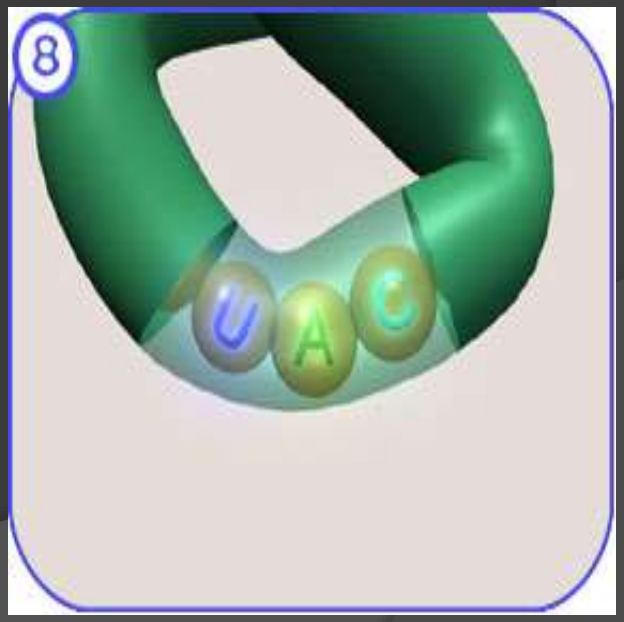
The small subunit then moves along the mRNA until it reaches the first readable **Codon**. This codon always codes for the amino acid ***methionine***.

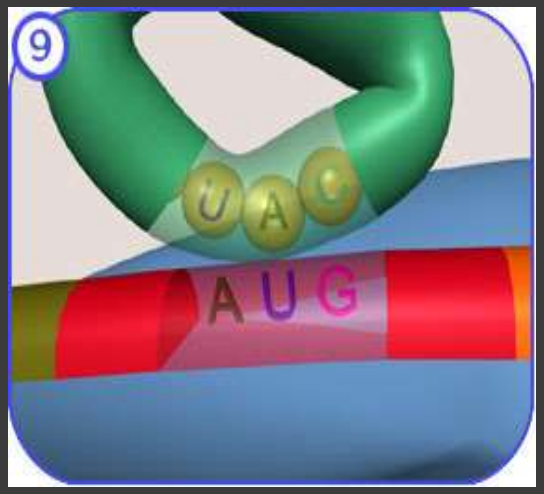




The tRNA molecules are the next to enter. These charged molecules of RNA bring the amino acids to the ribosome.

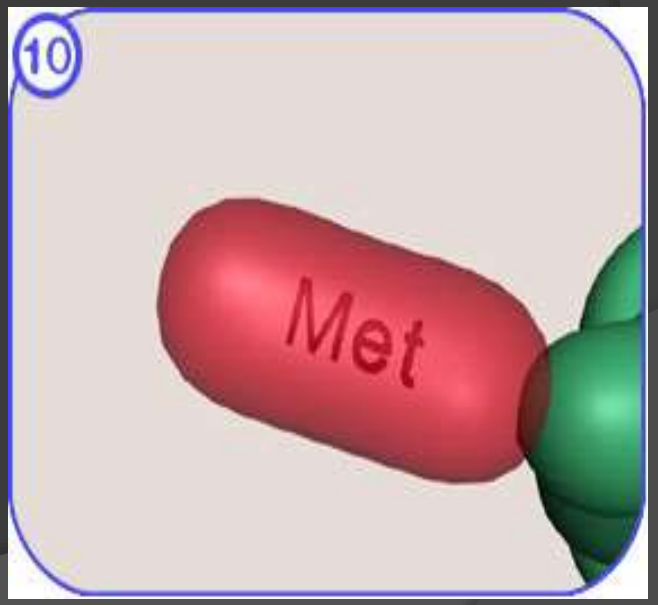
Each tRNA has a triplet coding sequence that corresponds with the amino acid it carries along.

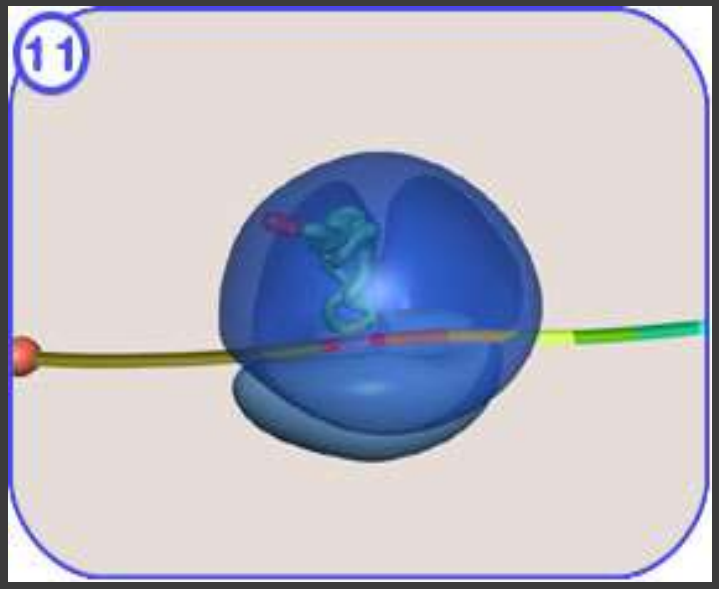




The triplet sequence of the tRNA is complementary to the triplet codon sequence in the mRNA.

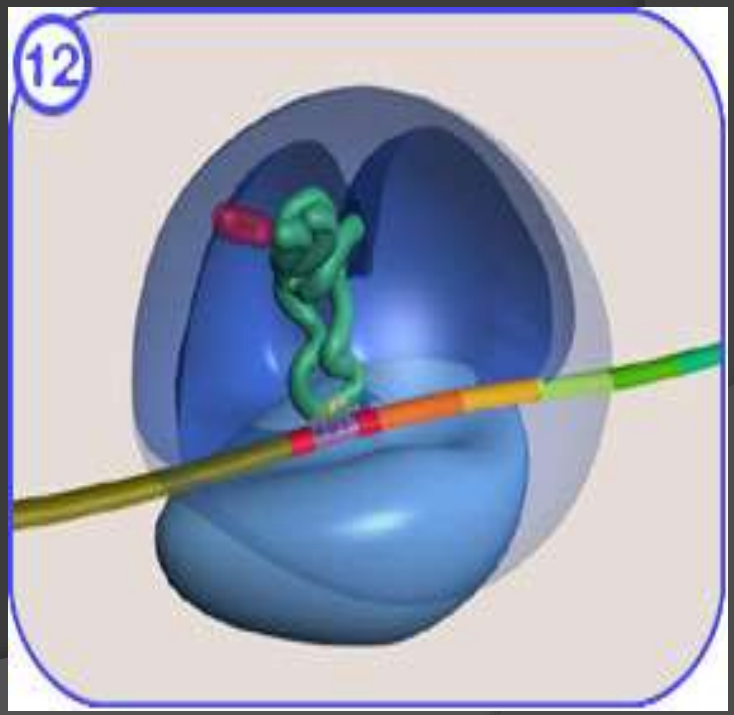
Each triplet codon sequence in the mRNA and the tRNA corresponds to a specific amino acid.



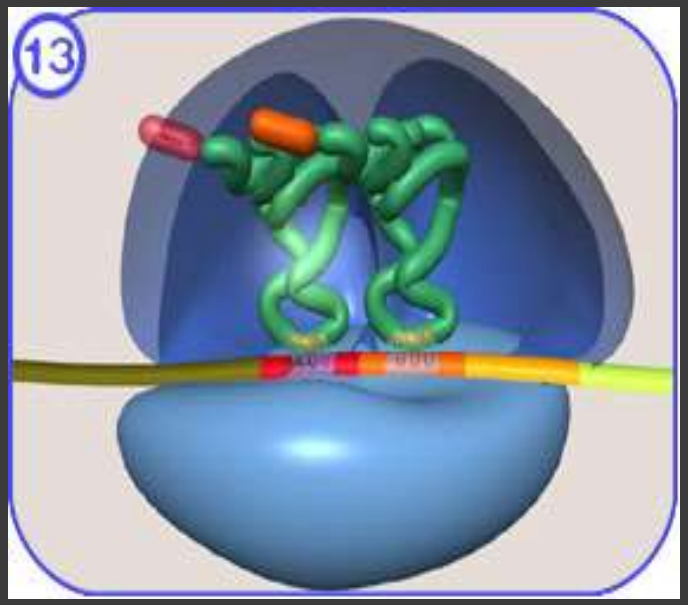


After the first tRNA moves into place, the large subunit of the ribosome attaches to the small subunit.

The complete ribosome consists of two sites: ***petidyl*** (left) and***aminoacyl*** (right).

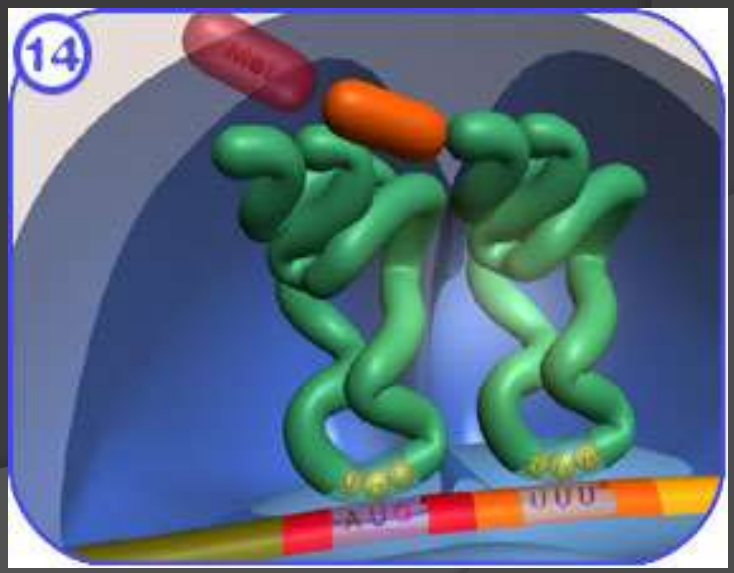


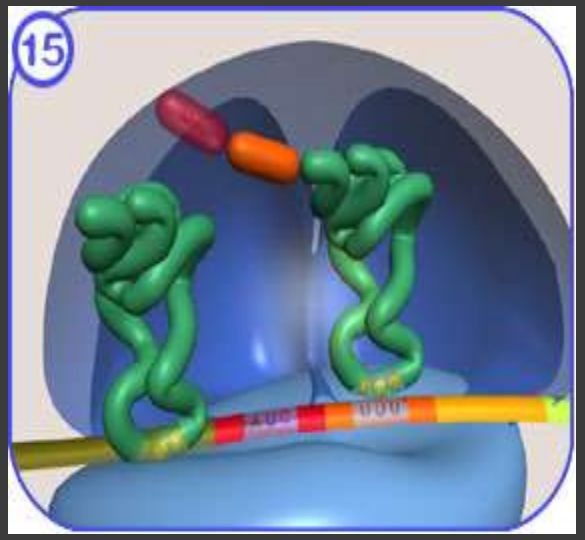
Elongation:



After the first tRNA has attached to the *peptidyl* site, a second tRNA enters the complete ribosome and attaches to its complementary mRNA codon in the *aminoacyl* site.

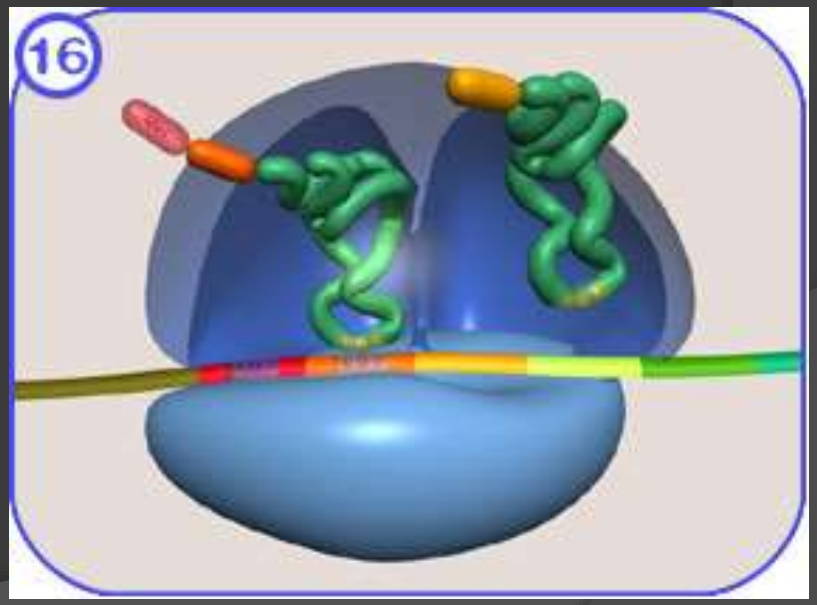
With the two tRNA in place, the amino acid from the *peptidyl* tRNA, moves and attaches to the tRNA in the *aminoacyl* site

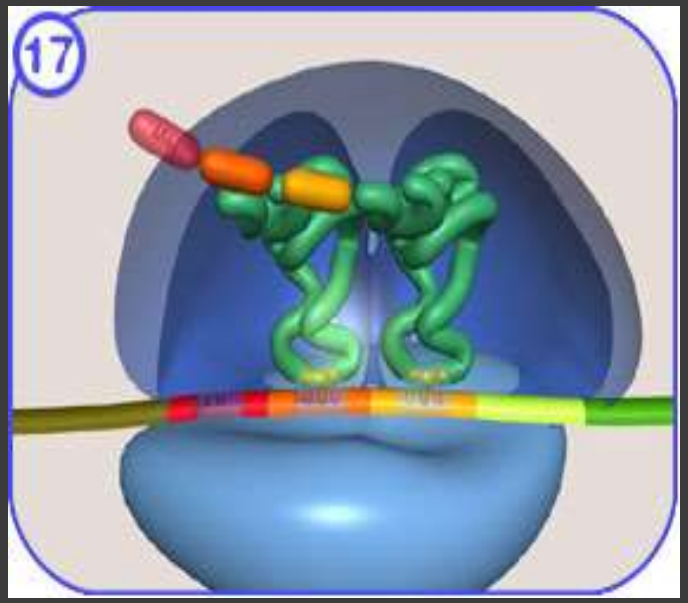




No longer bearing an amino acid, the tRNA from the *peptidyl* site leaves the ribosome

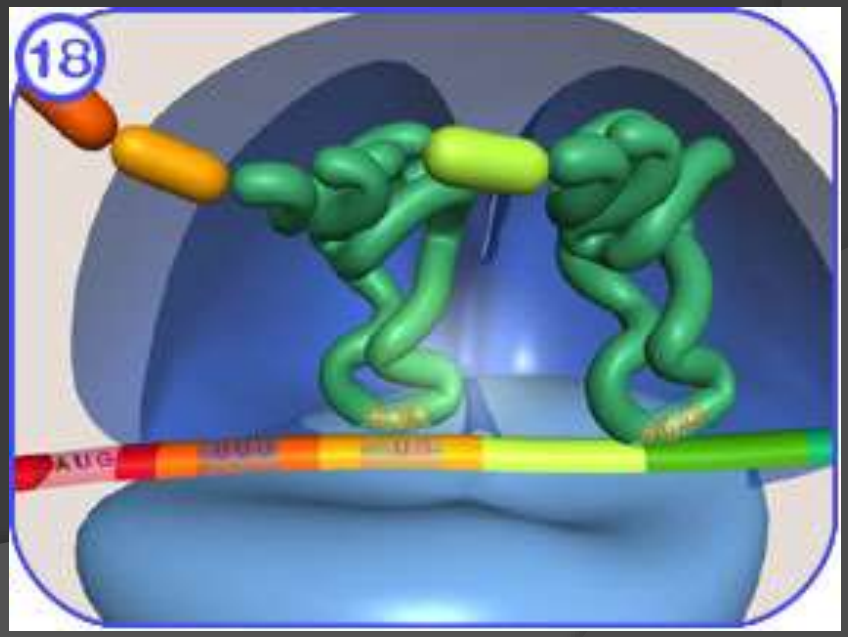
The ribosome then moves along the strand of mRNA, a new tRNA, based upon the triplet coding sequence of the mRNA, fills the new *aminoacyl*site.

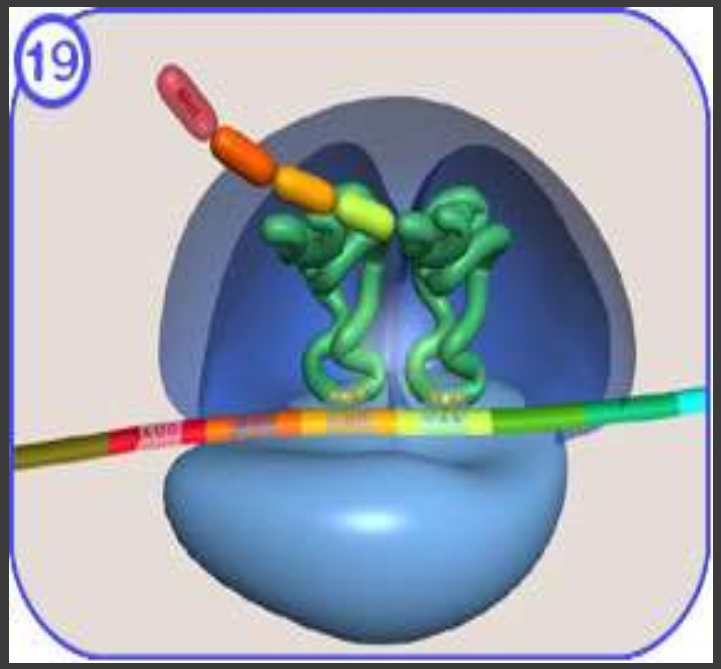




Again, the growing peptide chain of amino acids is transferred from the *petidyl* tRNA to the amino acid of the tRNA in the *aminoacyl* site.

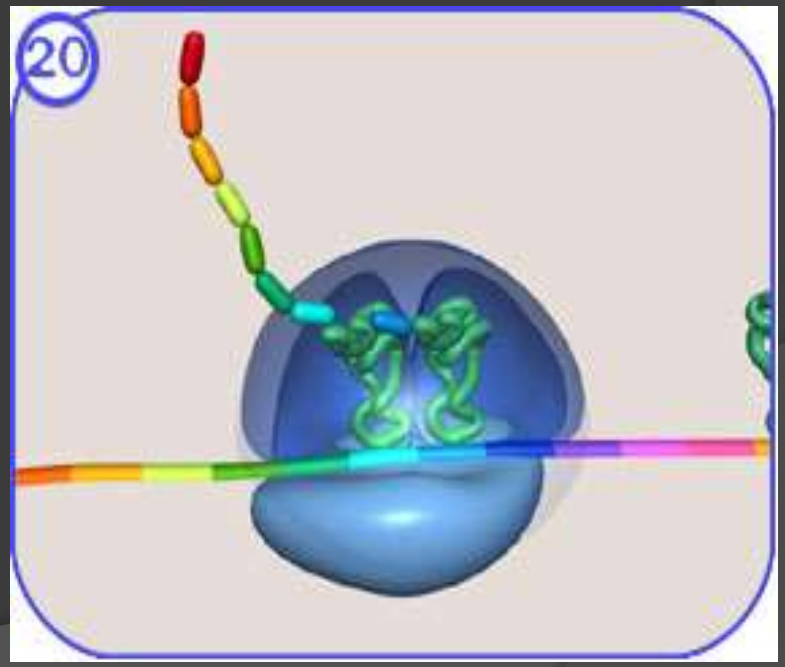
The ribosome moves along the mRNA again, and another charged (with its amino acid) tRNA fills the*aminoacyl* site.



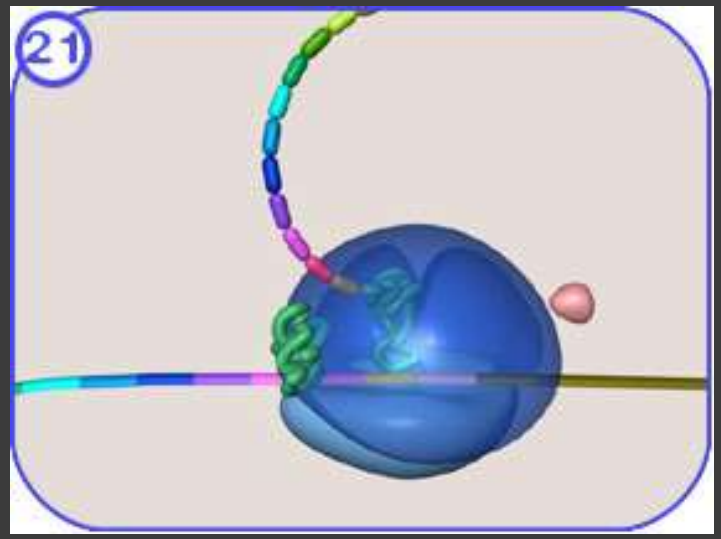


The growing peptide chain is again transferred from the *peptidyl* tRNA to the amino acid attached to the tRNA in the *aminoacyl* site.

This process of peptide synthesis continues as the ribosome moves along the mRNA, and the future protein grows longer.

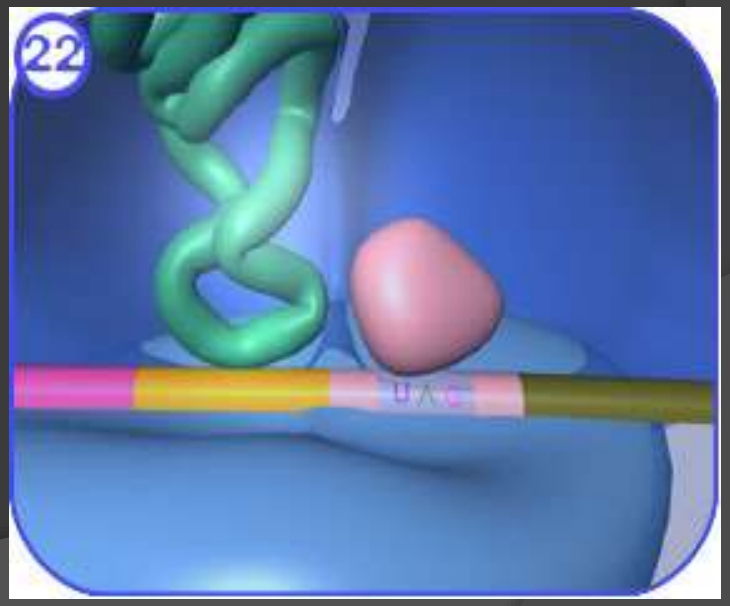


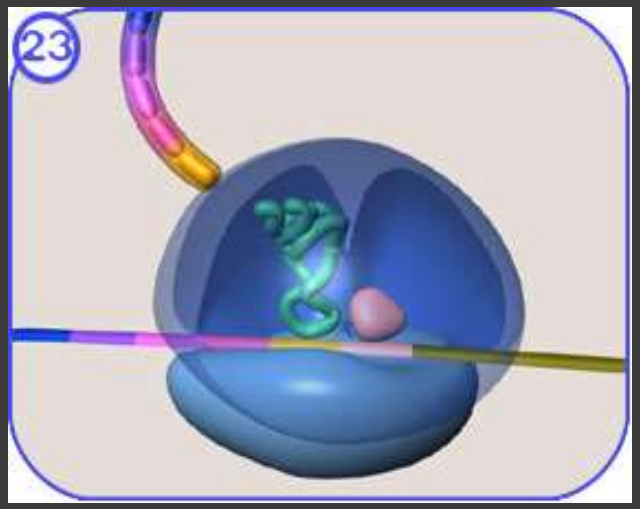
Termination:



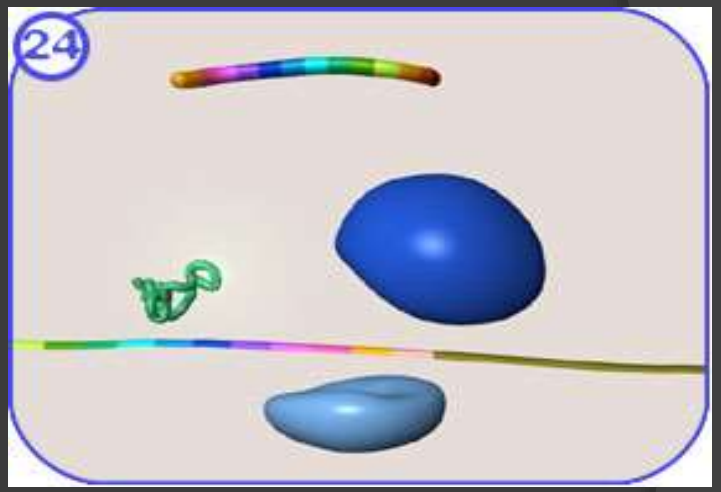
No tRNA exists that recognizes the triplet sequence in mRNA known as a *stop codon*. Instead, a *release factor* enters the ribsome.

The release factor interferes with peptide elongation, and the ribosome moves no further.

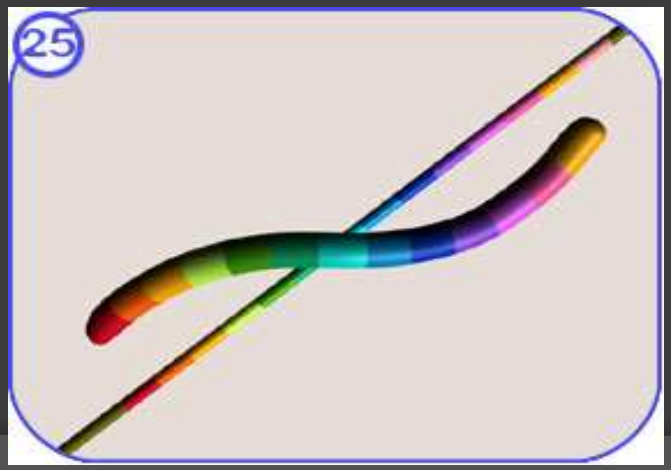




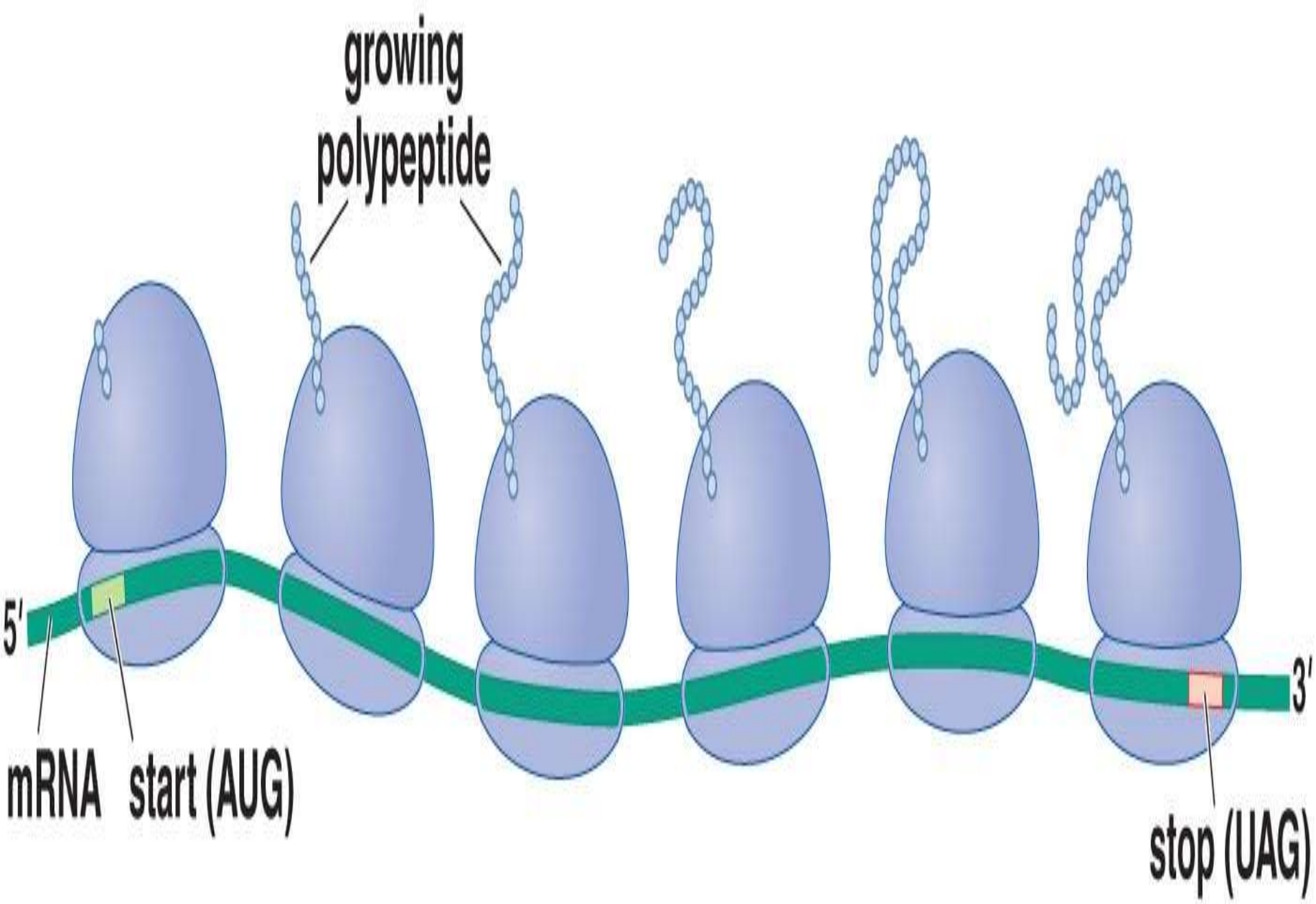
The peptide chain is released from the tRNA and leaves the ribosome.



With the peptide chain gone, the ribosome dissociates into its individual large and small subunits.



Protein synthesis is now complete. The peptide chain is ready to act as a protein or be combined with other chains to form larger, *polypeptide* proteins



Ribosome associated diseases:

- During overburdening or stress condition of endoplasmic reticulum and thus ribosomes present on them function improperly
- This improper functioning is characterized by improper folding of proteins
- As proper characteristic final folding of proteins determine their functioning

- Improper folding disrupts the normal functioning of proteins causing a number of deadly diseases

- Some of such diseases are:
  - Diabetes
  - Cystic fibrosis
  - Neurodegenerative disorders
  - And other conformational disorders

Latest researches

- According to Alexander Mankin :

"The ribosome is one of the most complex molecular machines in the cell"

His discoveries are:

- The ribosome is responsible for activating some antibiotic resistant genes in the presence of certain proteins
- Under normal conditions, the ribosome's catalytic centre can accept any of the 20 natural amino acids, which are then added to the growing protein chain

Others…

- **Dr Hayes** worked on prokaryotic ribonucleases that regulate gene expression and cell growth.
- **Nicholas Ingolia** discusses ribosomal profiling.

More…

3 scientists have showed how the information on DNA strands is encoded into protein sequence in ribosomes.

This proved to be a revolution in the field of genetics.

These three scientist have shared the Nobel prize in chemistry for year 2009

Scientists are:

- Venkatraman Ramakrishnan of the M.R.C. Laboratory of Molecular Biology in Cambridge, England
- Thomas A. Steitz of Yale University
- Ada E. Yonath of the Weizmann Institute of Science in Rehovot, Israel


Thank you