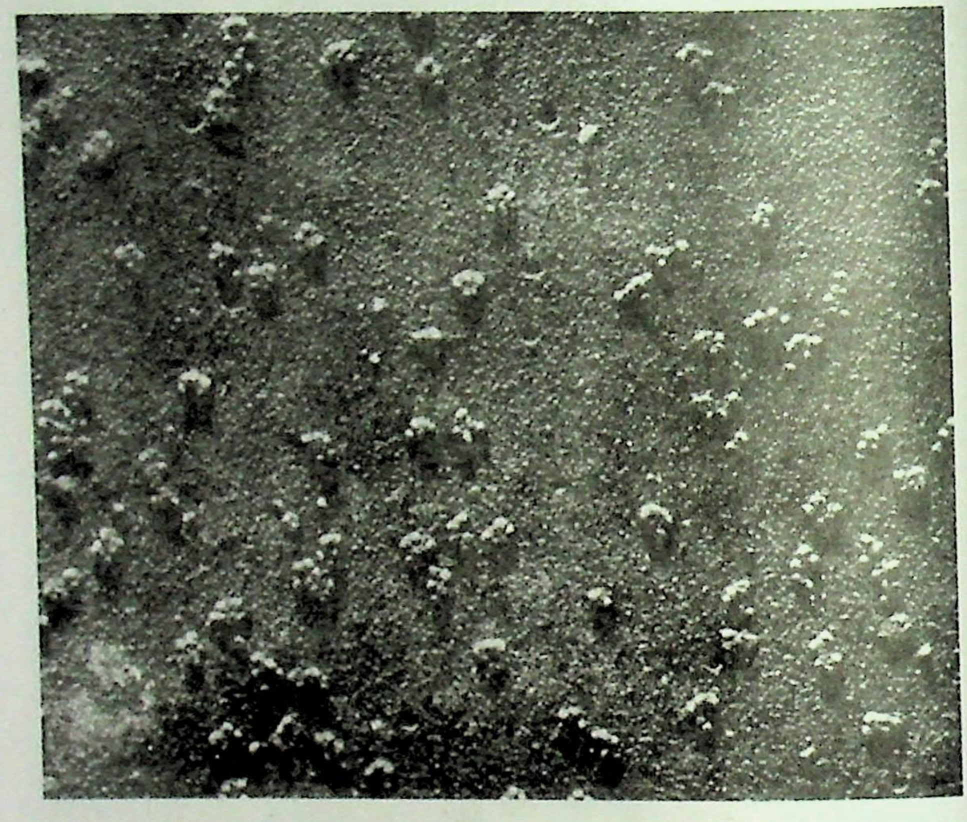


Fig. Plate 1.5. Electron Micrography of Polyribosomes. The individual ribosomes are making up fine units polysome which are believed to be held together by a single messenger RNA strand.
(*Courtesy*: Dr. A. Rich, Mass, USA).

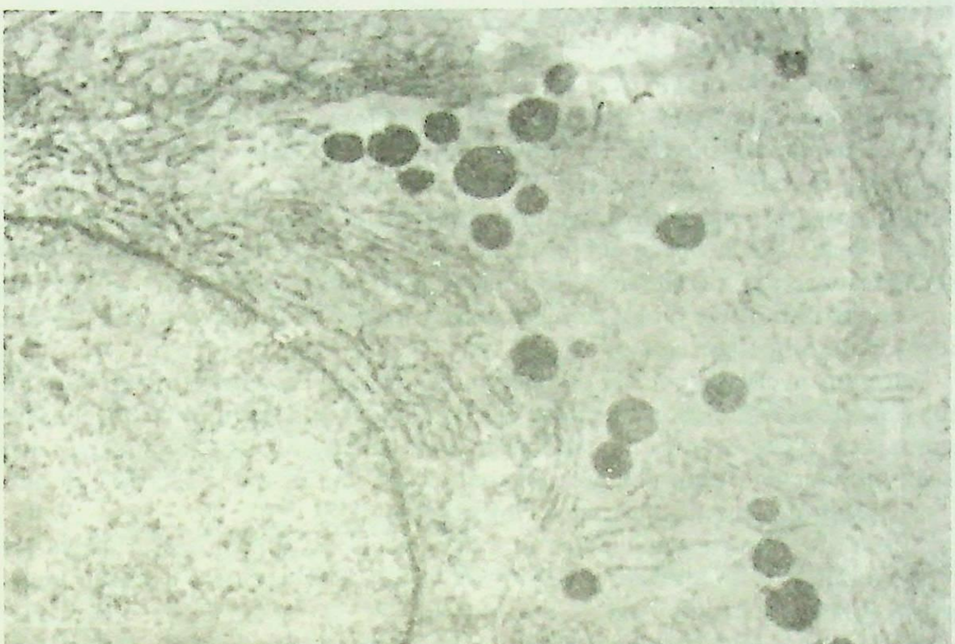
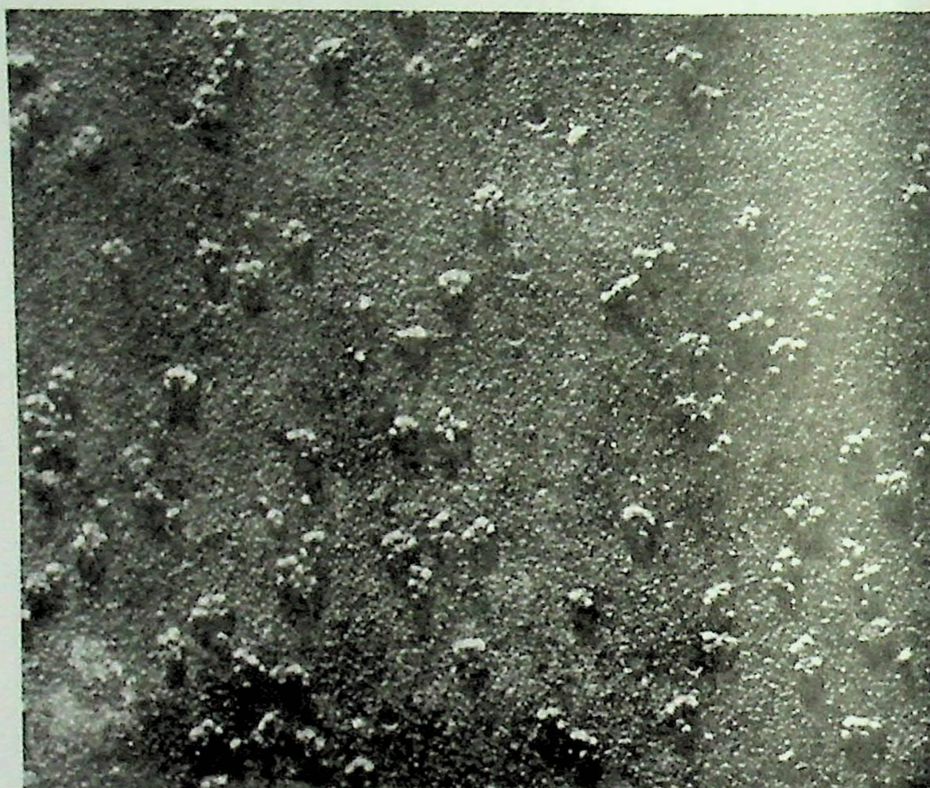


Fig. Plate 1.6. Micrograph showing Golgi Complex. In a more active Golgi region, the lamellar systems of cisternae are dispersed over a larger area. Secretion granules are present in large numbers in the interior of the Golgi Complex. Nucleus is also seen on left half of the micrograph. (Micrograph with Courtesy from Dr. D. Friend) Magnification 22,000X.



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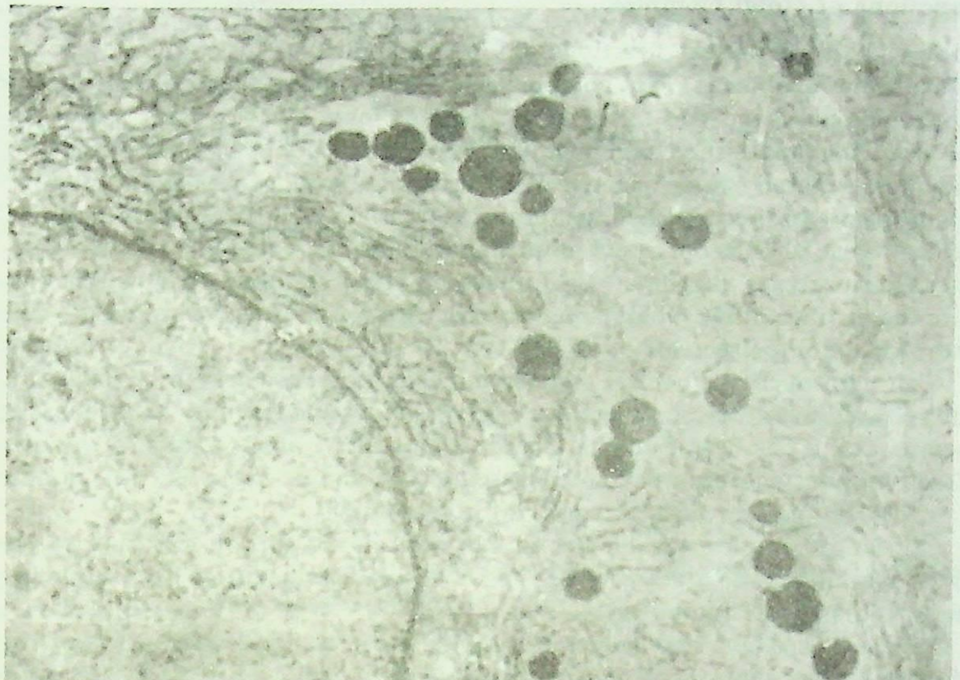

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Functions of Golgi Complex

Following are important functions of Golgi complex:

1. The main function of Golgi complex is to finally process the immature enzymes into functional forms and to secrete them in a closed vesicle. Thus, *secretion is the main function* of the Golgi complex. The dense secretory granules containing enzymes, generally in an inactive form are called *zymogen granules.*

It is now well established that most cytoplasmic membranes arise from RER (except those of chloroplast and mitochondria). This process involves the loss of attached ribosomes to generate SER, pinching off of vesicles, which will be fused with the *cis*-face of the Golgi complex, modification of proteins within the Golgi and production of secretory vesicles.

Virtually every major class of macromolecules is transported through the Golgi and secreted. This indicates that there is a continuous and fast turnover of the Golgi membranes. It has been estimated that in algae, dictyosomes take turnover every 20–40 minutes and cisternae are released at the rate of one every few minutes.

2. It participates in the transfer of glycoproteins.
3. Golgi complex participates in cell plate formation by releasing vesicles (or lomasomes) which actively organise cell plate orientation with the help of phragmoplasts (microtubules).
4. These are involved in secretion *e.g.* slime secretion from digestive glands of certain insectivorous plants like *Drosera, Nepenthes, Sarracenia* etc.
5. These play role in giving rise to the primary lysosomes.
6. These are supposed to play role in regulation of fluid balance.
7. These are also believed to play role in phospholipids synthesis and lipid absorption.

RIBOSOMES

(*Claude's Particles or RNP Particles*)

Palade (1953) for the first time reported the presence of some particulate units in the ground substance of animal cells. These small particles of about 150–200 Å dia. are found usually attached to the outer surface of ER. These are ribouncleoprotein (RNP) particles, *i.e.* RNA attached to proteins. Haguenau (1958) gave the name ribosome to these particles. Their presence in plants was first reported by Robinsen and Brown (1953).

Ribosomes are found in every type of living cells. According to their sedimentation values, two types of ribosomes are recognised, *i.e.* 70 S and 80 S types. In prokaryotic cells, only 70 S types are found while in eukaryotic cells, both 70 S in chloroplast and mitochondria and 80 S in the cytoplasm, attached on ER and inside the nucleus are found.

All ribosomes consist of two subunits of unequal sizes. The association and dissociation of these subunits depend on concentration of magnesium ions. The two subunits remain stapled together by Mg ions.

70 S ribosome consists of, (i) smaller subunits 30S and (ii) larger subunits 50 S, *i.e.*

$$30\ S + 50\ S \xrightleftharpoons{Mg^{++}} 70\ S$$ and 70 S dimers (two ribosomes) consists of 100 S *i.e.*

$$70\ S + 70\ S \xrightleftharpoons{Mg^{++}} 100\ S$$

Likewise, 80 S ribosome consists of (*i*) smaller subunit 40 S and (*ii*) larger subunit 60 S, *i.e.*

$$40\ S + 60\ S \xrightleftharpoons{Mg^{++}} 80\ S$$ and 80 S dimer (two ribosomes) consists of 120 S *i.e.*

$$80\ S + 80\ S \xrightleftharpoons{Mg^{++}} 120\ S$$

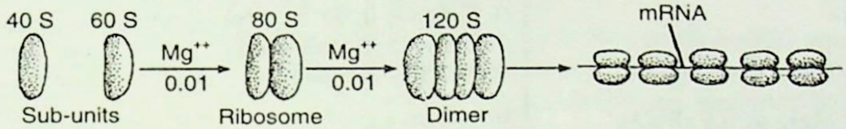

Fig. 1.15. Ribosomes with the formation of dimer and polysome.

According to Lake (1981), the smaller subunit of ribosome consists of a *head*, a *base* and *a platform*. The platform separates the head from the base with the help of a cleft. Similarly, the larger subunit consists of a *ridge*, a *central protuberance* and a *stalk* Fig. 1.16). The ridge and the central protuberance are separated with the help of a valley. The general shape of ribosome is corn-shaped.

In 70 S ribosomes, three molecules of *r*RNA are found, 16 S *r*RNA in 30 S subunit and 5 S *r*RNA and 23 S *r*RNA in 50 S subunit. In 30 S subunit, 21 molecules of protein and in 50 S subunit, 34 molecules of proteins are found. In 80 S type of ribosomes, four molecules of *r*RNA are found, 18 S *r*RNA in 40 S and 5 S *r*RNA, 5.8 S *r*RNA and 28 S *r*RNA in 60 S subunit. In 40 S subunit, 33 molecules of proteins and in 60 S subunit, 49 molecules of proteins are found. A comparative account of two types of ribosomes is given in Table 1.3.

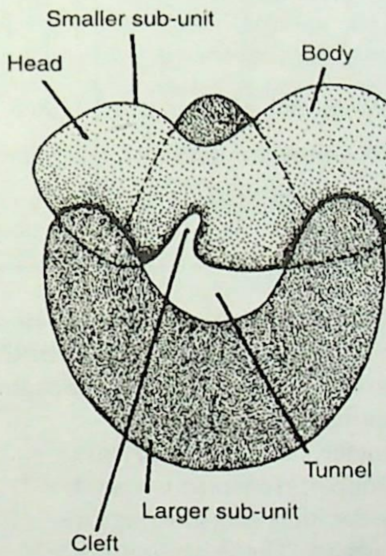

Fig. 1.16. The structure of a ribosome (ultrastructure based on studies of Stoffler and Wittmann, 1977).

Table 1.3. Comparative Summary of Two Types of Ribosomes.

No.	*Particulars*	*70 S ribosome*	*80 S ribosome*
1.	Occurrence	In prokaryotic cell and in chloroplast and mitochondria of eukaryotic cell.	In cytoplasm and nucleus of eukaryotic cell.
2.	Sedimentation coefficient	Average 70 S	Average 80 S
3.	Mol. wt.	3 million	4–5 million
4.	Subunits	Small-30 S and large-50 S	Small-40 S and large-60 S
5.	*r*RNAs	3 molecules of *r*RNAs. 16 S rRNA in 30 S subunit and 5 S and 23 S rRNAs in 50 S subunit.	4 molecules of *r*RNAs. 18 S *r*RNA in 40 S subunit and 5 S, 5.8 S and 28 S *r*RNAs in 60 S subunit.
6.	Mol. wt. of *r*RNAs	5S *r*RNA-40,000, 16 S *r*RNA-5,50,000 and 23 S *r*RNA-11,00,000	5 S *r*RNA-39,000, 5.8 S *r*RNA-51,000, 18S *r*RNA-7,00,000 and 28S *r*RNA-1,700,000.
7.	Protein molecules	21 Molecules (from $S_1 - S_{21}$) in 30 S subunit and 34 molecules (from $L_1 - L_{34}$) in 50 S subunit.	33 molecules (from $S_1 - S_{33}$) in 40 S subunit and 49 molecules (from $L_1 - L_{49}$) in 60 S subunit.
8.	Average mol. wt. of proteins	11,800	21,000
9.	*r*RNA-protein ratio	2:1 (*i.e.* RNA rich)	1:1 (*i.e.* protein rich)
10.	First critical Mg ions level	0.5 mole Mg ions per mole of phosphorus.	0.3-0.1 mole Mg ions per mole of phosphorus.

The lobes of both subunits of a ribosome are set in a way that a hole is formed between them and through which *m*RNA molecule passes at the time of translation. The lower subunit of each ribosome has two cavities, P site (peptidyl site) and A site (amino-acyl site).

In bacteria or in a prokaryotic cell, a group of ribosome is found connected with a single string of *m*RNA strand. These are collectively called polyribosome or polysome. The number of ribosomes attached to a single molecule of *m*RNA may be few to 30 or even more.

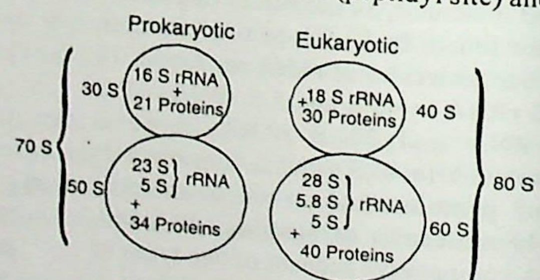

Fig. 1.17. Prokaryotic and eukaryotic ribosomal subunits.

Function of Ribosomes

The function of a ribosome is similar to a working table processing the protein synthesis. The smaller subunit provides surface for attachment of *m*RNA while the larger subunit helps in translocation and translation during protein synthesis. (The details of the function of various parts are given in the chapter on Gene action or Protein synthesis).

Biogenesis of ribosomes. The exact mechanism of biogenesis of 70 S type of ribosomes is less known. Perhaps the cell membrane and genophore collectively play an important role in the process. The genes for transcribing 5 S, 23 S and 16 S *r*RNAs are found associated with a single operon.

Some studies have been made on biogenesis of 80 S type of ribosomes. The 18 S and 28 S *r*RNA molecules are synthesised by *r*DNA (*r*RNA genes) found in the nucleolus. The DNA which transcribes 5 S *r*RNA is not found inside the nucleolus, rather it is found in the telomeric region of chromatids.

The genes for synthesising ribosomal proteins are found in chromatid and as such ribosomal proteins are synthesised in the cytoplasm. The assembly of 80 S type of ribosome takes place at the surface of nucleolus (inside nucleus) where *r*RNAs are clothed in ribosomal proteins. Thus, nucleolus plays a key role in the biogenesis of ribosomes.

LYSOSOMES

One of the recent electron microsopic discoveries were the rounded dense bodies observed in the liver tissues. These were named in 1955 by Christain de Duve as lysosomes on the basis of composition. These contain about 50 hydrolytic enzymes and as a matter of fact, these are the lytic bodies functioning as **suicidal bags**.

Structurally, lysosomes are polymorphic, submicroscopic bodies ranging in size from 0.4 to 0.8 micron but may be up to 5 microns as in kidney cells of mammals. These are frequently found in the animal cells particularly in the cells of liver, spleen, brain and thyroid of mammals. Lysosomes are also found in plant cells.

A lysosome has a single limiting membrane composed of lipoprotein, a densely granulated stroma and a large vacuole. Chemically a lysosome is a bag filled with *acid hydrolases* functioning at acid pH. Some of them are *Acid phosphatase, Acid ribonuclease, Acid deoxyribonuclease, Acid lipase, β-galactosidase* etc. It is because of this reason the lysosome is called a body rich in *hydrolases*. The characteristic oxidative enzymes of mitochondria are not present in lysosomes.

According to a recent concept, primary lysosomes are the secretion products of the cell. Lysosome enzymes are synthesised in the ER and then packaged at the GERL region of the Golgi complex to form the primary lysosomes. The mechanism by which these proteins are sorted out and routed towards the lysosomes is not yet fully known. However, different findings suggest that carbohydrates (like mannose-6-phosphate) may act as sorters in the intra-cellular traffic of proteins synthesised in the ribosomes attached to ER.

Functions of Lysosomes

Because of the presence of a larger number of enzymes, lysosomes are capable of hydrolysing various substances. Some functions assigned to them are as follows:

1. **Intracellular Digestion.** Lysosomes are responsible for the digestion of particles that are taken into the cell by phagocytosis. These particles when en-