Ribosomes

B.Sc. Part-II, Paper-III
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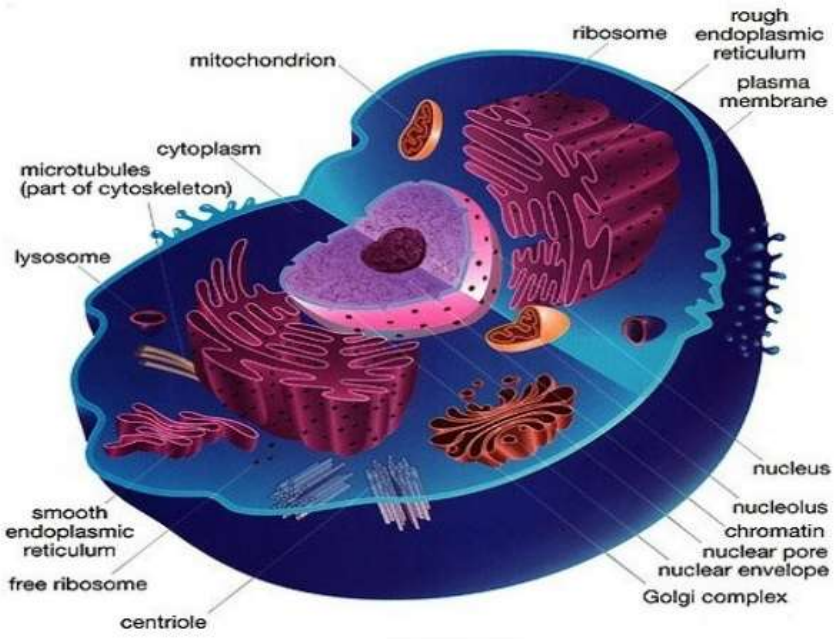
The ribosomes are sub-microscopic particles that appear as round or spherical body in the cytoplasmic region of the cell. Ribosomes were first observed in the mid-1950s by Romanian-American cell biologist George Emil Palade, using an electron microscope, as dense particles or granules.[.]The term "ribosome" was proposed by scientist Richard B. Roberts in the end of 1950s: Found in prokaryotic and eukaryotic cells except in mature mammalian cells. They are numerous in any give cell but numbers increase in cells which are engaged in protein synthesis, as liver and pancreatic cells. In cells they remain to attached to endoplasmic reticulum but some free ribosomes are also seen in the ribosomes are sub-microscopic particles that appear as the cytoplasm.

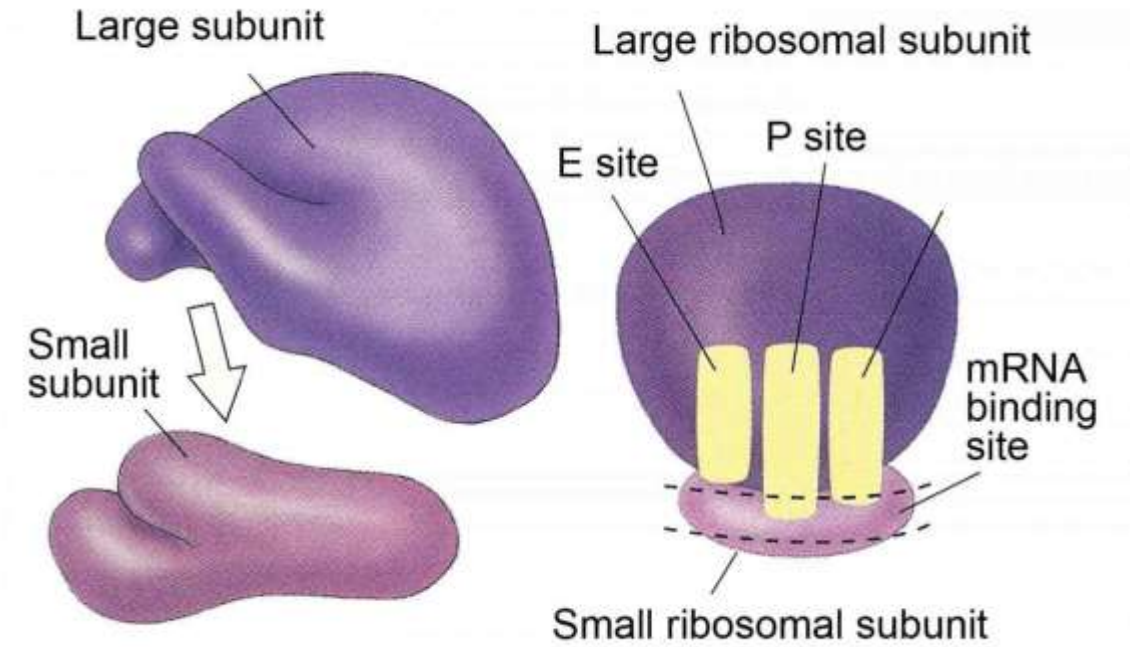
There are two types of ribosomes are found which are differentiated on the basis of their sedimentation properties. Prokaryotes posses 70s ribosomes while eukaryotes posses 80s ribosomes. The chloroplast and mitochondria, which are semiautonomous organelles, also contains 70s types of ribosomes.

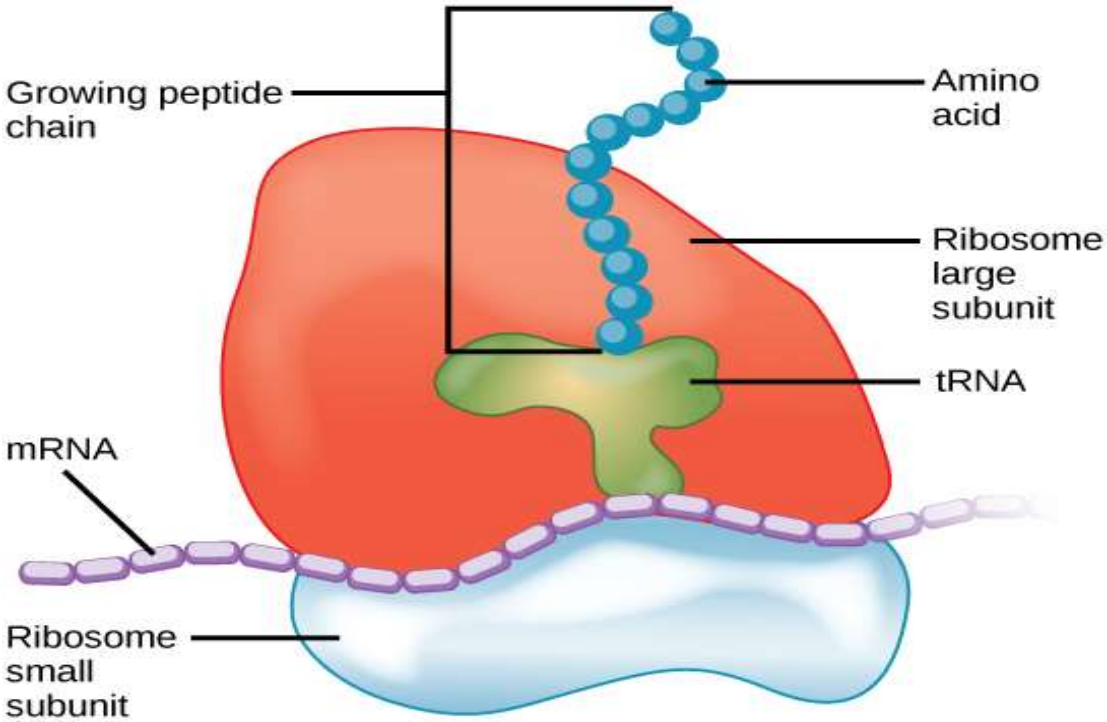


Structure of Ribosomes

- A ribosome is made from complexes of RNAs and proteins and is, therefore, a ribonucleoprotein.
- Each ribosome is divided into two subunits:

1. **A smaller subunit** which binds to a larger subunit and the mRNA pattern, and
2. **A larger subunit** which binds to the tRNA, the amino acids, and the smaller subunit.





- Prokaryotes have 70S ribosomes respectively subunits comprising the little subunit of 30S and the bigger subunit of 50S.
- Their small subunit has a 16S RNA subunit (consisting of 1540 nucleotides) bound to 21 proteins.
- The large subunit is composed of a 5S RNA subunit (120 nucleotides), a 23S RNA subunit (2900 nucleotides) and 31 proteins.
- Eukaryotes have 80S ribosomes respectively comprising of little (40S) and substantial (60S) subunits.
- The smaller 40S ribosomal subunit is prolate ellipsoid in shape and consists of one molecule of 18S ribosomal RNA (or rRNA) and 30 proteins (named as S1, S2, S3, and so on).
- The larger 60S ribosomal subunit is round in shape and contains a channel through which growing polypeptide chain makes its exit.
- It consists of three types of rRNA molecules, i.e., 28S rRNA, 5.8 rRNA and 5S rRNA, and 40 proteins (named as L1, L2, L3 and so on).

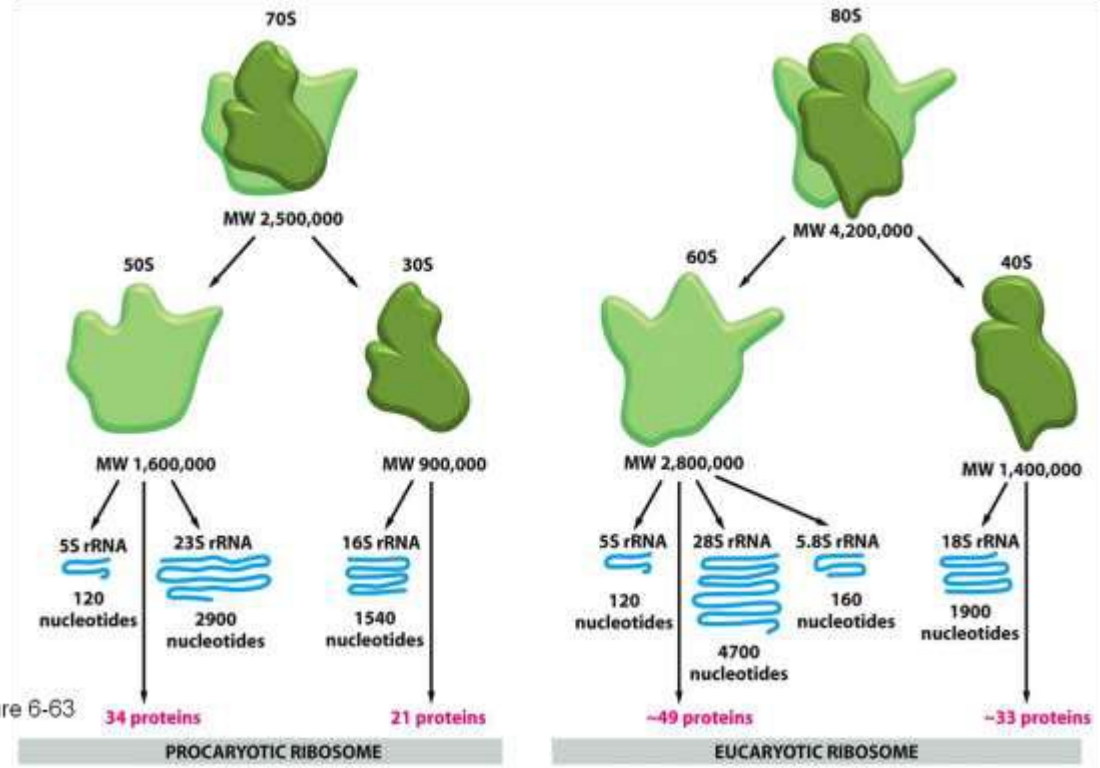


Figure 6-63

- The differences between the ribosomes of bacterial and eukaryotic are used to create antibiotics that can destroy bacterial infection without harming human cells.
- The ribosomes seen in the chloroplasts of mitochondria of eukaryotes are comprised of big and little subunits composed of proteins inside a 70S particle.
- The ribosomes share a core structure that is similar to all ribosomes despite differences in its size.
- The two subunits fit together and work as one to translate the mRNA into a polypeptide chain during protein synthesis.
- Because they are formed from two subunits of non-equal size, they are slightly longer in the axis than in diameter.
- During protein synthesis, when multiple ribosomes are attached to the same mRNA strand, this structure is known as polysome.
- The existence of ribosomes is temporary, after the synthesis of polypeptide the two sub-units separate and are reused or broken up.

Reconstitution of Ribosomes

The ribosomes contain several RNAs and many types of proteins, Which can be partially disassembled and reconstituted. Centrifugation of ribosomes and their subunits in 5 M CsCl gradient results in about 40% separation of protein population. The 50s and 30s subunits are dissociated into inactive core particles containing RNA and core protein, whereas the split proteins are released from the subunits. The split proteins from 50s and 30s subunits, when added to the core particles, are able to partially reconstitute rapidly at 37 degrees Celsius.

Partial reconstitution has helped us in understanding the role of some proteins which are essential for ribosomal function. Nomura and co-workers were able to demonstrate reconstitution of 30s subunit of E.coli ribosome by mixing 16 S rRNA and 21 proteins of 30 S subunit. reconstitution of 50 S subunits was also achieved by employing a slightly different technique.

Dissociation of 30 S subunit has been possible by treatment with 4M urea and 2M LiCl solution. The treatment allows the separation of all the proteins. Reconstitution may be achieved in two steps by placing 16 S RNA with two proteins from 30 S subunit. First, 16 S RNA bind some of the 30 S proteins, forming reconstitution intermediate(RI) particles. When the RI particles are heated at 40 degree Celsius in the presence of other S proteins, fully active 30 S ribosome subunits are produced.

Biogenesis of Ribosomes

The origin of ribosomes has been studied in eukaryotes. Nucleolus is the site of synthesis of rRNA, Where a specific RNA polymerase transcribes a precursor RNA from a cistron of the nuclear DNA. The 18 S, 5.8 S and 28 S RNAs are synthesised in the nucleolus, whereas 5 S RNA is synthesised on the chromosome outside the nucleolus. ribosomal protein are synthesized in the cytoplasm. Different components of ribosomes are cleaved separately but rapidly, and at the same time ribosomal proteins are translocated from the cytoplasm to the nucleolus, where they become associated with each 40 S and 60 S subunits. The 40 S subunit move out first into the cytoplasm, where it becomes associated with the mRNA. After a short while, the 60 S subunit is also translocated out of the nucleus that attaches to the 40 S mRNA complex to form a complete 80 S mRNA complex. The 5 S RNA is believed to be involved in binding of the two subunits.

Functions of Ribosomes

The ribosome is a complex molecular machine, found within all living cells, that serves as the site of biological protein synthesis (translation).
Ribosomes link amino acids together in the order specified by messenger RNA (mRNA) molecules.

Ribosomes act as catalysts in two extremely important biological processes called peptidyl transfer and peptidyl hydrolysis.

Ribosomes are minute particles consisting of RNA and associated proteins that function to synthesize proteins. Proteins are needed for many cellular functions such as repairing damage or directing chemical processes.

Ribosomes can be found floating within the cytoplasm or attached to the endoplasmic reticulum. Basically, their main function is to convert genetic code into an amino acid sequence and to build protein polymers from amino acid monomers.

Ribosomes act as catalysts in two extremely important biological processes called peptidyl transfer and peptidyl hydrolysis. The "PT centre is responsible for producing protein bonds during protein elongation".

References

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