# Cell Surface Modifications

# Morphological changes in the cell surface (Cell Surface Modifications):

1. Structures that provide transportation.
2. Structures that provide movement.
3. Structures that connecting the cells to each other.

# 2. Structures that provide movement

There are three types of changes on the cell surface to provide movement:

a)Pseudopodia

b)Kinocilia

c)Flagella

## 2. Structures that provide movement

### a)Pseudopodia:

- **Pseudopodia** are temporary projections of eukaryotic cell membranes. Cells that possess this faculty are generally referred to as amoeboids. Pseudopodia extend and contract by the reversible assembly of actin subunits into microfilaments. Filaments near the cell's end interact with myosin which causes contraction. The pseudopodium extends itself until the actin reassembles itself into a network.

# 2. Structures that provide movement

**a)Pseudopodia:**

- Pseudopodia are found in unicellular (protists) organisms.
- Cells move with pseudopodia.
- This feature is evident in amoeba.
- Embryonic cells and germ cells have move ameboid.
- Ameboid movements are seen cellular (microphages, macrophages, T-lymphocytes) and humoral (B-lymphocytes) immunity cells also.

# 2. Structures that provide movement

**b) Kinocilia:**

- Kinocilia are permanent structures.
- Such as microvilli, occur with the cytoplasm evaginasyo. However, they are thicker and longer.
- Kinocilia or just cilia are parallel oriented, motile, finger-like protrusions of cell membranes connected to a basal body.

## 2. Structures that provide movement

**b) Kinocilia:**

- As a characteristic, cilia possess a **central pair of microtubules** sourrounded by an inner sheath. **Nine outer pairs of microtubules** are connected to the central pair by radial spokes which extend at right angles onto them. The 9 outer pairs of microtubules are connected to each other by **nexin bridges**. All ciliary microtubules run parallel to each other. In cross sections their **specific 9x2+2 structure** is well defined.

## 2. Structures that provide movement

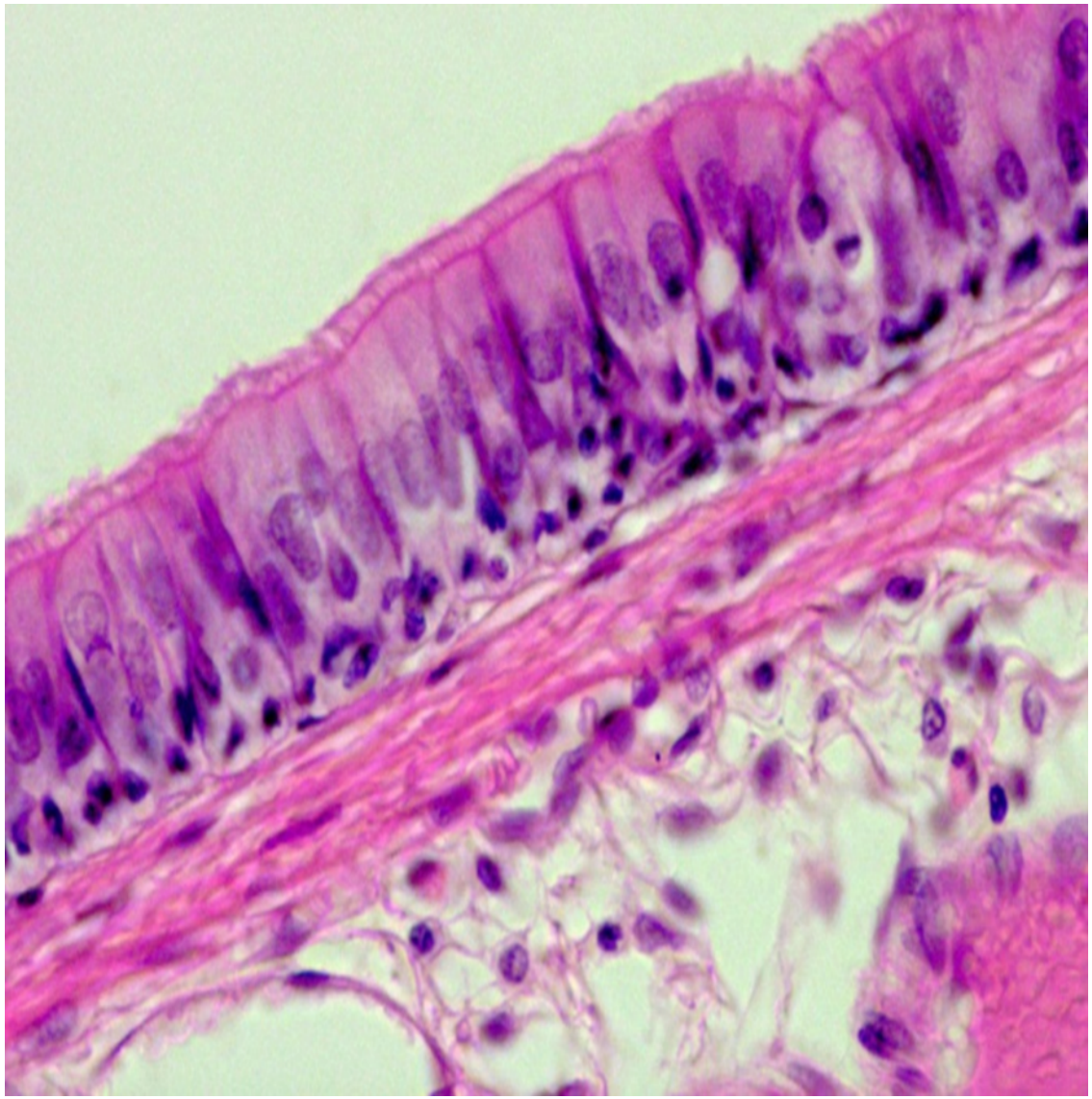
**b) Kinocilia:**

- Kinocilia motility provides by the **basal body**. Basal body is made by **centrioles**.
- During the development of the cells, centrioles, migrate to the cell surface, proliferation, differentiation and become basal bodies.
- Kinocilia and basal body is made of microtubules. Microtubules, are formed as a result of organizing the tubulin protein.

## 2. Structures that provide movement

## b) Kinocilia:

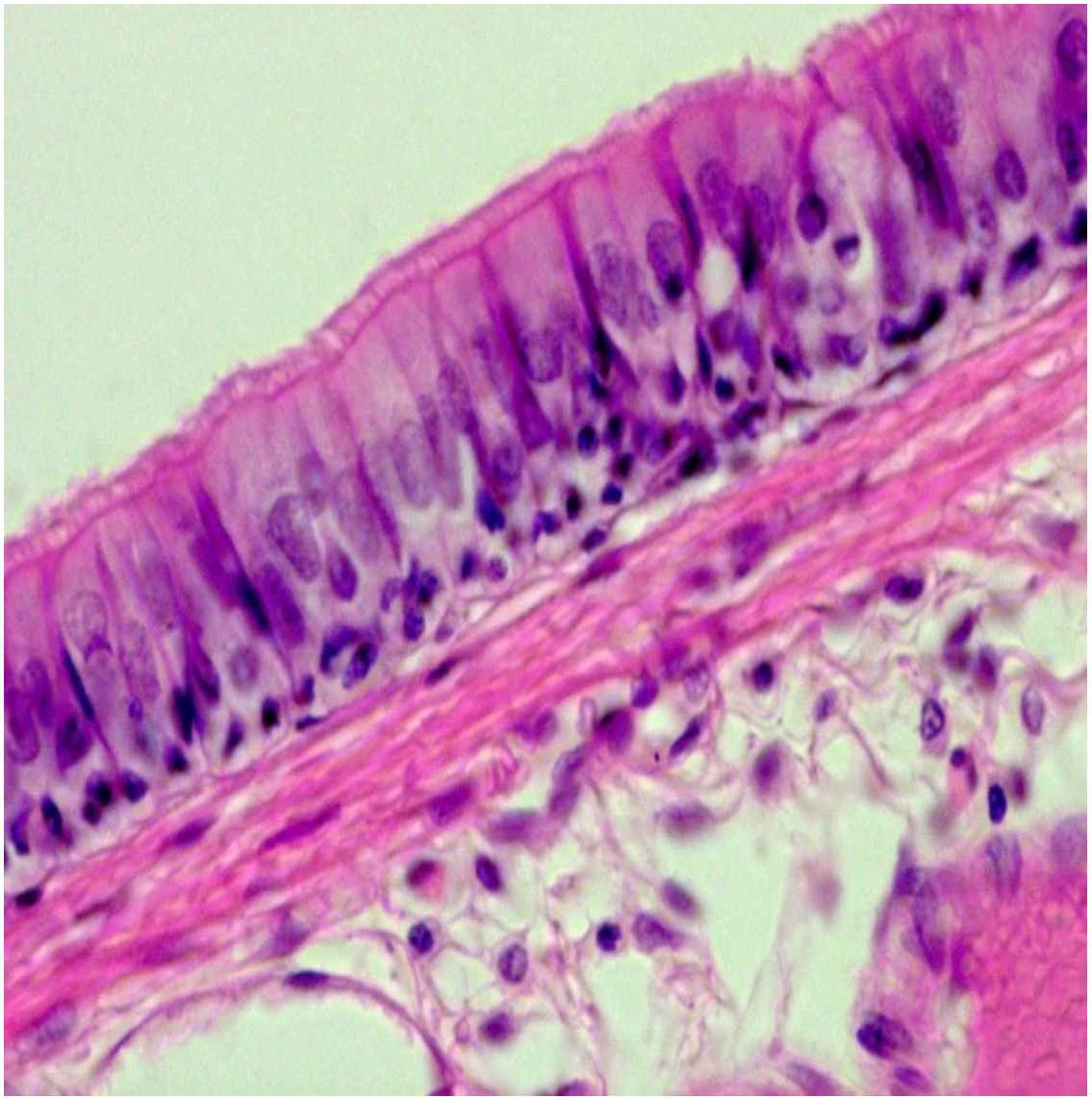
•Kinocilia are found in the respiratory epithelium present in the nose, paranasal sinuses, larynx, trachea, and bronchies.



**2. Structures that provide movement**

## b) Kinocilia:

•Kinocilia move to the same direction (outward), and nasal mucus flows towards the outside. Thus, they prevent foreign bodies down to the lungs.



**2. Structures that provide movement**

## b) Kinocilia:

•Kinocilium also found in the ductulus efferentis. Spermatozoa are forwarded to the next channel by kinocilia.

•Kinocilia are found the oviduct and uterine epithelium. Oviduct epithelial kinocilium, transmit to embryo toward the uterus.

## Stereocilia:

- There are no microtubules and basal body in the stereocilia.
- It is motionless.
- Stereocilia, similar to  microvilli. They contain actin filaments. However, they are longer than the microvilli and exhibit branching.
- Stereocilia, like microvilli, is believed to take part in the transport of substances.
- Stereocilia are found columnar epithelial cells in the epididymis.

## 2.Structures that provide movement

### c)Flagella:

- These are similar to kinocilia, but much longer. Flagella have permanent cytoplasmic extension and active motion.
- The most typical example is the spermatozoon tail in mammals. This tail is 40-50 microns in length.
- Flagella are found mostly in the unicellular organisms.

# 3.Structures that connecting the cells to each other.

# (Cell Junctions)

•During embryonic development, cells are divided, come together and they constitute tissues. Here, cell adeziyo molecules (integrins) constitute tissue from cells. These glycoprotein molecules are transmembrane proteins.

•Integrins are the bridges for  cell-cell and cell-extracellular matrix (ECM) interactions.

## 3.Structures that connecting the cells to each other.

- In adult epithelial tissues, cells are held together via **integrins**.
- However, some cell types (secretory epithelial cells, cardiac muscle cells, etc.) have variety of **cell junctions** together with integrins.

## 3.Structures that connecting the cells to each other.

•These cell junctions, besides connecting functions, have an important role in the transport of substances from cell to cell.

The major **cell junctions** :

a)Zonula occludens

b)Zonula adherens

c)Macula adherens(desmosomes)

d)Hemidesmosomes

e)Gap junctions

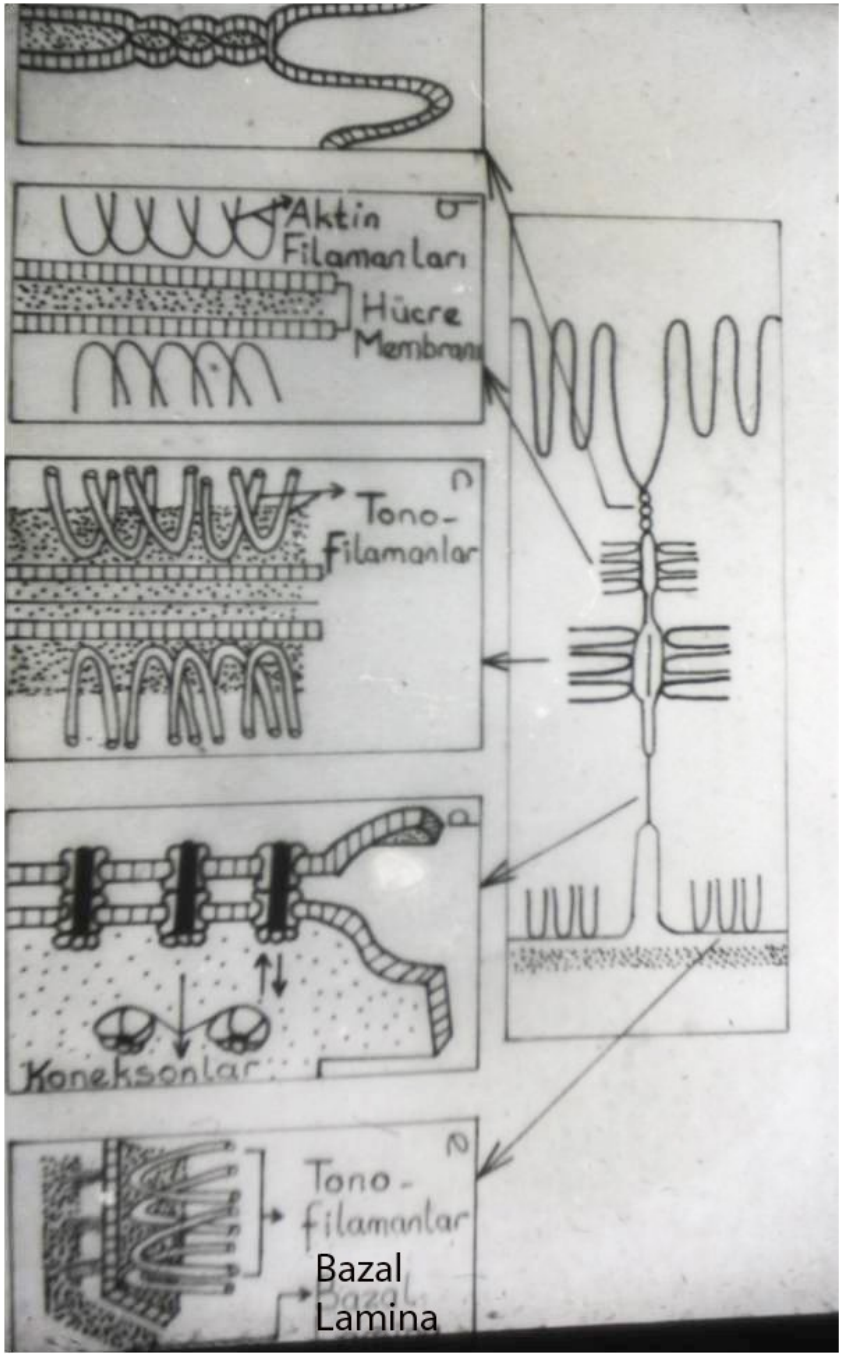
f)Lateral cell infoldings (interdigitations)

## 3.Structures that connecting the cells to each other.

- When secretory epithelial cells are examined by light microscop, a little line appears between the apical ends of adjacent cells. This is called the **terminal bar.**
- The terminal bar is seen detail in the electron microscope.
- The terminal bar is located on the lateral surface of epithelial cells.
- This structure, called **binding complexes**, shows a complex structure in the EM.

## 3.Structures that connecting the cells to each other.

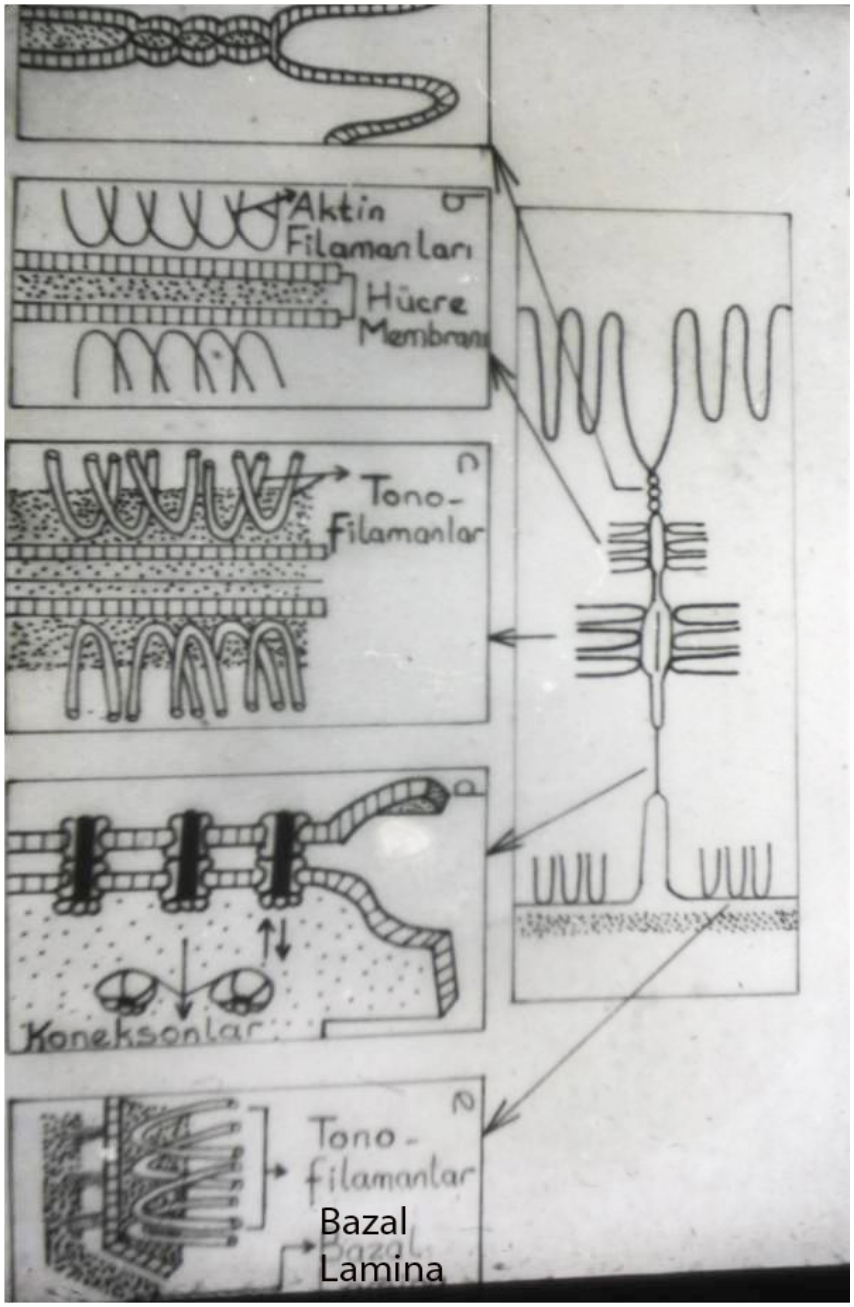
- In most binding complex, the first two or three of these connection types has settled consecutively.
- Sometimes, a gap junction is join to this unity.
- These binding complexes are visible in simple columnar epithelium under the EM.



## a)Zonula occludens:

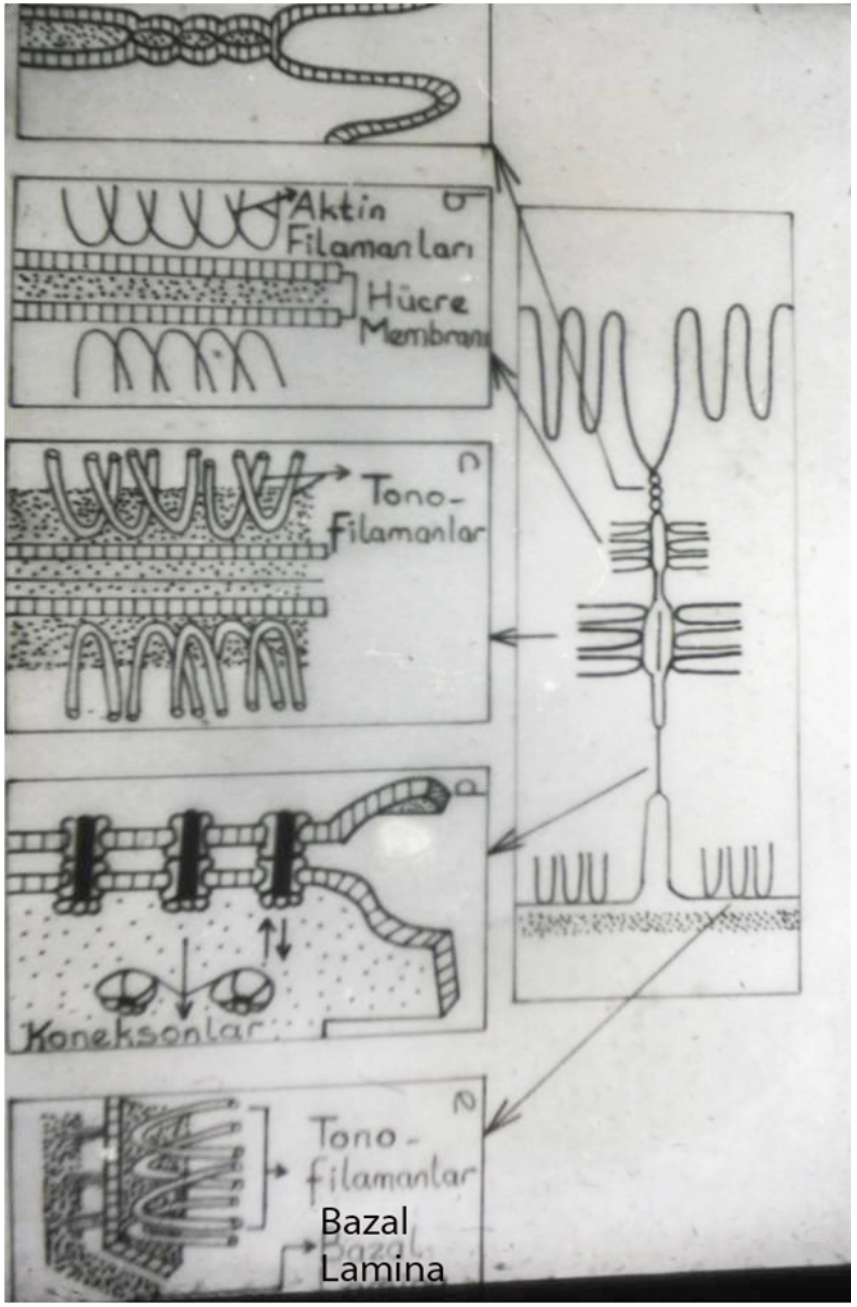
- There are 10 nm in gap between the epithelial cells, and glycocalyx is found in there. This portion is called zonula occludens.

- Neighboring membranes are fused to each other tightly. This structure is also known as **tight junction**.



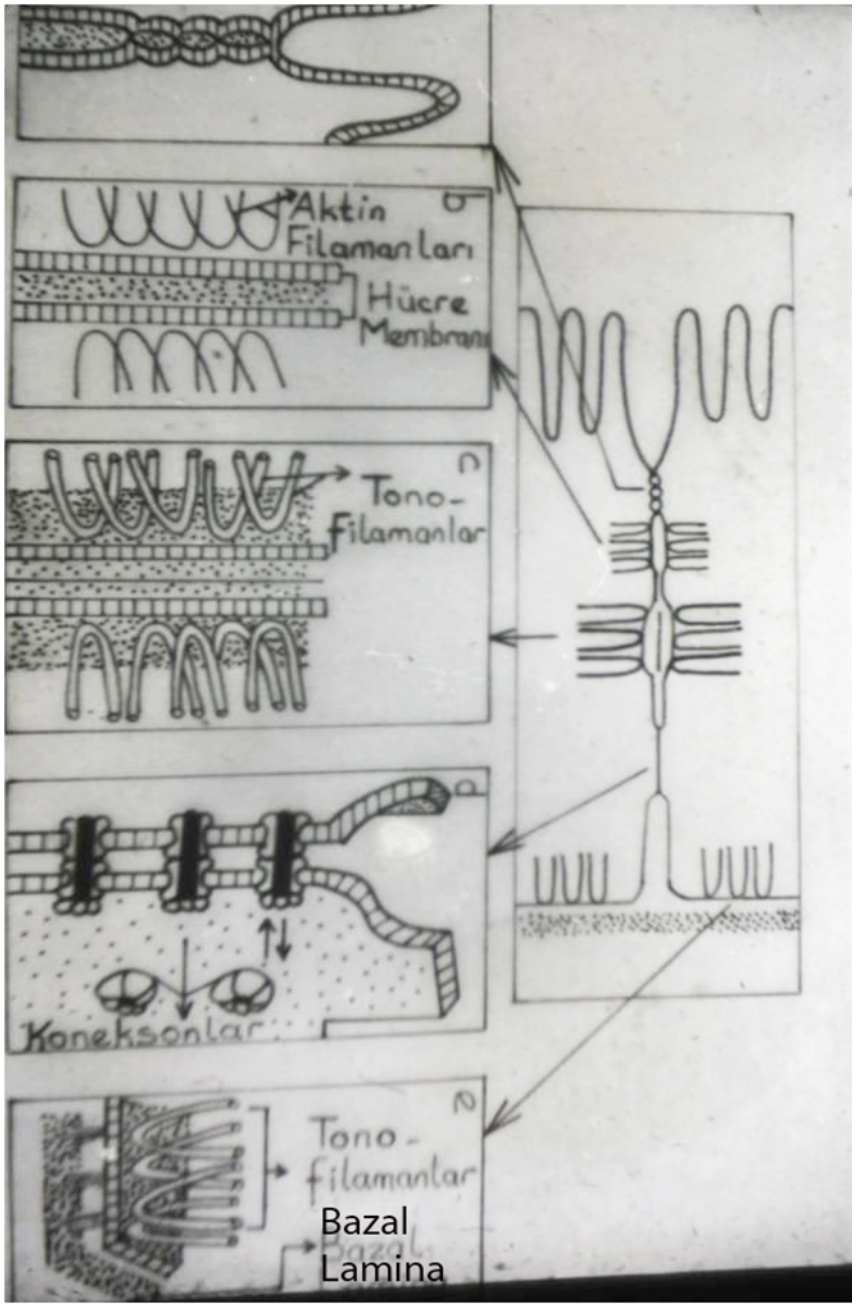
## a)Zonula occludens:

The integral protein molecules on the two adjacent membranes enter between each other and connect the two cell membranes to each other like a zipper.



# a)Zonula occludens:

- Zonula occludens are closed the intercellular space to the lumen.
- Substances cannot pass through to the intercellular space from lumen.
- Zonula occludens is found in almost all types of epithelial tissue and surrounds the cells like a belt.



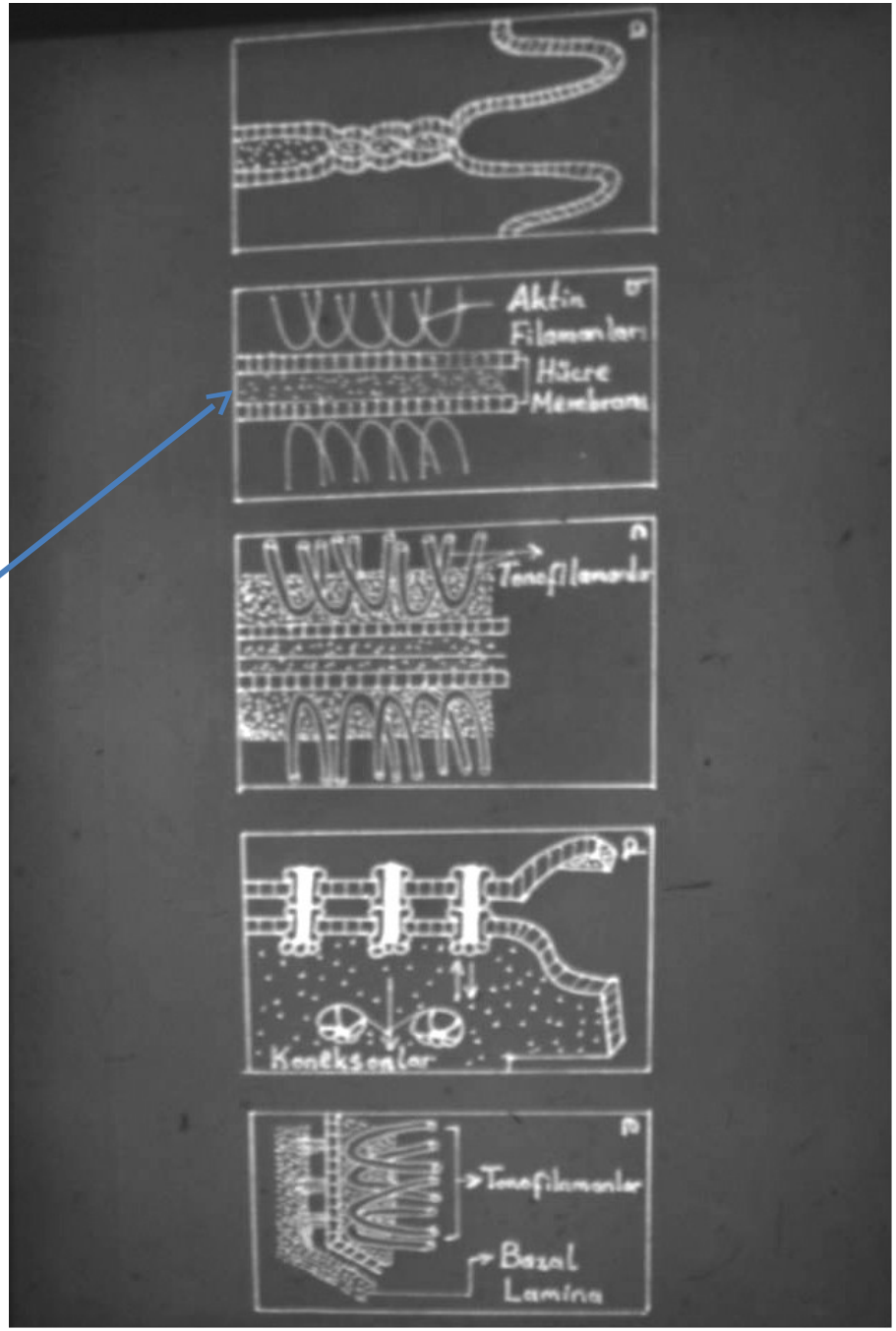
## b)Zonula adherens:

•They are located just under the zonula occludens.

•They are located under the zonula occludens.

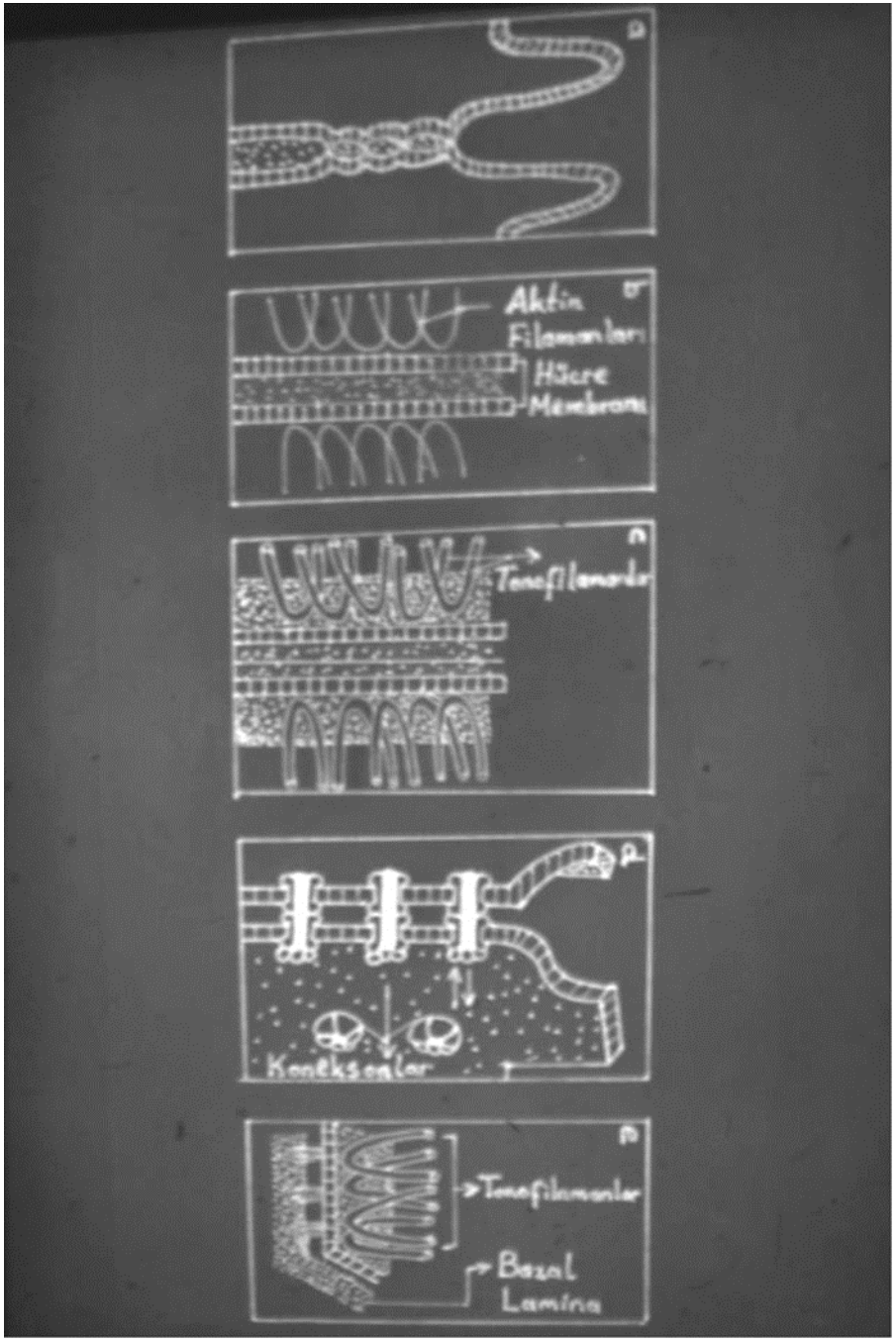
•Cell membranes are not fused with each other, There is a distance up to 20 nm between them.

•Glycocalyx between the cells is more intense in this region and the sialic acid is richer.



# b)Zonula adherens:

- Cells are connected to each other with actin microfilaments which comes from terminal web area.



## c)Macula adherens (desmosomes):

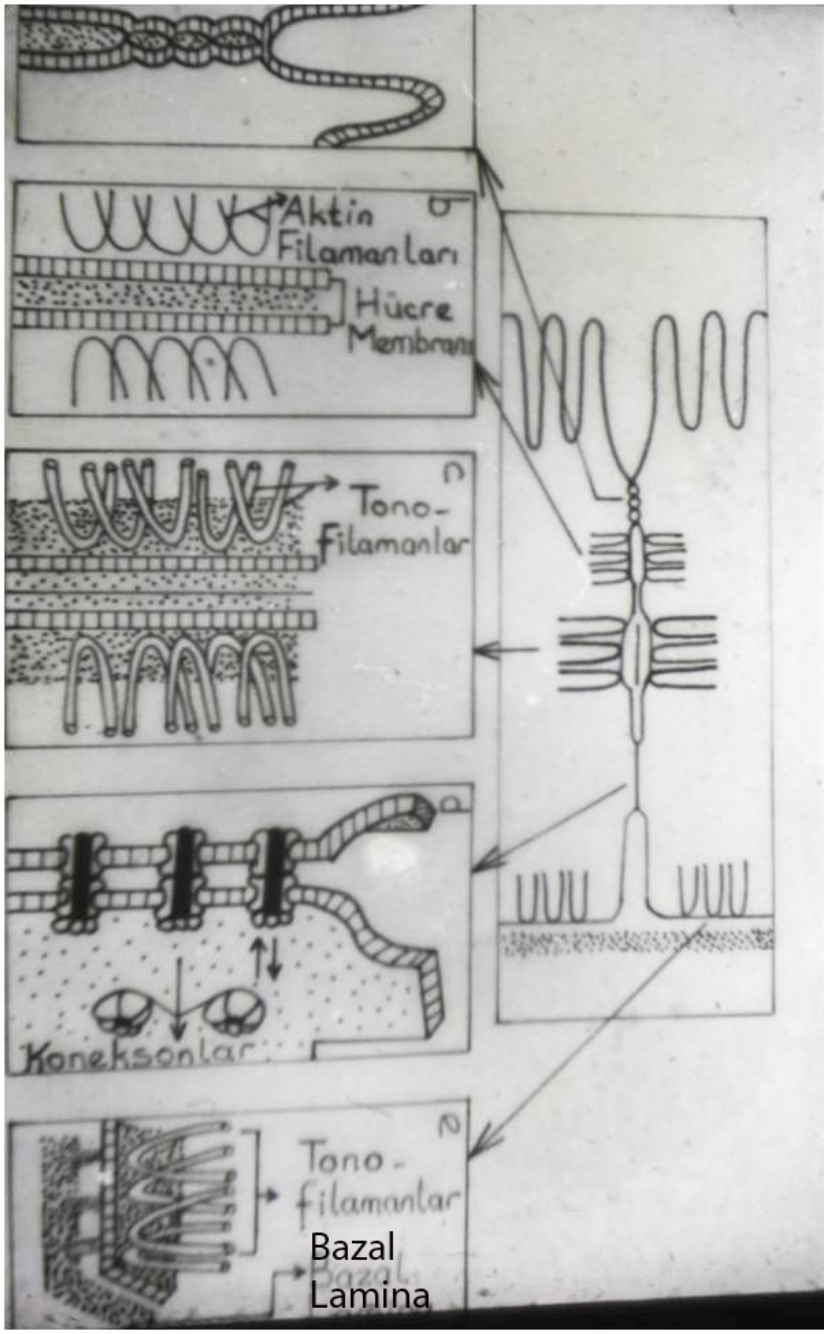
•They are located under the zonula occludens and zonula adherens.

- it is a spot like structure,  not belt- or band shaped like adherens junctions.
- Desmosomes are locally settled and round spots (are macular spots) format.
- The desmosome is a disk-shaped structure at the surface of one cell that matches with an identical structure at the surface of another adjacent cell.

# c)Macula adherens (desmosomes):

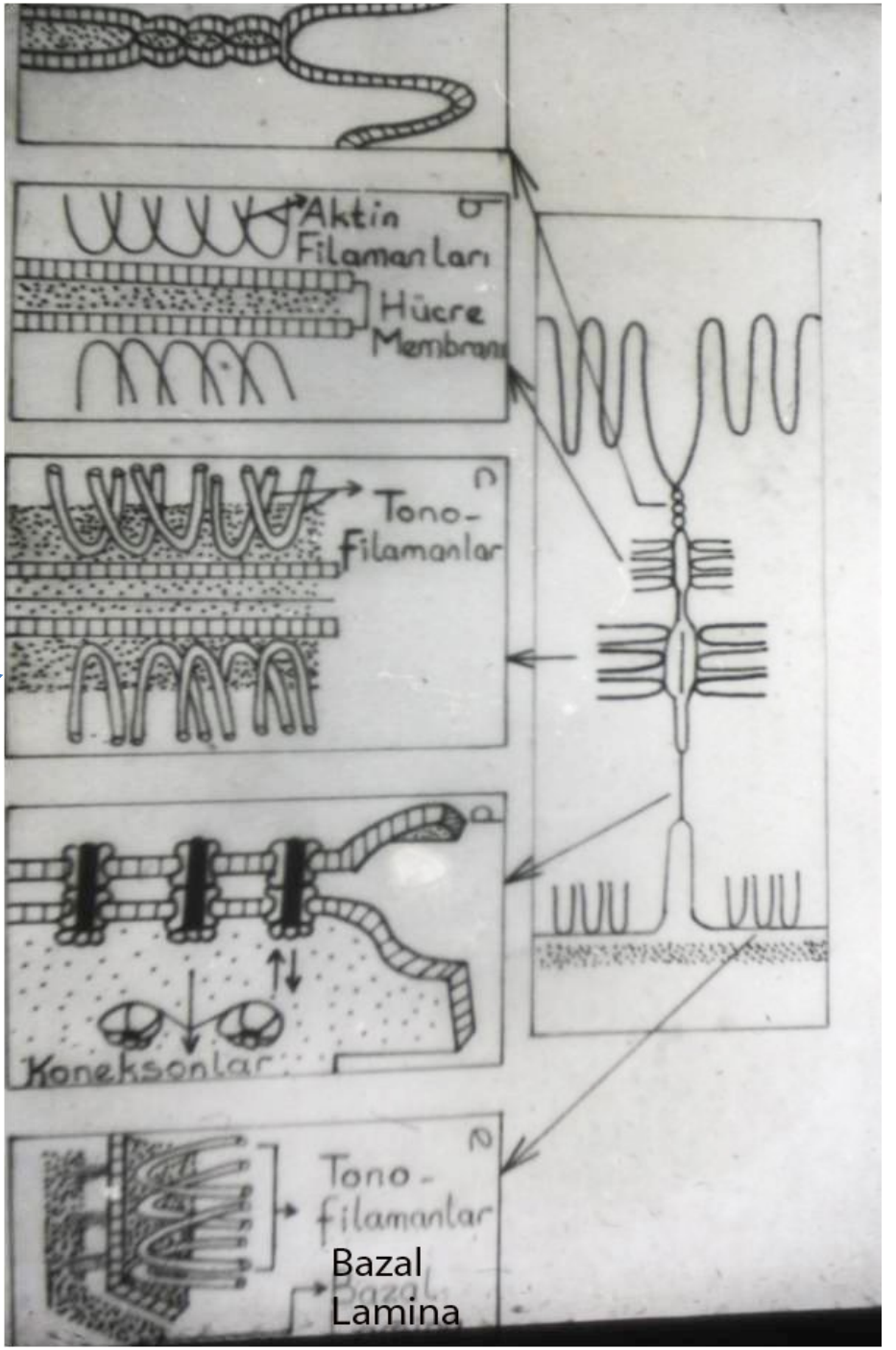
- Cell spacing is larger than for zonula (20-25 nm).

- Cell spacing (gap) is filled with cell adhesion molecules. There is a dense region in the middle of the gap.



## c)Macula adherens (desmosomes) :

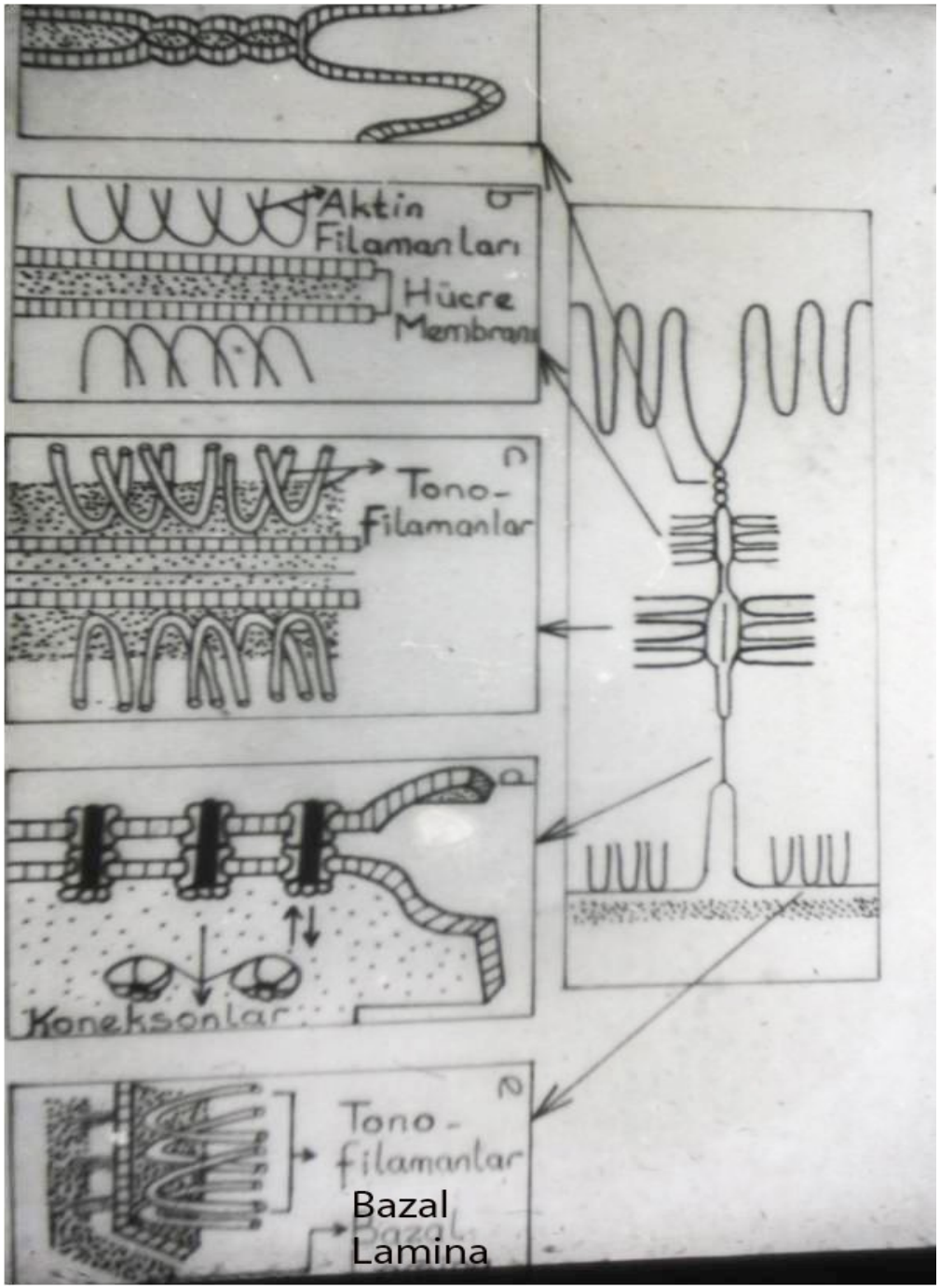
•On the cytosolic side of the membrane of each cell and separated from it by a short distance is a circular plaque of material called an **attachment plaque,** made up of at least 12 different proteins.



## c)Macula adherens (desmosomes):

In epithelial cells, groups of intermediate cytokeratin filaments (**tonofilaman**) are inserted into the attachment plaque or make hairpin turns and return to the cytoplasm. Because intermediate filaments of the cytoskeleton are very strong, desmosomes provide a firm adhesion among the cells.

Desmosomes are found in epithelial cells at the stratum spinosum of the epidermis.



## d)Hemidesmosomes

- They have the structure of one half of desmosomes.
- These junctions anchor the basal surface of the cell to the basal lamina.
- Here, intermediate filament bundles are attached to the cell membrane along the basal surface of the cell, and the role of the junction is to anchor these keratin-containing filaments (tonofilaments) strongly to the underlying basement membrane through an integrin which is a transmembrane linker protein.

# e)Gap junctions

- Gap junctions (nexus) are communicating junctions that allow the passage of electrical signals, ions, and small water-soluble molecules between cells.
- At these junctions, neighboring cell membranes are separated by a 2- 4-nm gap.
- Protein complexes known as connexons span the gap and form narrow channels through which small molecules may pass from one cell to another.

# e)Gap junctions

- Gap junctions occur in many cell types. For example, these communicating junctions are important for conducting electrical signals through intercalated disks of cardiac muscle cells, thereby contributing to a coordinated contraction wave throughout the heart muscle.
- Gap junctions are also found between osteocytes, astrocytes, cardiac muscle cells, smooth muscle cells, and endocrine cells.

# e)Gap junctions

- Gap junctions consist of *connexons*, 6 transmembrane proteins clustered in a rosette that defines a central pore.
- Connexons from adjacent cells abut one another, forming a continuity between cells.
- Provides metabolic and electrical continuity (coupling) via the pores between cells.

## e)Gap junctions

- The permeability of gap junctions is regulated by the intracellular concentration of calcium ions.
- Normally, the cell keeps its cytosolic calcium level below the extracellular calcium level. At such low calcium concentrations, connexons remain in the open configuration. A massive influx of extracellular calcium, however, will close these channels.

## e)Gap junctions

- This is a self-sealing mechanism that preserves the integrity of living cells if an epithelium or epithelial organ is damaged.
- Connexons also close when the cytosolic pH decreases.

## f)Lateral cell infoldings (interdigitations)

- Lateral cell surface folds(plicae) create interdigitating cytoplasmic processes of adjoining cells.
- The lateral surfaces of certain epithelial cells show a tortuous boundary due to infoldings or plicae along the border of each cell with its neighbor.

## f)Lateral cell infoldings (interdigitations)

- These infoldings increase the lateral surface area of the cell and are particularly prominent in epithelia that are engaged in fluid and electrolyte transport, such as the intestinal epithelium.

# Ergastoplasm

- Ergastoplasm consists of two organelles.
    1. Free ribosomes
    2. Endoplasmic reticulum

# 1.Free ribosomes

- They consist of the ribosomal RNA molecules and protein molecules.
- Free ribosomes contain 60% RNA and 40 % proteins
- First protein synthesis occur in the ribosomes.
- Synthesized proteins are increased the cytosol and constitute various catalytic enzymes.

# 1.Free ribosomes

- Each ribosome, one of them is larger than the other, is formed by joining the two subunits.
- In eukaryotic cells, the small subunit have 1, and large subunit have 3 RNA molecules.

## 1.Free ribosomes

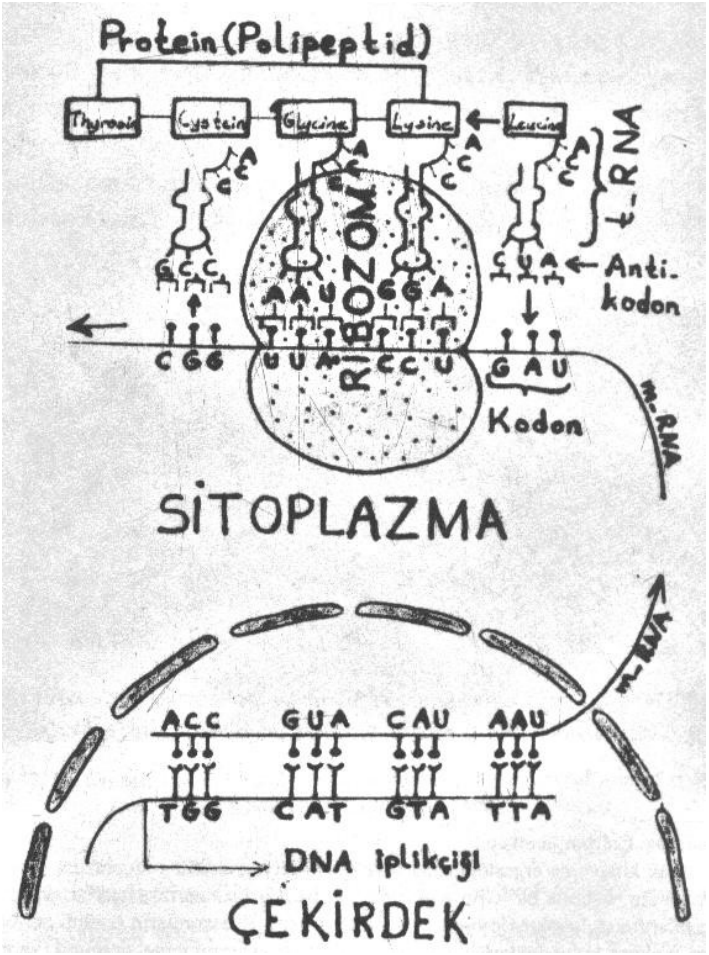
- Subunits are synthesized within the nucleolus.
- The proteins used in the subunits passes from the cytoplasm to the nucleus.
- These units are transported from the nuclear membrane pores into the cytoplasm and are combined with each other and then are occured functional ribosomes.
- The proteins, which is present in ribosomes and surrounding RNA molecules, have a role in faciliting the functions of the molecules.

# 1.Free ribosomes

- Free ribosomes are located individually or a few of them come together and are constituted polyribosomes (polysomes).
- Ribosomes are arranged on the mRNA molecule and form polysome.
- The ribosome is bound to mRNA molecule with the small subunit.

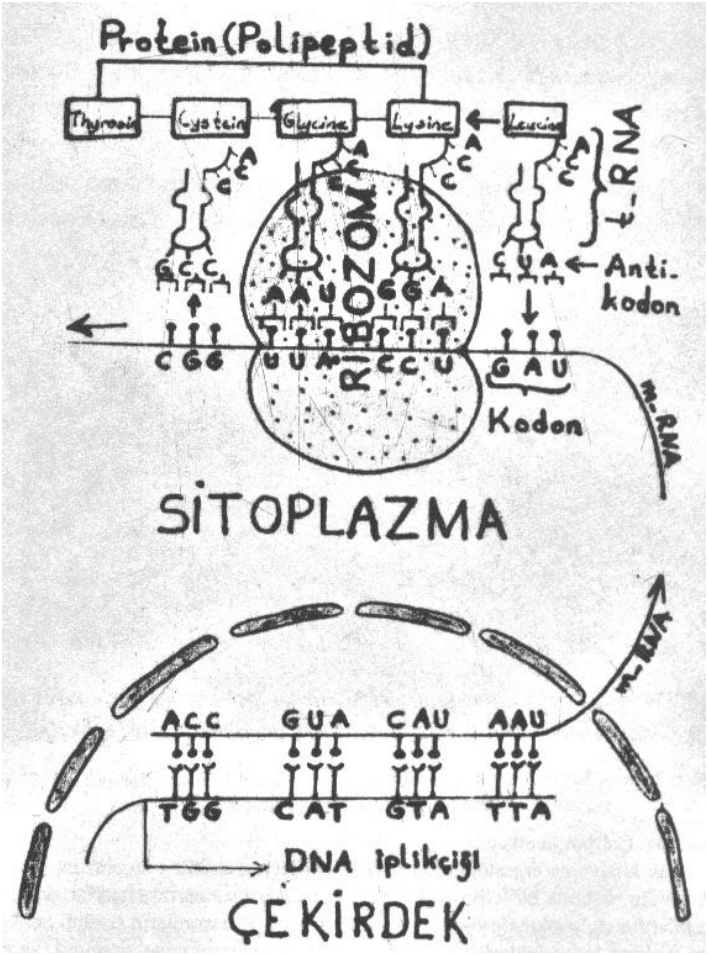
# Protein biosynthesis (Translation)

- Inactive amino acids are taken into cells via active transport and they are activated by enzymes which are present independently to the cytosol.
- Then, these amino acids bind to tRNA molecules (tRNA molecule is specific for each amino acid) and are moved to ribosomes or polysomes.



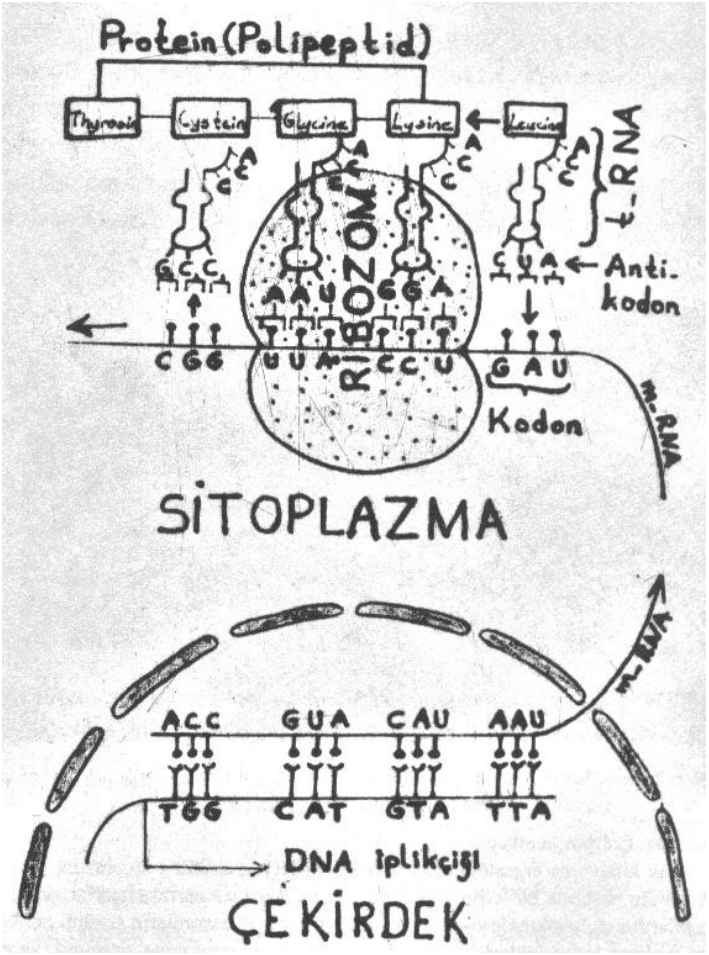
# Protein biosynthesis (Translation)

- tRNA molecules, such as mRNA molecules, are thread shape. However, these threads are twisted and folded.
- Amino acids are connected to the tRNA, which is terminating with CCA nucleotides to the ends.



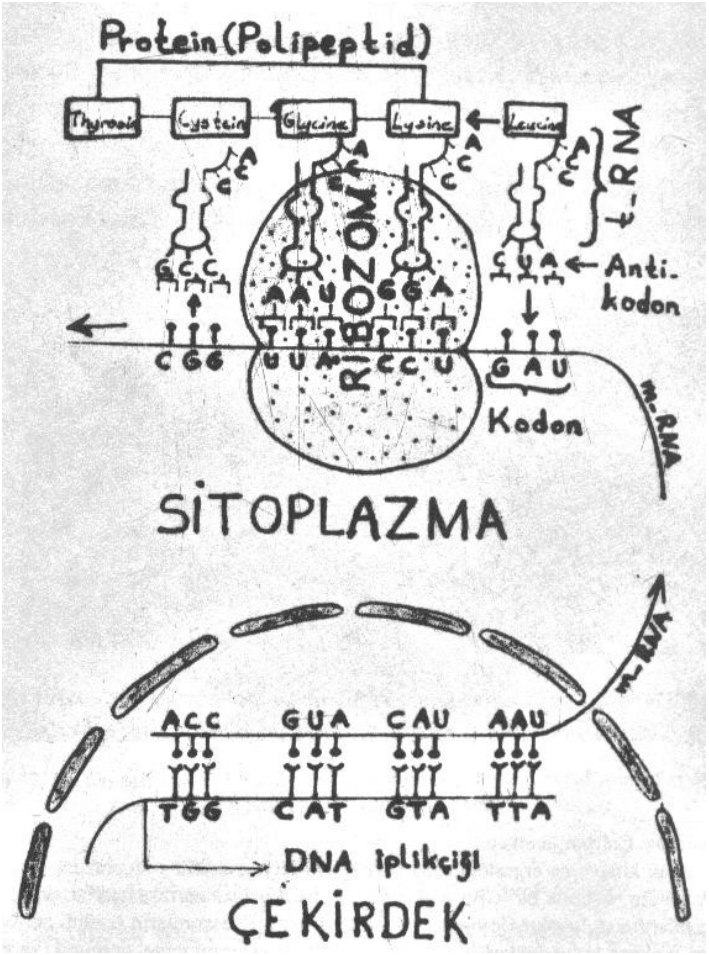
# Protein biosynthesis (Translation)

- Adenine must find to uracil and, guanine must find to cytosine.
- Thus, the mRNA molecule determines the arrangement of the amino acid sequence.



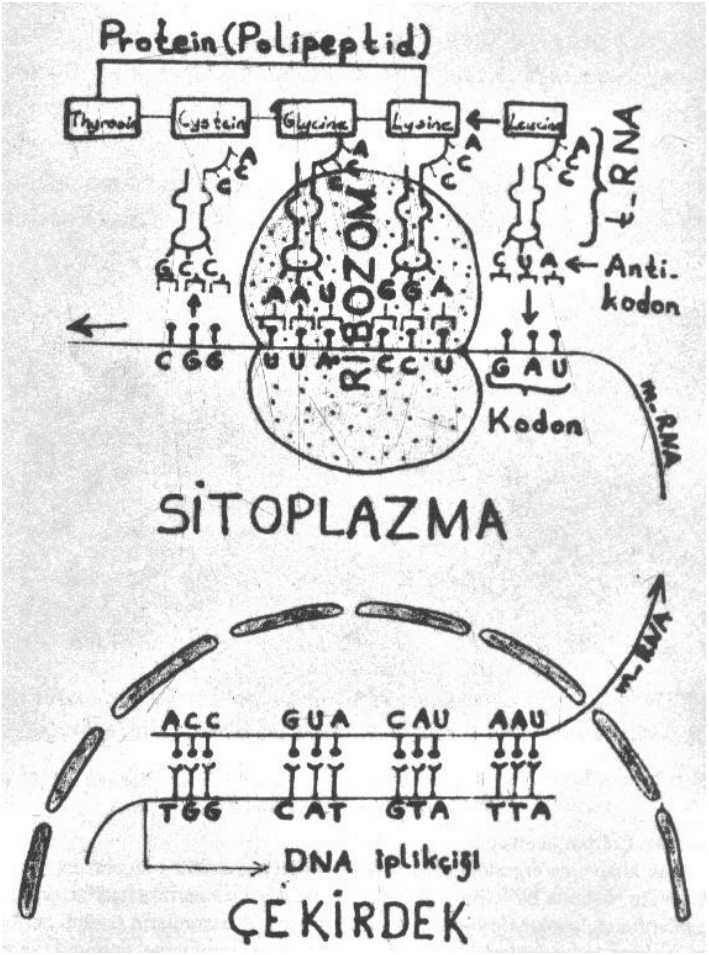
# Protein biosynthesis (Translation)

- mRNA molecules bring together amino acid. This task is made according to the DNA message.
- Because DNA molecule determines the nucleotides sequence of the mRNA molecule (transcription).



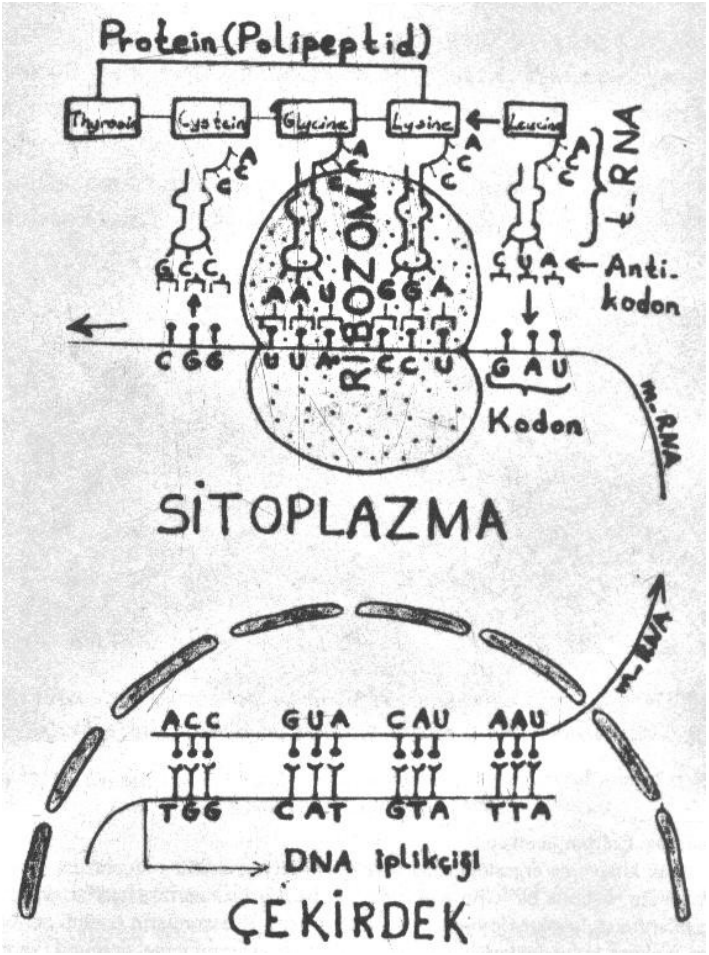
# Protein biosynthesis (Translation)

- Three nucleotides on the mRNA is called **codon**.
- Opposite the codon, 3 nucleotides of tRNA molecules are called the **anticodon**.



# Protein biosynthesis (Translation)

- The rRNA molecule in the small subunit of the ribosome, link to of the anticodons to the codons.



# Protein biosynthesis (Translation)

- The meaning of the anticodons connecting to codons, the amino acid binds to the protein molecule.
- Large subunit rRNA molecule is started to the connection. After that, the protein in the ribosomes are occupied.
- Until the end of the synthesis of the protein molecule, ribosome makes sliding movement on the mRNA. Thus, anticodons binds to codons.
- There are some special codons on the mRNA. When the ribosom comes here, protein synthesis is stopped.

# Protein biosynthesis (Translation)

- When the synthesis complete, ribosomes are separated into subunits. And when the new synthesis begins, these subunits are combined again.
- Initially, protein molecules are  produced thread-shaped. Then they take the globular form.

# Endoplasmic reticulum

- After the cell division occurring in young cells, ergastoplasm composed of only independent ribosomes.
- When the cells reaches a certain maturity level, second part of ergastoplasm begins to appear. This is endoplasmic reticulum.
- Endoplasmic reticulum can develop from cytosol directly. It can also originate from the outer membrane of the nucleus.
- Endoplasmic reticulum doesn't find in the mature red blood cells, platelets and bacteria.

## Endoplasmic reticulum:

There are two types of endoplasmic reticulum: rough endoplasmic reticulum and smooth endoplasmic reticulum. Smooth endoplasmic reticulum shows tubular structure and rough endoplasmic reticulumin exhibits vesicul structure. There are large number of ribosomes on the rough endoplasmic reticulum.

## ROUGH ENDOPLASMIC RETICULUM(RER) :

Rough ER (RER) is involved in some protein production, It is called ‘rough’ because it is studded with ribosomes.

Protein synthesis occurs by ribosome and polysome. Some of the proteins pass through the space of rough endoplasmic reticulum. Another portion of proteins is distributed in the cytoplasm.

Globular proteins in the rough ER vesicles are turned into glycoproteins. And these proteins with the help of the carrier vesicles go to the Golgi.

Here, they are concentrated in the Golgi. Then, given to the cytoplasm as secretory granules, and finally sent to the cell surface.

# ROUGH ENDOPLASMIC RETICULUM(RER) :

- RER is composed of anastomosing vesicles and tubules with each other.
- RER is found too much in protein biosynthesizing cells (epithelial cells, plasma cells, fibroblasts, nerve cells).
- Ribosomes are bound to the vesicles with their large subunit.
- The majority of synthesized proteins, with the aid of channel proteins, enters in the vesicles.
- The proteins are converted to more complex protein in these vesicles.
- The remaining proteins are used  the construction of organelles in the cytoplasm.

## ROUGH ENDOPLASMIC RETICULUM(RER) :

Some of these proteins are transported to the Golgi.

In the Golgi, some substances are added to these proteins. Thus, these proteins are matured.

These proteins are granulated in the Golgi. Then, they are excreted from the cell.

# Smooth endoplasmic reticulum (SER)

- SER is found in liver epithelial cells, sebaceous glands,  muscle cells, and steroid hormone-secreting glands.
- The smooth endoplasmic reticulum (abbreviated SER) has functions in several metabolic processes.
- It synthesizes **lipids, phospholipids**, and **steroids.**
- Cells which secrete these products, such as those in the **testes**, **ovaries**, and **sebaceous glands** have an abundance of smooth endoplasmic reticulum.

# Smooth endoplasmic reticulum (SER)

- It also carries out the metabolism of carbohydrates, detoxification of natural metabolism products and of alcohol and drugs, attachment of receptors on cell membrane proteins, and steroid metabolism.
- In muscle cells, it regulates calcium ion concentration. The smooth endoplasmic reticulum is found in a variety of cell types, and it serves different functions in each.

# Smooth endoplasmic reticulum (SER)

- In liver cells, for example, smooth ER enables glycogen that is stored as granules on the external surface of smooth ER to be broken down to glucose.
- Smooth ER is also involved in the production of steroid hormones in the adrenal cortex and endocrine glands.

**KAYNAKLAR**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