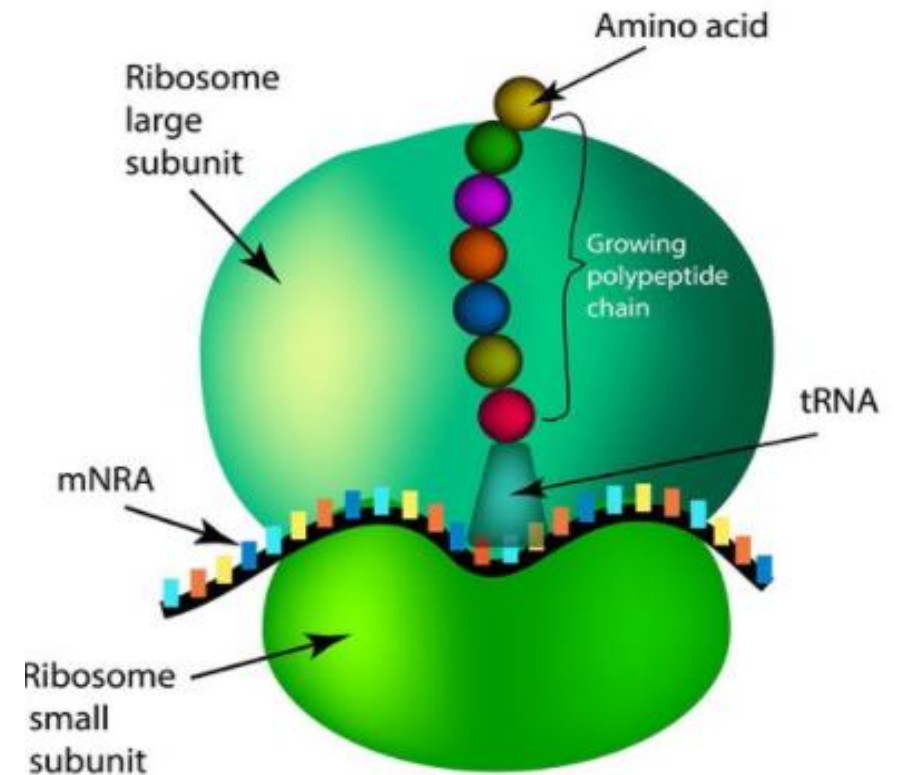


# RIBOSOMES

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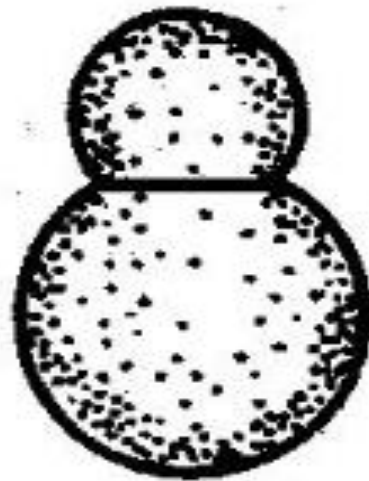


# ***Ribosomes***

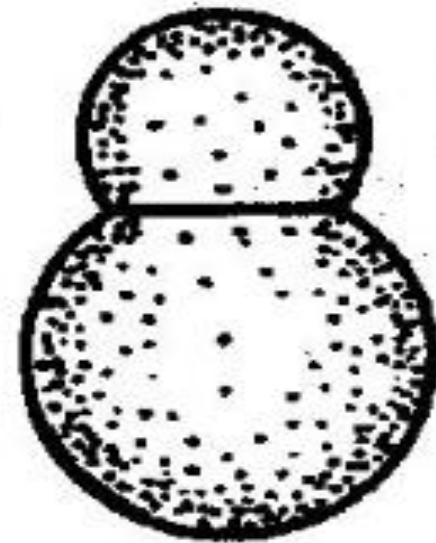
Ribosomes are ***ribonucleo-protein particles*** found in almost all cells. Ribosomes are ***assembly shops*** for protein synthesis. They are also described as ***protein factories***. They are found in the cytoplasm or attached to the endoplasmic reticulum.

Ribosomes were first observed by ***Claude*** in 1941 and named them as ***microsomes***. ***Palade*** in 1955 named them as ***ribosomes***.

Ribosomes are found in all the living cells which synthesize protein. They are usually located on the membranes of the endoplasmic reticulum. Some ribosomes remain scattered in the cytoplasm. They are also present inside the cell organelles like mitochondria and chloroplasts.



***70S Ribosome***



***80S Ribosome***

***Ribosomes.***

The number of ribosomes are directly related to the RNA content of the cell. In rabbit's reticulocytes, their number is found to be  $1 \times 10^5$  per cell. One mm of liver contains about  $2 \times 10^{13}$  ribosomes. In *E. coli*, there are about 20,000-30,000 ribosomes per cell.

Ribosomes are spherical in shape. Their size remains constant. The ribosomes of prokaryotes are smaller in size and those of eukaryotes are larger in size. In prokaryotes they are  $150\text{\AA}$  and in eukaryotes they are  $250\text{\AA}$  in diameter.

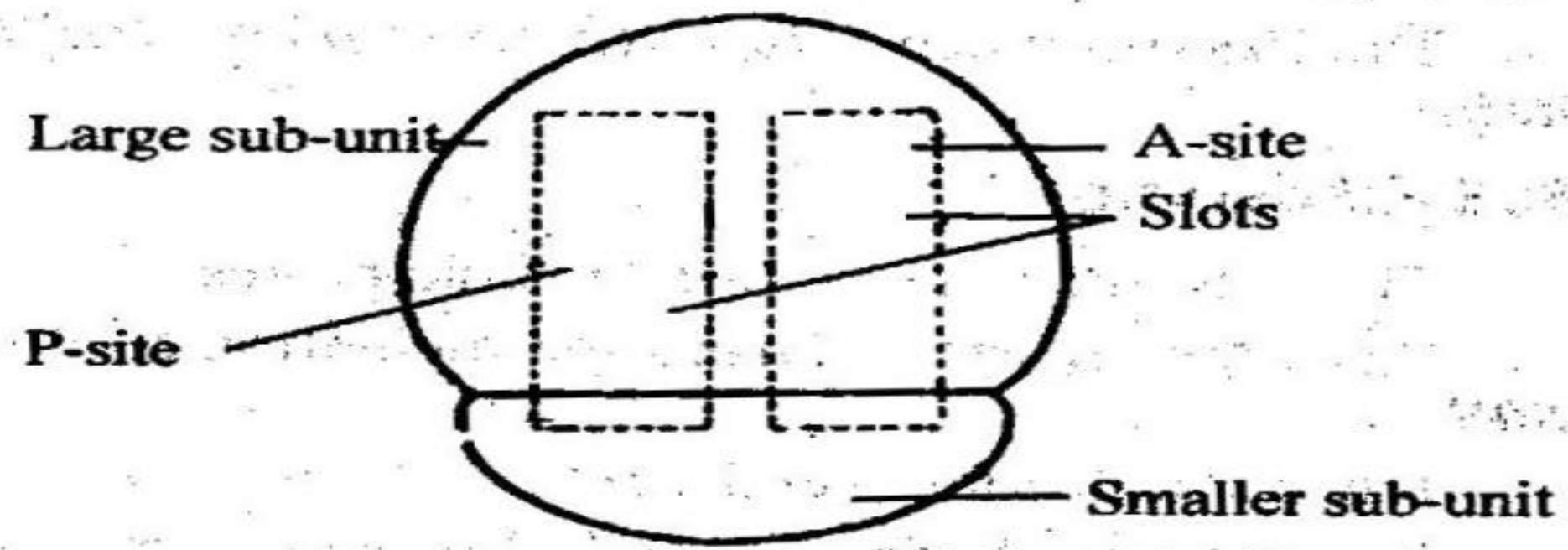
Ribosomes are spherical bodies. Each ribosome consists of two *sub-units*, namely a *large sub-unit* and a *small sub-unit*.

The sub-units occur separately in the cytoplasm. They join together to form ribosomes only at the time of protein synthesis.

Generally 5 or more ribosomes line up and join an mRNA chain. Such a string of ribosomes is called *polyribosome* or *polysome*.

The small sub-unit holds the mRNA during protein synthesis.

The large sub-unit has two slots, namely *P-site* and *A-site*. The P-site carries a tRNA containing polypeptide chain. The A-site carries a tRNA containing activated amino acid.



*A ribosome showing slots.*

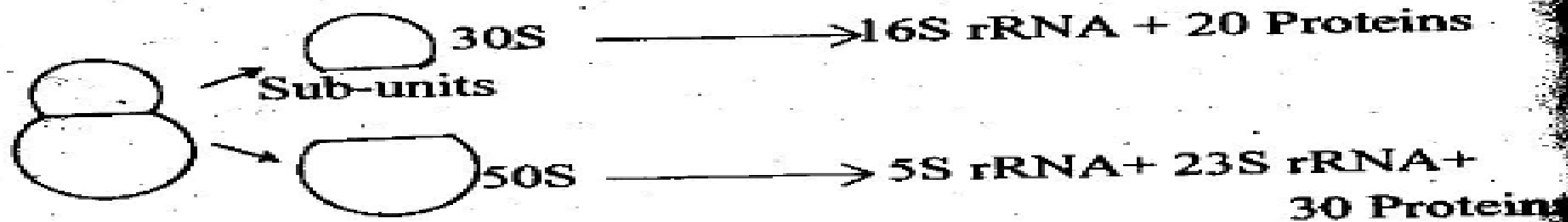
According to the size and sedimentation co-efficient, 2 types of ribosomes have been reported. They are 70S ribosomes, and 80S ribosomes.

ரைபோசோம் வகைகளின் பண்புகள்

ரைபோசோம் வகை	காணப்படும் இடம்	பெரிய துணை கூறு		சிறிய துணைக் கூறு	
		அளவு	RNA	அளவு	RNA
80S	யூகேரியாட் விலங்குகள்	60S	29S + 5S + 5.8S	40S	18S
80S	யூகேரியாட் தாவரங்கள்	60S	25S + 5S + 5.8S	40S	16 - 18S
70S	புரோகேரியாட்கள்	50S	23S + 5S	30S	16S
55S	முதுசெலும்பிகளின் மைட்டோகாண்ட்ரியா	40S	16S + 5S	30S	12 - 13 S

## 70S Ribosome

The 70S ribosome is found in *prokaryotic cells*. The 70S ribosome is smaller in size and it has a sedimentation coefficient of 70S. It has a molecular weight of  $3 \times 10^6$  daltons. It is composed of rRNA and proteins.



*Fig.10.3: Diagram to show the composition of prokaryotic ribosome (70S)*

The 70S ribosome is made up to two sub-units, named a large **50S** and a small **30S**.

Each sub-unit is made up of rRNA and ribosomal proteins. The 50S sub-unit is composed of **23S rRNA**, **5S rRNA** and about **30 different proteins**.

The 30S sub-unit has **16S rRNA** and about **20 different proteins**.

## **80S Ribosome**

The 80S ribosome is found in eukaryotes.

It is larger in size and has a sedimentation coefficient of **80S**.

It has a molecular weight of  $5 \times 10^6$  daltons.

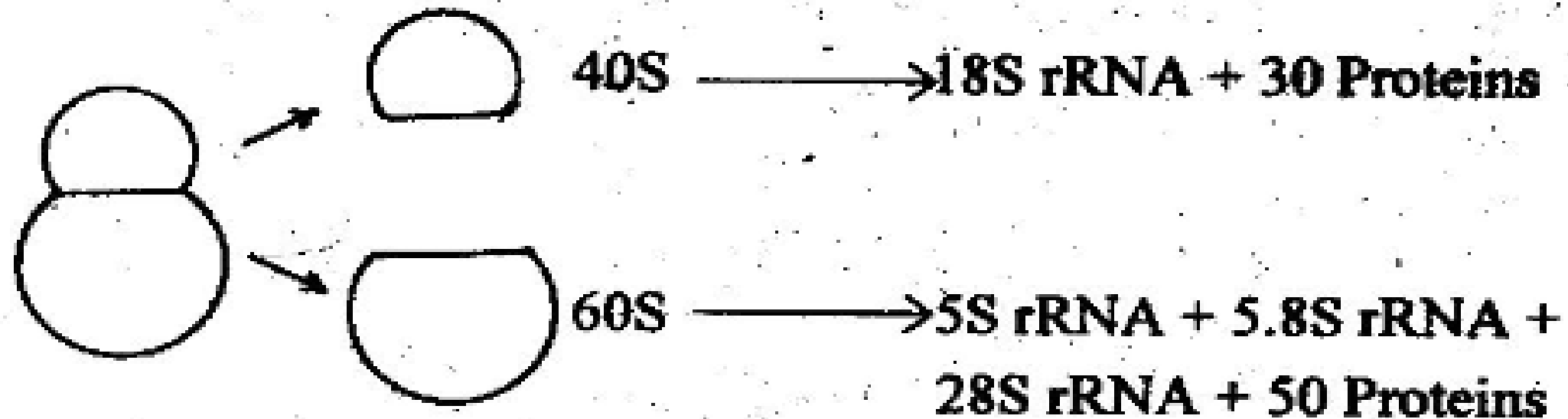
It is composed of rRNA and ribosomal proteins.

The 80S ribosome is made up of two sub-units, named **60S** and **40S**.

Each sub-unit is composed of ribosomal proteins and rRNA. The 60S sub-unit has **28S rRNA**, **5.8S rRNA**, **5S rRNA** and about **50 different proteins**.



The 40S sub unit has *18S rRNA* and *30 different ribosomal proteins*.



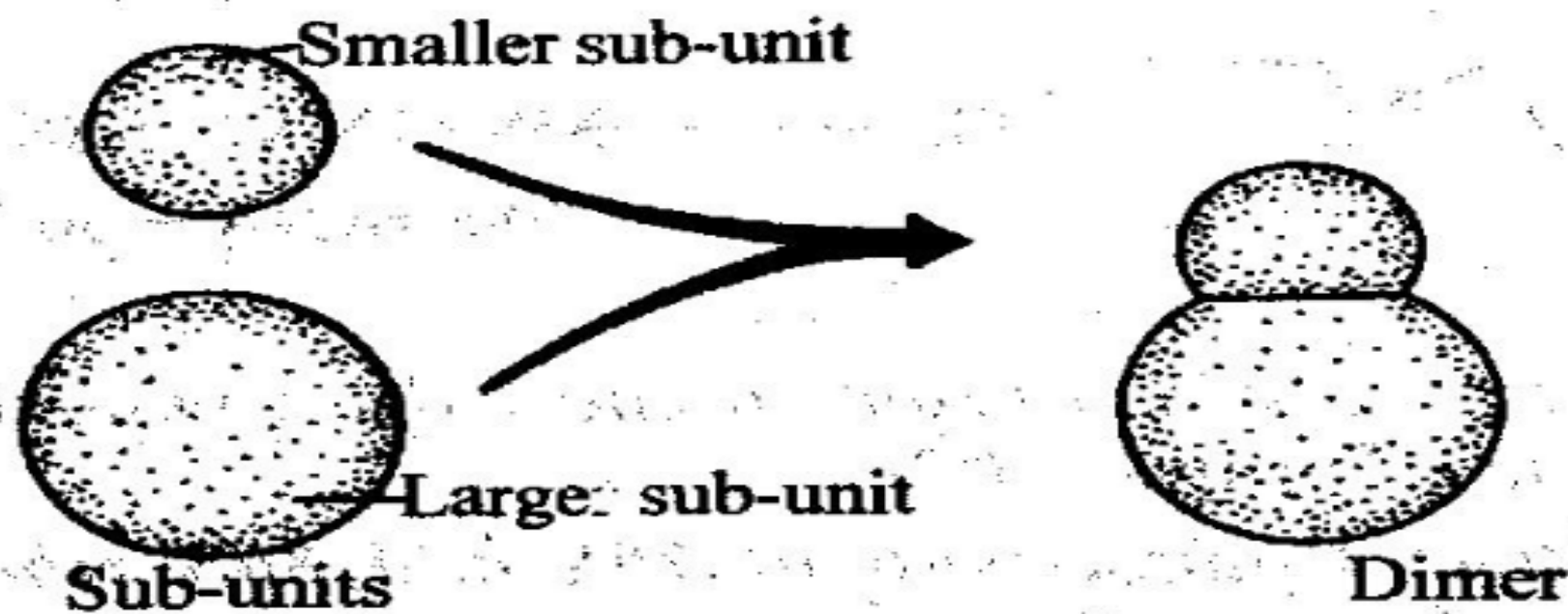
*Diagram to show the composition of eukaryotic ribosome (80S).*

**Comparison of 70S and 80S ribosomes  
(Prokaryotic and eukaryotic ribosomes)**

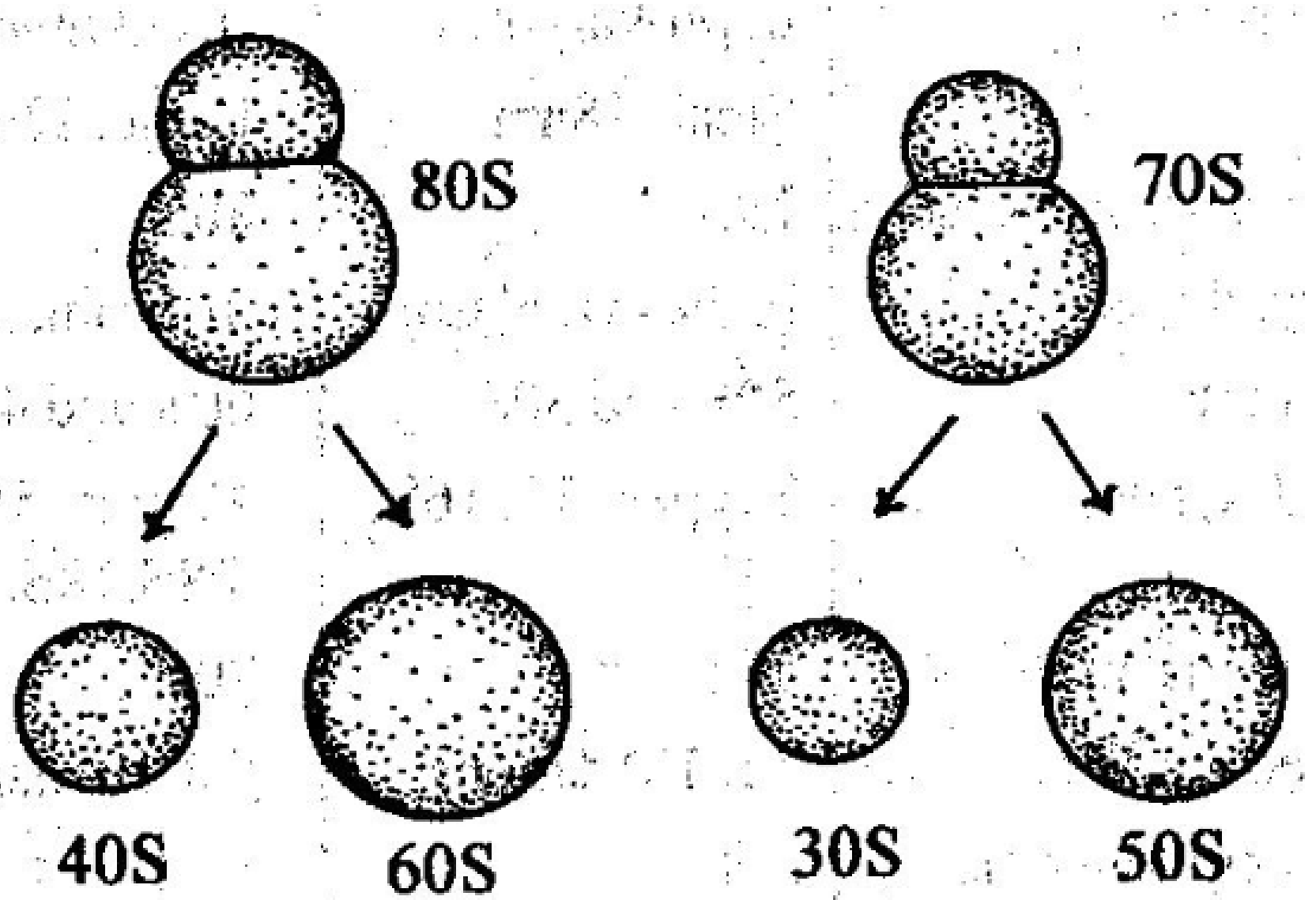
<b>Description</b>	<b>70S</b>	<b>80S</b>
1. Occurrence	In prokaryotes	In eukaryotes
2. Size	Small, 18nm	Large, 22nm
3. Sedimentation co-efficient	70S	80S
4. Biosynthesis	In the cytoplasm	In the nucleolus
5. Sub-units	50S and 30S	60S and 40S
6. rRNA types	3 types; 5S, 16S, 23S	4 types; 5S, 5.8S, 18S, 28S
7. Ribosomal proteins	55	70
8. Molecular Wt.	$3 \times 10^6$ daltons	$5 \times 10^6$ daltons
9. RNA-protein ratio	2 : 1	1 : 1

The sub-units remain freely in the cytoplasm. In the beginning of protein synthesis the two sub-units unite together and at the end of protein synthesis they dissociate. Similarly two ribosomes unite together to form a *dimer*. Many

ribosomes together to form a *polyribosome*. The association of sub-units as well as ribosomes occur at a high concentration of  $Mg^{++}$ . The dissociation is brought about by a low concentration of  $Mg^{++}$ .



*Association of ribosomal sub-units.*



*Dissociation of ribosomes.*

## **Chemical Composition**

The ribosomes contain RNAs, proteins, enzymes, and metal ions.

### **1. Ribosomal RNA**

The RNA present in the ribosomes are called *rRNA*. In eukaryotic cells rRNAs are found in three forms, namely 28 S rRNA, 18 S rRNA, 5S rRNA and 5.8 S rRNA. In prokaryotic cells they are in the form of 23 S rRNA, 16S rRNA and 5S rRNA.

### **2. Ribosomal Proteins**

The 70S ribosomes contain 50 to 60 proteins. The 80S ribosome has 70 to 80 proteins. These proteins are of two types, namely *core proteins* (CP) and *split proteins* (SP).

### **3. Enzymes (protein factors)**

The ribosomal enzymes (protein factors) play important roles in protein synthesis. They are grouped into three types, namely *initiation factors*, *elongation factors* and *termination factors*.

**a) Initiation factors:**

The initiation factors include *IF1*, *IF2* and *IF3*. They combine with GTP and then bind the 3' end of mRNA with the small sub-unit of ribosome. *IF<sub>3</sub>* is concerned with the dissociation of ribosomal sub-units.

**b) Elongation factors:**

The elongation factors include *Tu*, *Ts*, *G* and *peptidyl transferase*. *Tu* and *Ts* help in the binding of aminoacyl tRNA Tu-GTP complex to ribosome.

*G* factor helps in the translocation of peptidyl tRNA and the release of free tRNA.

Peptidyl transferase is involved in the formation of peptide bond.

### **c) Termination factors:**

Termination factors include R1 and R2 (releasing factors). They help in the release of proteins.

### **4. Metal Ions**

Ribosomes contain a number of metal ions such as Mg, Ca, Mn, Fe, etc.

## ***Functions of Ribosomes***

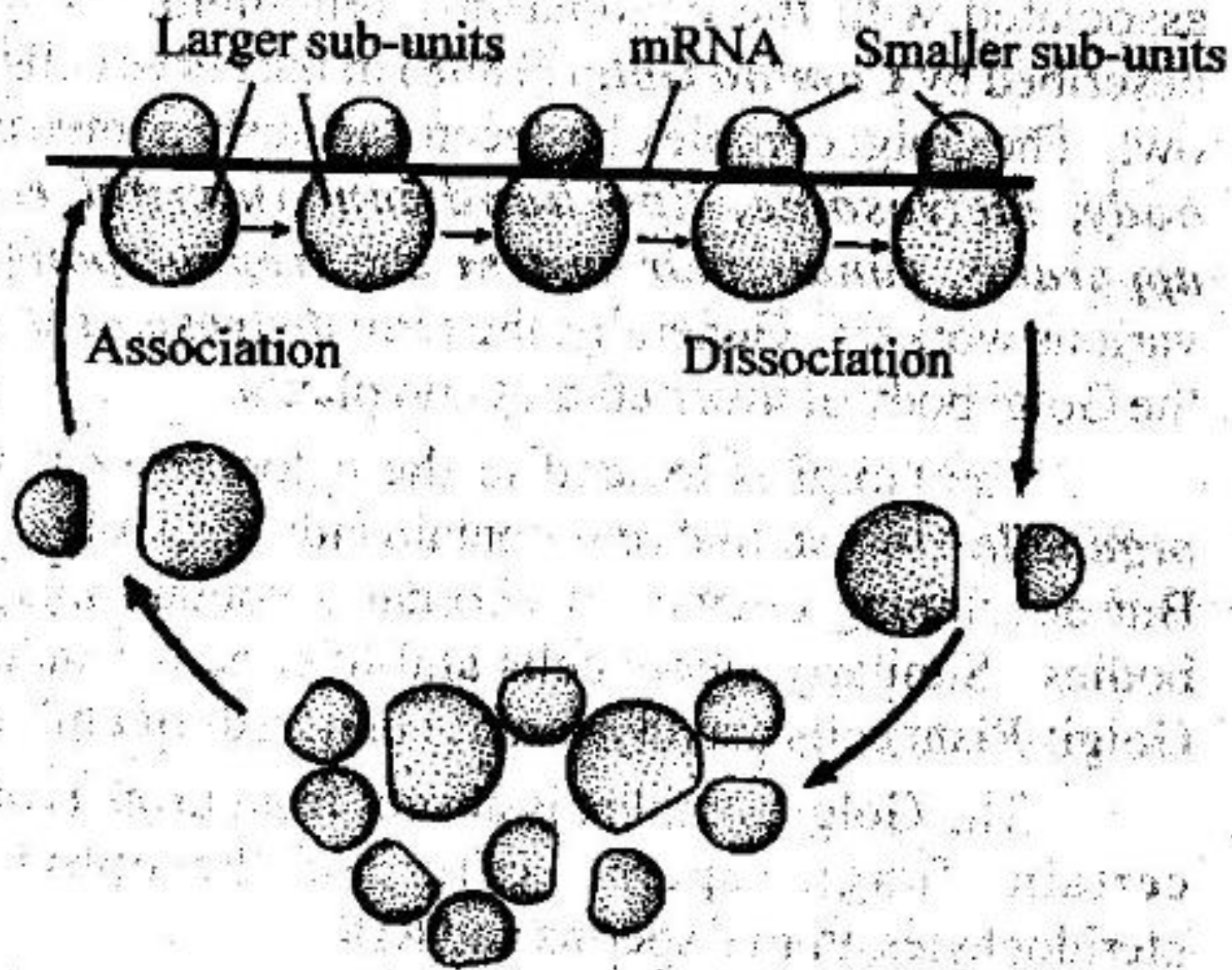
Ribosomes do the following functions:

### **1. Protein synthesis**

Ribosome plays an important role in protein synthesis. It is the *assembly shop* or *engine* where amino acids are linked

to produce proteins. During protein synthesis the two subunits join together on the mRNA. Like this many ribosomes are attached to the mRNA to form a *polyribosome*. The ribosomes contain slots for the attachment of tRNA containing activated amino acids and tRNA containing peptide chain. The ribosomes move on the mRNA. As they move the triplet code on the mRNA is translated and the peptide chain is elongated by the addition of correct amino acids one-by-one.





*Polyribosomes in protein synthesis.*

## **2. Protection**

The mRNA passing through the ribosomes is protected from *nucleases*. Similarly newly synthesized polypeptide chains are protected from *proteases*.