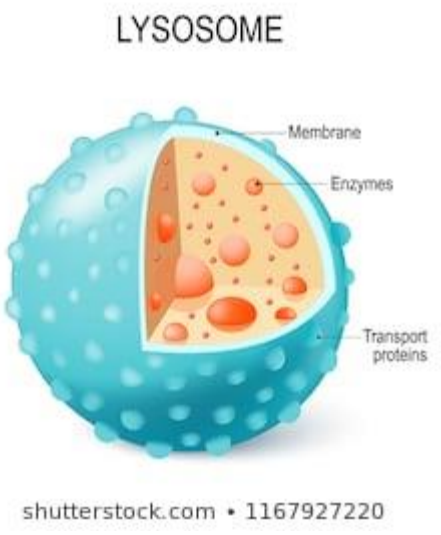
Lysosomes

- ✓ Lysosomes are membrane bound tiny bags filled with digestive enzymes. They are concerned with intracellular digestion. They were discovered by de Duve in 1955.
- ✓ Alysosome is a lytic body. It is capable of lysis.
- ✓ Lyso means digestive, soma means body.
- ✓ It can destroy a cell in which it releases its enzymes. Hence, it is often called suicidal bag.
- ✓ As the lysosome digests the components of the cells, it is often referred to as the digestive tract of the cell (de Duve, 1963).
- ✓ It is a cell organelle.
- ✓ Lysosomes were first named as pericanalicular bodies because of their location. They are renamed as Iysosomes by de Duve in 1955.
- ✓ Lysosomes occur in most animal cells and in a few plant cells. They are most abundant in cells which are related with enzymatic reactions such as liver cells, pancreatic cells, kidney cells, spleen cells, leucocytes, etc.
- ✓ Lysosomes are usuall*y spherical in* shape; but they are irregular in certain meri cells of roots.
- ✓ The size of the lysosomes usually ranges from 0.2 micron to 0.8 micron in di may be exceptionally large as 8 microns in mammalian kidney cells and leucocytes
- ✓ Lysosomes arc spherical dense bodies filled with large number of dense granule *hydrolytic enzyme*s *and acid phosphatases.*



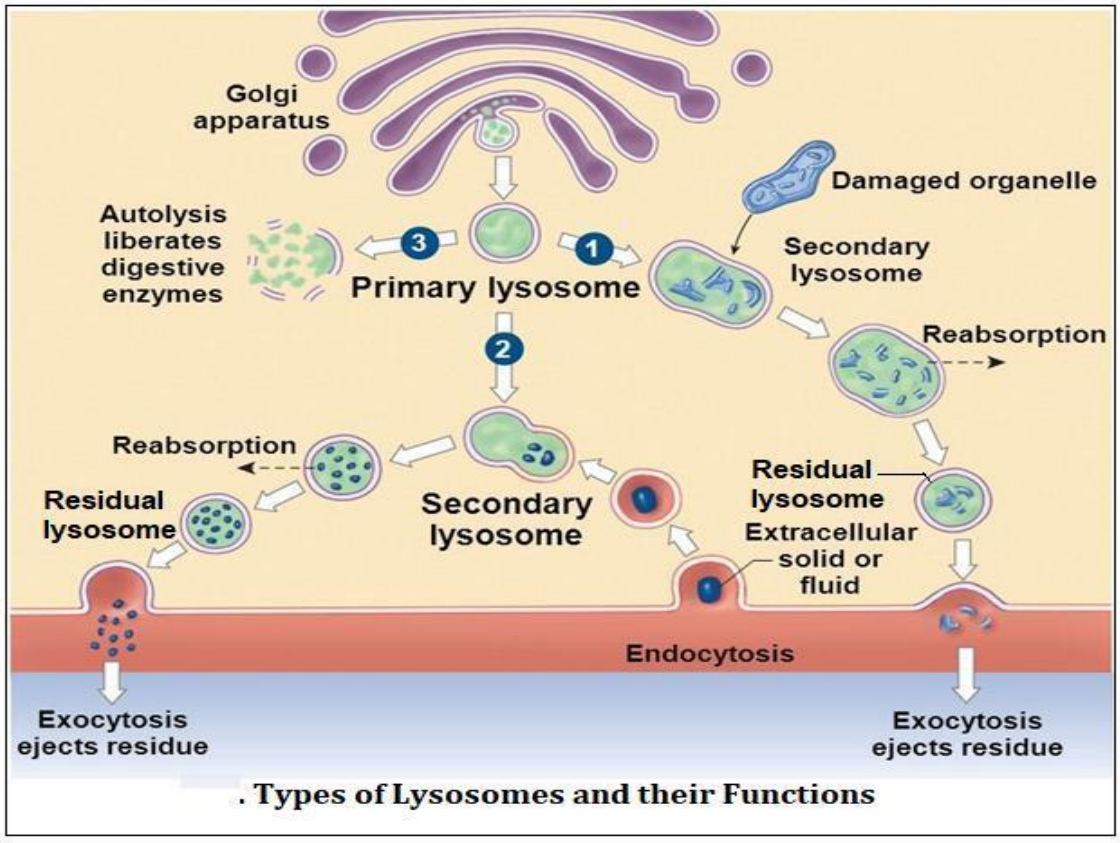
- ✓ The lysosomes are bounded b*y a single layered membrane* in contrast to the layered membranes of other organelles. It is *a membrane* like that of plasma membrane made up o*f proteins and lipids.* Proteins in the lysosome membrane are glycosylated with si residues.
- ✓ The interior of some lysosomes are uniformly solid while others have very dense oito zone and a less dense inner zone.
- ✓ The interior of the lysosome is *acidic* with a *pH of 4*.8, but the pH of the surrounding cytosol is *7*.2.
- ✓ The low pH is maintained by pumping *proton*s (H") from the cytosol.

polymorphic structure of lysosome

- ❖ Lysosomes are polymorphic structures because their contents vary with the stage digestion. On this basis, the lysosomes can be differentiated into four types. They are the following
- ➢ **Primary Lysosomes**: These are small s*ac-lik*e structures enclosing enzymes sy*m* by the Golgi body or endoplasmic reticulum. Since they store enzymes, they are also se *storage granule*s. The enzymes present in primary lysosomes are *acid hydrolases*.
- ➢ **Secondary Lysosomes** (Digestive Vacuoles): These are formed by the primary lysosomes with *phagosom*es. They contain

engulfed materials and enzymes materials are progressively digested by the enzymes.

- **Residual Body:** The secondary lysosomes with undigested wastes are called *lysosome*s. The digested materials are diffused into the cell cytoplasm through the membrane.
- **Autophagic Vacuole**:Autophagic vacuole are also called autophagosomes.These are special type of lysosomes, Which are formed when the cell feed on their own intracellular organelles such as mitochondrion, endoplasmic reticulum, etc. and they digest them ultimately. This happens only during starvation. This process is call*ed microautophagy:*



. Types of Lysosomes and their Functions

Chemistry

- Lysosomes contain a wide variety of enzymes. About 50 enzi mes have been isolated. It enzymes are enclosed by a *membrane.* All enzymes ar*e acid hydrolases.* Oxidative enzıma are completely absent from lysosomes. These enzymes remain inactive inside the lisosoma When the membrane is punctured all enzymes are released and become active. The follows: are the enzymes located inside the lysosomes:

- Acidribonuclease
- Acid deoxyribonuclease
- Acid phosphatase
- Acid phosphodiesterase
- Esterase
- Phospholipase
- Cathepsin
- Collagenase
- Peptidase
- Beta-galactosidase
- Beta-glucuronidase
- Alpha – maunosidase
- Alpha -glucosidase
- Sulphatase.

- *The lisosomal enzymes are collectiv*ely called *hydrolase*s. The hydrolases bring abor: the cleavage of substrates by the addition of a water molecule (hydrolysis).
- Most of the lysosomal enzymes function in the acid medium. Hence they are calledac*ii hydrolases.*
- The lysosomes contain about 50 hydroħtic enzymes. A single lysosome may not contain all the enzymes.

The lysosomal enzymes are classified into six main types. They are following:

- Nucleases
- Phosphatases
- Sulphatases
- Lipases
- Proteases
- Glucosidases

❖ **Nucleases**

Nucleases act on *nucleic acids.* They hydrolyze nucleic acids into nucleotides The nucleases are of two types, namely *ribonuclea*se and *deoxyribonuclease.* Ribonuclease acts on *R*NA and deoxyribonuclease acts on *D*NA.

❖ **Phosphatase**

Phosphatase's hydrolyze phosphate compounds. Phosphatases include acid phosphatuse's and acid phosphodiesterases.

❖ **Sulphatases**

Sulphatases break down sulphate esters into fragments.

❖ **Lipases**

Lipases hydrolyze lipids into *fatty acids* and *glicerol.* They include esterases and phospholipases.

❖ **Proteases**

Proteases liydrolyze proteins into amino acids. Profcases include *cathepsin, collagenase* and *peptidases.*

❖ **Glycosidases**

Glycosidases hydrolyze polysaccharides into monosaccharides. They include *ß galactosidase, ß - glucuronidase', mannosidase, a- glucosiduse,* etc. The interior of the lysosome i*s acidic.* The pH is *4.8.*

Origin

- Several possibilities have been suggested regarding the origin oflysosomes. The orien lysosomes depends on the tissues in which they are located or on their function in a specific

➢ **Extracellular Origin**

Lysosomes may be the vacuoles formed from the plasma membrane by pinocytosis. Trong the cytoplasm, these vacuoles obtain enzymatic activities and become changed into lisosore

➢ **Origin from the Golgi**

The accumulation of secretory products inside the vacuoles of Golgi leads to the forma of lysosomes. The lysosomal membranes are derived from the Golgi membrane.

➢ **Origin from Endoplasmic Reticulum**

*Novikof (19*65) has shown that lysosomes directly originate from the granular endoplas reticulum

Functions of Lysosomes

The lysosomes have the following functions:

❖ **Heterophagy**

- ✓ *Heterophagy is the lysosomal digestion of foreign materials.* It is an *intracer digestion.*
- ✓ In heterophagy, the cells digest the foreign or extracellular food materials. Th materials are taken into the cells by endocytosis such as *phagocytosis or pinocito*s.
- ✓ The food materials are enclosed in vesicles called *phagosomes* or *pinosomies.*
- ✓ These vesicles move towards lysosomes and fuse with the primary lysosom digestive vacuole called s*econdary lysosome.*
- ✓ The vacuole now moves to the plasma membrane. The enzymes of lysosomes digest the food materials in the digestive vacuole.

- ✓ The digested food materials disfuse into the cytoplasm through membra vacuole.
- ✓ The digestive vacuole containing waste materials is called *residual body:* The waste material are expelled out by exocytosis.
- ✓ This vacuole suscs with the plasma membrane so that its content is discharged out.

❖ **Autophagy**

- ✓ *Autophagy* refers to *the lysosomal digestion of own cell components. (Auto* = self: *phag*y = eating). It is an *intracellular digestion.*
- ✓ In autophagy, the cell organelles, worn out cells, dead cells, cell debris and stored food materials are digested by the lysosomes.
- ✓ In autophagy, the organelle to be digested, is enclosed by a membrane called *isolation membrane*. The isolation membrane is derived from endoplasmic reticulum or Golgi body.
- ✓ The vesicle formed in this way is called an *isolation body.* The isolation body fuses with the lysosome to form an *autophagic vesicle.* The digested particles diffuse into the cytoplasm and are utilized by the cell for the metabolic activities.
- ✓ *Menstruation i*s caused by the autophagy of uterine epithelium.

❖ **Extracellular Digestion**

- ✓ *Digestion of materials outside the cell* is called *extracellular digestion.* In certain occasions, lysosomes release enzymes outside the cell by ex*ocytosis* and bring about digestion. During fertilization, the sperm releases lytic enzymes of the acrosome on the surface of egg membrane. The lytic enzymes dissolve the egg membranes. This helps the sperm penetration.

- ✓ Extracellular digestion occurs during *bone erosion.* The *osteoclasts* are rich in lysosomes. In the area of erosion, the lysosomes release enzymes outside the cell and bring about extracellular digestion of bonc.

❖ **Fertilization**

- ✓ During fertilization, the *acrosome** of sperm ruptures and releases enzymes such as *hyaluronidase, protease,* etc. These enzymes dissolve the egg membrane and make way for the entry of sperm into the egg.
- ✓ These enzymes also activate the egg by the breaking down of *cortical granules.*

❖ **Chromosomal Breakage**

- ✓ The lysosomes contain the enzyme *deoxyribonuclcase*. This enzyme attacks chromos and brings about chromosomal breakages.

❖ **Lysosomes and Diseases**

- ✓ Indigestible substances accumulate in the cells and damage the lysosomes.
- ✓ When *silicius* inhaled, it is taken into the lung cells by*phagocytosis*. The particles of smica isrupt the lysosomal membrane and the lysosomes are ruptured. As a result, the hydrolytic
- ✓ unts are released into the cell. This results in the break down of the cell and the silica is
- ✓ insed. The silica is absorbed by other lung cells and these cells are also ruptured. This leads Finlammation oflungs and deposition of fibrous tissue (fibrosis) in the lungs. All these reactons mused by silica constitute *silicosi*s. It causes ***tumour.***
- ✓ Similarly, inhalation ofasbestos causes *asbestosis.*
- ✓ *Arthritis* is caused by the excessive extracellular release of lysosomal enzymes.

❖ **Role of Lysosomes in Developmental Process**

✓ In vertebrates, the regression of *Wolfiun ducts* in the female embryos and *Mullerian duc*ts in male is due to the activity of lysosomes.

✓ The degeneration *o*f *tadpole tail* is due to the action of cathepsins present in the lysosomes.

❖ **Menstruation**

✓ Bleeding during menstruation is due to the breaking ofthe endometrial cells of the uterus. The breaking is due to the lysosomes by autophagy.

❖ **Programmed cell Death**

✓ Lysosomes kill the cells which are destined to die by releasing enzymes.

Ribosome

- Ribosomes are ribonucleo-protein particles found in 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.
- Ramakrishnan, Steitz, and Ada E. Yonath described the structure and functions of ribosomes and for their work they were given Nobel Prize in 2009.
- Ribosomes are found in all the living cells which synthesize protein. They are usually located 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.
- Bacterial ribosomes are *70*S type and eukaryotic ribosomes are *80 S type*.
- The number of ribosomes are directly related to the RNA content of the cell. In rabbit reticulocytes, their number is found to be 1 x 10^5per cell. One mm of liver contains about 2 x 10^{13} ribosomes. In *E.coli*, there are about 20,000 - 30,000 ribosomes per cell.

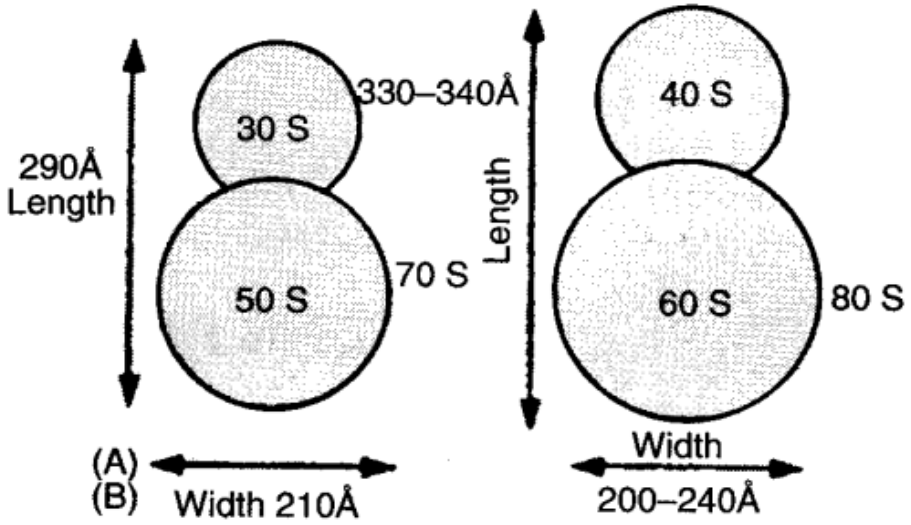
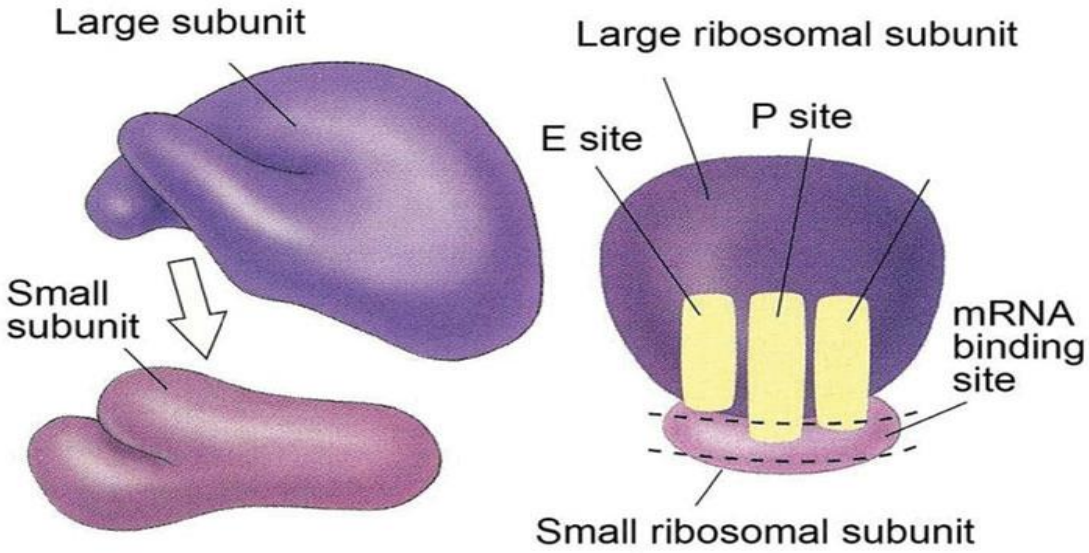


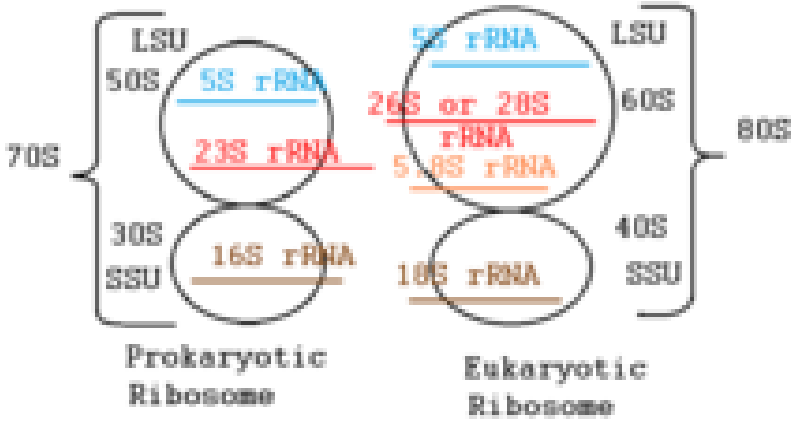
Fig. Ribosomes : (A) Prokaryotic, (B) Eukaryotic

Structure of Ribosomes

- Ribosomes are *spherical* in shape.
- The ribosomes of prokaryotes are smaller in size and those of eukaryotes are larger in size.
- In prokaryotes, they are 150A°and in eukaryotes, they are 250A^{o} in diameter. Each ribosome consists of two sub-units, namely a *large sub-unit a*nd *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 ribosome has 3 binding sites, namely A-*site,P-sit*e and *E site.* The A-site carries tRNA containing activated amino acid. The P-site carries a tRNA containing polypeptide chain. The E site is the *exit site* from where the deacylated tRNA is released into the cytosol.



- The eukaryotic ribosome has only two sites, namely A *site* and *P site*, the E-site bells absent. The binding sites are contributed by both the ribosome units.
- According to the size and sedimentation co-efficient, 2 types of ribosomes have been reported. They a*re 70S ribosomes* and *80S ribosomes.* 70S is found in prokaryotes. It is made up of two subunits namely, 30S and 50S.
- 80S is found in Eukaryotes. It is made up of 40S and 60S.
- The small subunit is somewha*t* flat and discoid. Its lower surface is slightly convex but its under surface is slightly concave. The small subunit is an *asymmetrical* structure. There is a cleft on the upper surface, which divides the subunit into a *head* and a *base.*
- The large subunit is a spherical structure with three convex sides and a concave bottom. Main body of this subunit is called *base*. There is a large protuberance on one side. On either side of the protuberance there is a *depression.* It makes a clear *stalk o*n one side of the protuberance.
- The concave surface of small subunit is bound to the bottom of the large subunit. Protuberance of the large subunit is aligned with the head of the small subunit.



- There are two spaces between the two subunits. One space is called P-site and is called A-site. The A-site carries tRNA containing activated amino acid and P-site carries tRNA containing the peptide chain.
- At the base of the larger subunit, there is a space called *exit site (*E-site).
- The synthesized polypeptides pass from one domain to another domain throughn the ribosome and comes out through the exit site.
- The base of large subunit constitutes *exit domain t*hrough which the ribosome binds with cell membrane.
- The mRNA binding domain occurs in the concave upper surface of the small subunit. Peptidyl transferase site occurs in the interior of the large subunits, connecting the A-site and P-site.
- 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.
- Many ribosomes together to form a *polyribo**some.***
- 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++

Chemical Composition

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

❖ **Ribosomal RNA**

The RNA present in the ribosomes are called r*RNA*. In eukaryotic cells, rRNAs are found in four forms, namely 28S *rRNA, 18 S rRNA*, 5S *rRN*A and 5.8S rRNA. The 18S rRNA present in small subunit and the others are found in the larger subunit. In prokaryotic cells, they are in the form of 23S rRNA, 16S rRNA and 5S rRNA. The later is present in small subunit alle the first two are present in the larger subunits.

❖ **Ribosomal Proteins**

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

❖ **Enzymes (protein factors)**

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

✓ **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_3 in small subunit is concerned with the dissociation of ribosomal sub-units.

✓ **Elongation Factors**

The elongation factors include *Tu, T*s, G and *peptidyl transferase.* Tu and Ts help in the binding of aminoacyl tRNATU-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.

✓ **Termination Factors**

Termination factors include R_1 and R_2 (releasing factors). They help in the release of proteins.

❖ **Metallons**

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

Biogenesis of Ribosomes

In eukarvotes, the ribosome is synthesized in the nucleolus and then it is transported to the cytoplasın. In prokaryotes, the ribosome is synthesized in the protoplasm.

Biogenesis of 80S Ribosome

- ❖ 80S ribosome is present in eukaryotes. In eukaryotes, the ribosome is synthesized in the nucleolus.
- ❖ The 80S ribosome is made of two sub-units, namely 60S and 40S. The 60S sub-unit has 28S rRNA, 5S rRNAs and 5.8 rRNAs and over 50 ribosomal proteins. The 40S sub-unit has 18S rRNA and over 30 different ribosomal proteins.

The synthesis of 80S ribosome involves the following steps:

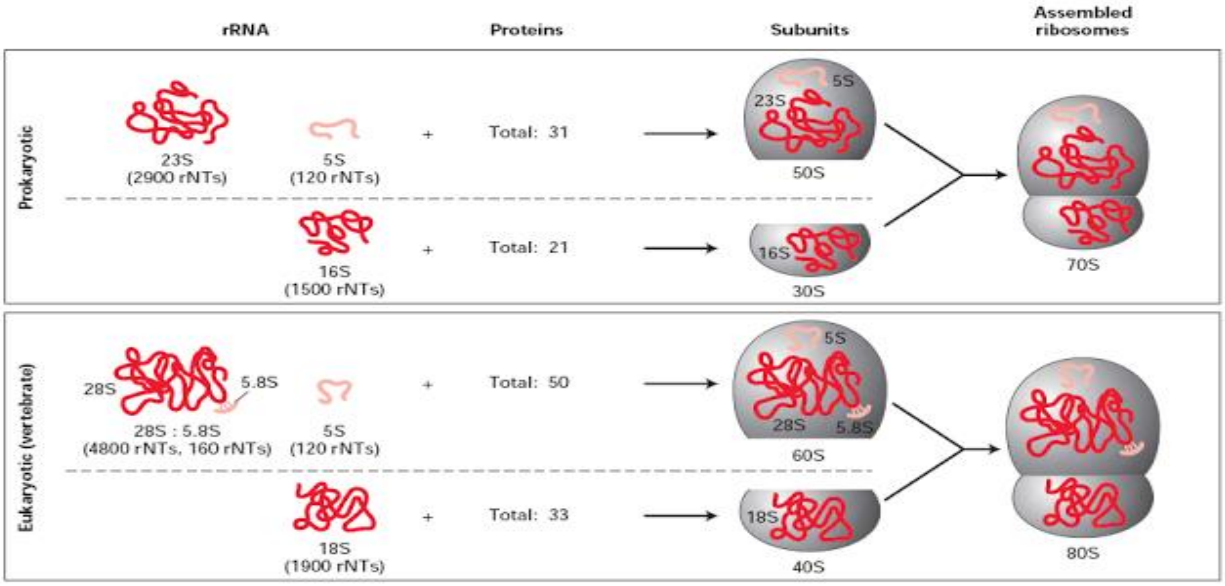
- ✓ One of the chromosomes of a set has a specific nucleolar organizer region. This region contains ribosomal DNA (rDNA). The rDNA contains a set of 2 genes, namely 18S rRNA gene. 5.8S rRNA gene and 28S rRNA gene. There are 200 copies of these genes in human. These genes produce 45S rRNA is formed in the presence of RNA transcription.
- ✓ The ribose sugar of certain regions of 45S rRNA undergoes methylation (addition of methyl group).
- ✓ The 28S rRNA, 18S rRNA and 5.85 rRNA are formed from the 45S rRNA by cutting at a non-methylated site.
- ✓ The 5S rRNA is formed from another region of the chromosome outside the nucleolus. 2000 copies of this gene are present in human
- ✓ In the nucleolus, the ribosomal protein binds with 28S and 5S rRNA to form 60S sub unit. Similarly ribosomal protein binds with the 18S rRNA to form 40S sub-unit

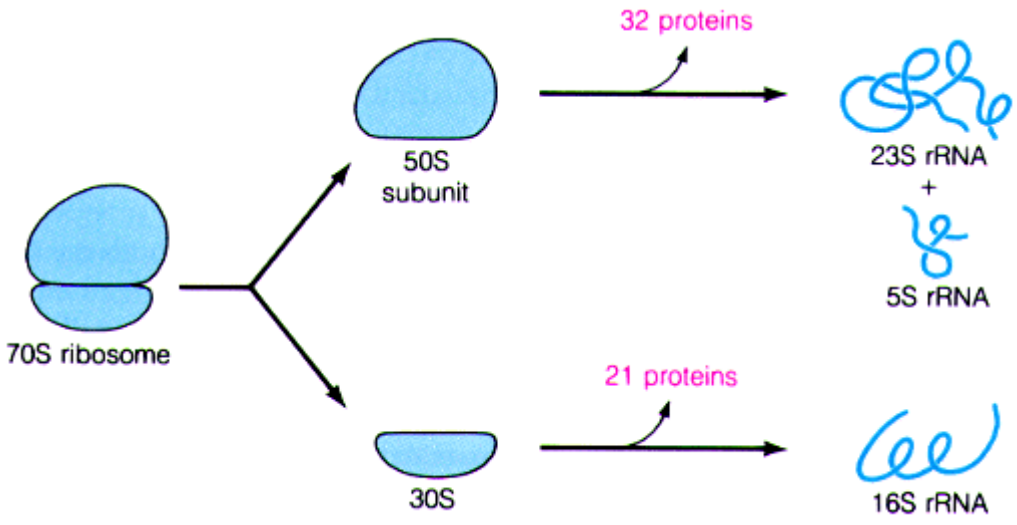
✓ The 60S and 40S sub-units pass into the cytoplasm through pores in the nuclear membrane. In the cytoplasm, the 60S and 40S sub-units unite to form the 80S ribosome when needed.

Biogenesis of 70S Ribosome

❖ 70S ribosome is present in prokaryotes. It is synthesized in the cytoplasm. It is made up of two sub-units, namely 50S and 30S. The ribosomal RNA genes occur in a single operon. They produce 23S, 16S and 5S rRNA

❖ The 235 and 5S rRNAs bind with 31 ribosomal proteins to form 50S sub-unit. Similarly, the 16S rRNA binds with 21 ribosomal protein to form 30S sub-unit. The 50S and 30S sub-units join together to form 70S ribosome.





Functions of Ribosomes

Ribosomes do the following functions:

- ✓ **Protein Synthesis**

Ribosome plays an important role in protein synthesis. It is the *assembly shop o*r engine where amino acids are linked to produce proteins. During protein synthesis, the two sub-units join together on the mRNA. Like this, many ribosomes are attached to the mRNA to forma *polyribosome.* The ribosomes contain binding sites for the attachment of tRNA containing activated amino acid and tRNA containing peptide chain. The ribosomes move on the mRNA. As they move along the triplet codon, the mRNA is translated and the peptide chain is elongated by the addition of correct amino acids one-by-one.

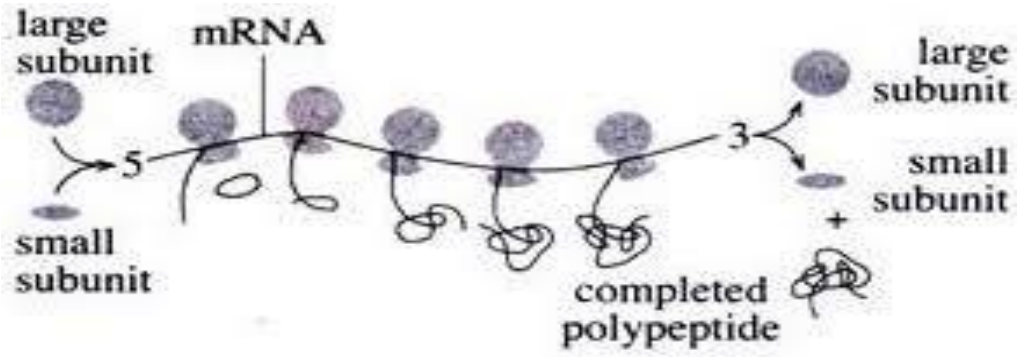


Fig. 3.16 : Schematic drawing of a polyribosome (polysome).

- ✓ **Decoding of mRNA**

Ribosome *read*s and *translate*s the code present in the mRNA. It assembles the amino acids as per the sequence of nucleotides

in the mRNA. The 30S subunit is involved in decoding.

- ✓ **Acceptance of Correct Amino Acyl + RNA**

During protein synthesis, the ribosome allows the correct amino acyl tRNA to be attached to the A site.

- ✓ **Peptide bond formation**

During protein synthesis, ribosome links the amino acids by peptide bonds helps in peptide bond formation.

- ✓ **Translocation of Peptidyl tRNA**

The peptidyl tRNA is shifted from A site to P- site. The 30S and 50S subunits are involved in translocation.

- ✓ **Translocation of deacylated tRNA**

The deacylated tRNA is shifted from P-site to E-site.

- ✓ **Exit of deacylated tRNA**

The deaclylated tRNA is removed from E-site.

- ✓ **Protection**

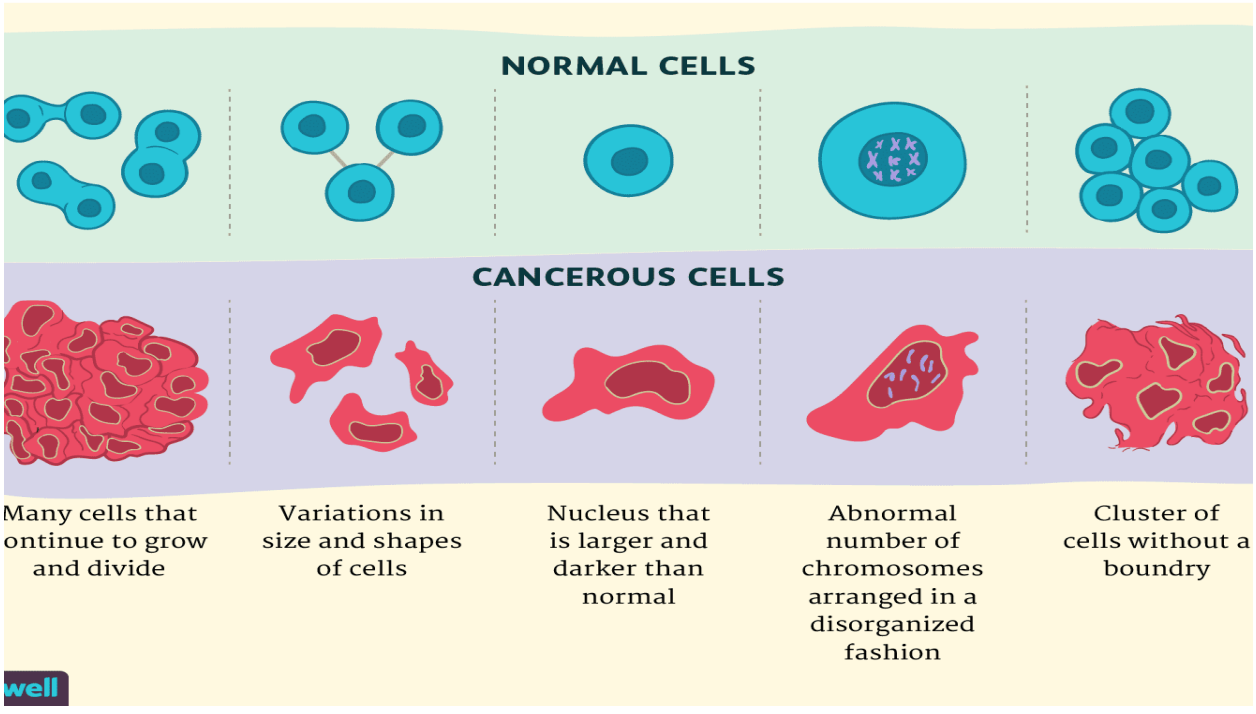
The mRNA passing through the ribosomes is protected from *nuclease*s. Similarly, newly synthesized polypeptide chains are protected from *proteases.*

Cancer

- ✓ A canc*e*r is a *tumour*.
- ✓ It is an abnormal growth or enlargement of tissue.
- ✓ It has no co-ordination with the normal tissue.
- ✓ It is an independent, autonomous, uncontrolled growth of tissue containing a mass of aberrant or abnormal cells.
- ✓ A tumour serves no useful purpose *b*ut is harmful as it grows at the expense of the host like a parasite.
- ✓ Cancers now cause the second largest number of deaths in most countries. There is no cure for cancer.
- ✓ The tumour is of two types, namely benign tumour and malignant tumour.
- ✓ The **benign tumour** remains fixed in the place of origin. It will not spread from one place to other. It can be cured by surgically removing the tissue.
- ✓ The **malignant tumour** spreads from one place to another through circulation and invasion. *she spreading of tumour from one place to another* is called **metastasis.**

Characteristics of Cancer

- ✓ A tumour arises from an existing tissue or cells of the body.
- ✓ The growth of tumour is autonomous. it follows its own laws of growth; it is not regulated by those governing the tissues from which or in which it grows.
- ✓ The tumour cells are undifferentiated and anaplastic in nature. '**Anaplasio**' refers to the reversion of differentiated cells into undifferentiated or embryonic cells.
- ✓ They have a greater potentiality for growth and multiplication.
- ✓ They carry out none of the functions of normal adult cells.
- ✓ They have large and irregular nuclei.
- ✓ They lose their contact inhibition.



Types of Cancer

The cancers are classified mainly in two ways

On the basis of position

On the basis of tissues.

First of all cancers are classified into two types on the basis of position. They are malignant tumour and non-malignant tumour.

- Malignant Tumour

It grows rapidly and spreads from the place in which it started, to the other parts of the body, nearby or away.

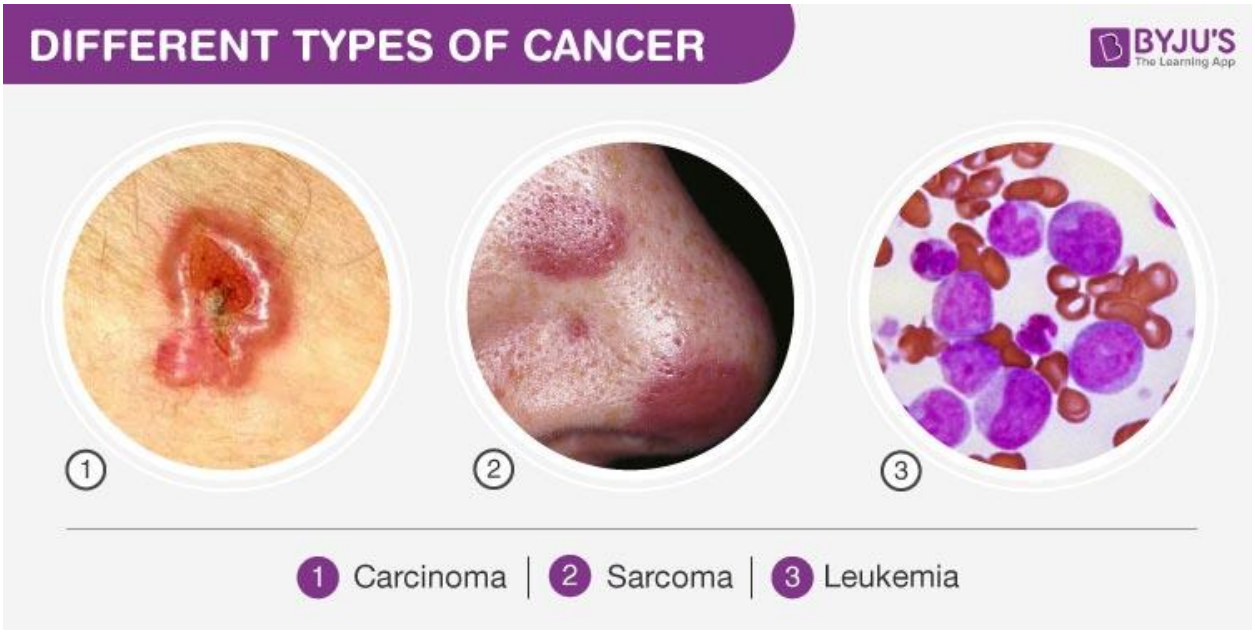
- Non-malignant Tumour (Benign tumour)

It is contined to the area in which it originated; its growth is always slow.

Secondly, physicians classify cancers on the basis of the tissues in which they originate. A few are given below:

✓ Carcinoma

Carcinoma is a tumour arising from epithelial cells. It occurs on the skin and in the lining membranes of internal organs.



✓ Sarcoma

Sarcomas are malignant tumours arising from any connective tissue.

✓ Osteoma

Ostcoma are tumours of bones.

✓ Fibroma

It is a tumour arising from Fibrous tissues.

✓ Glioma

These cancers develop in the network of supporting connective tissues in the brain central nervous system.

✓ Melanoma

This is a rapidly growing pigmented tumours. It originates in certain types of pigmented moles found on the skin. If these moles are irritated, they rapidly become malignant and the resulting cancers metastasize rapidly.

✓ Lymphoma

The cancerous growths developing on the lymph nodes and the other tissues of the lymphatic system are called *lymphomas.*

✓ Teratoma

Teratomas arise from cell-rest derived in the morula stage itself; later they acquire the ability for growth. It is suggested that teratoma is a suppressed foetus resulting from an undifferentiated germ cell or a fertilized polar body or it develops by parthenogenesis. In other words, teratoma is considered an inclusion of a parasitic foetus in an individual.

Causes of Cancer

In the present state of our knowledge, it is still not clear just what causes a cancer. However, there are certain contributing factors:

- **ChronicIrritatin**

Chronic irritation causes cancers. There are various examples. Irritation caused to the tongue by broken or malformed teeth has often led to the cancer of the tongue; Cancers of the lip were quite common when clay pipes were in use.

- **AtmosphericPollution**

There are evidences to show that cancers easily strike city dwellers than country dwellers. It is true that the atmosphere over cities is often polluted with the products of the combustion of coal and oil with motor exhaust gases. The increase in industrialization has caused a corresponding increase in cancer cases.

- **Smoking**

Statistical studies show that heavy smoking of cigarettes causes and increases in the number i lung cancer cases. There is as yet no positive evidence that cigarette smoking alone causes lungcancer.

- **Chemicals**

Chemical substances added to food and medicines may have the effect of causing the development of cancers.

Diagnosis

- ✓ Here is a list of symptoms that may indicate pre-cancerous or cancers growth:
- ✓ Any sore that fails to heal or any sore that heals, but returns.
- ✓ Any continuous or repeated discharge or bleeding from any opening in the body.

- ✓ Any lump or mass, whether a sore or not, that appears in a tissue, particularly a lumn developing in the breast.
- ✓ Indigestion or any abnormal feeling in the stomach, which persists or disappears, but returns repeatedly.
- ✓ Any such things as alternating constipation and diarrhoea. Unexplainable loss of weight.
- ✓ Persistent cough or sore throat.
- ✓ If a person has any one of these symptoms once, only once, there is no reason to be alarmed. However, if they persist or if they keep coming back, it is wise to consult a competent physician.
- ✓ Biopsy : It is a technique by which a suspected cancer tissue can be tested. It is a liable technique. It consists of microscopic examination of a small portion of the suspected tissue.
- ✓ **X-rays** : X-rays are also used to diagnose the cancers that affect the digestive tract, kidney and chest.

Treatment

There was a time when the diagnosis of cancer was equivalent to a sentence of death. Today cancers can be cured. Almost all cancers start at some definite location in the body but a few start in more than one place. It is vitally important to root out any cancer at its starting point before it invades nearby tissues or before it sends cells to the other parts of the body.

- ➢ **Surgery**

A cancer can be cured by completely removing the cancerous growth.

- **Radiation**

Cancers can be treated successfully by treating them with X-rays or radioactive substances. Beams of radiation are focused on the tumour. The radiations kill the cancer cells. In some cases, minute particles of radioactive substances are inserted directly into the cancerous tumour to kill the cancer cells.

- **Laser Treatment**

In laser treatment, a reddish black drug called *hematoporphyria derivative (HPD) is* iniected into the body. HPD is retained only by the cancer cells. After one or three days, tumours are loaded with the drug; but most of the normal tissues are free from it.

The drug glows in the blue laser light allowing the doctors to precisely locate the tumour. ***Dr.Alan wi****le s*aid that the young tumours which cannot be detected by X-rays, can be traced with the help of the blue laser light. Once the cancer is located, it is attacked by focusing a red laser beam on it in a single course of treatment. The red laser beam activates the HPD to kill malignant cel*ls (Mr.Berns).*

- **Stem Cell Transplantation**

Leukemia, myeloma and lymphoma can be treated by stem cell transplantation.

- **Chemotherapy**

Treatment of cancer using drugs is called chemotherapy

The cancer drugs inhibit mitosis.

Mustard gas is used as a cancer drug. It adds alkyl group to the guanine of DNA of cancer cells. This prevents replication of DNA of cancer cell and stops division. Vinca alkaloid drug destroy spindle fibres and stop mitosis.

The drugs Irinotecan and topotecan obtained from the Chinese ornamental tree Camptotheca acuminata inhibit DNA gyrase enzyme. Hence DNA double helix cannot unwound and DNA replication cannot occur.

Oncogenes

- Oncogenes are genes responsible for the transforination of normal cells into tumour cells. (Greek, *oncos*= mass or tumor) The cellular oncogenes are called *proto-oncogenes.* For example, *neu g*ene in rat causes *neuroblastoma* and *Kra*s in man causes lung carcinoma. *Kras* is activated by *re**trovirus.***
- The oncogenes of viruses are not themselves of viral origin but are cellular genes. The viruses pick up the oncogenes from animal and human cells by *recombination* during the course o*f infection.*
- Though oncogenes of viruses are found in all the human cells (except RBC which does not contain a nucleus), majority of the cells never become cancerous. Oncogenes have the potential of causing cancerous transformation of cells when appropriately activated.
- About 20 oncogenes have been discovered. *C-myc, N-myc, L-myc, c-abl, c-myb, c e*roB and c-*K-ra*s are different oncogenes associated with human cancers. 3. Oncogenes are found i*n all human cells a*nd *viruses.*
- The oncogenes of cells are called *cellular oncogenes (c-oncogenes)* and that of nruses are called v*iral oncogenes (v-oncogenes).*

- The oncogenes are not viral origin. They are cellular origin. The viruses pick up the Oncogenes from the cells during infection.
- The term *'oncogene'* was coined by *George Todaro* and *Robert Heubner*. Oncogenes are activated ***protooncogenes.***
- Protooncogenes are found in all cells.
- Bishop and Harold demonstrated that oncogenes are activated protooncogenes.
- They were given *Nobel Prize* in 1989 for this discovery.
- Oncogenes are the *mutant forms* of protooncogenes.
- The proteins produced by protooncogenes are called *oncoproteins.*
- The oncoproteins and protooncogenes are essential for *embryogenesis*.com *development* and normal functioning of an organism.
- *Protooncogene activities are turned off, once the developmental processes a*re *stopped.*
- If protooncogene activity remains high or if protooncogenes are reactivated later in life, cancer may occur.
- In cancer cells they are expressed at high levels.
- Protooncogenes as such cannot cause cancer. They become cancer genes when are activated.
- Hence oncogenes are said to be the *mutant forms of protooncogen*es.
- The activated protooncogenes produce excess amount of proteins. They turn normal walls into cancer cells. They

exhibit uncontrolled division and growth causing cancerous growth.

Prevention of Cancer

- ✓ Avoid *smoking*
- ✓ Avoid *alcohol*
- ✓ Avoid *stress.*
- ✓ Avoid *tobacco.*
- ✓ Eat healthy and balanced diet.
- ✓ Maintain a healthy weight.