The communication system of the cell

The cell's communication system includes:

1. plasma membrane
2. nucleus
3. nucleolus

Cytoplasmic membrane

- unitary (three-layer structure)[1] = **biological**
- 7–10 nm thick, visible in an electron microscope
- **selective barrier** (regulates the passage of certain materials in and out), on the surface with **receptors**

- functions of the cytoplasmic membrane include:

1. maintaining gradients
2. transfer of excitement
3. cellular recognition
4. communication (interaction) with the environment

Composition

The plasma membrane (CM) is composed of: phospholipids and cholesterol ("glue"), proteins and oligosaccharides covalently linked to some proteins and lipids. **Membrane lipids** are most stable when *the hydrophobic* chains are in the middle and *the hydrophilic chains* are at the edges. The 2 layers are not identical. Some lipids can have attached oligosaccharides → glycolipids and these protrude above the plane → both layers are not symmetrical.

It contains integral and peripheral glycosylated proteins **glycosylated proteins**. *Integral proteins* are built directly into the lipid bilayer, and *peripheral proteins* are more loosely attached to the outer or outer surface of the membrane → they are easily separated from the membrane, integral - complexly, using *detergents*. Integral proteins are distributed in the form of globular molecules interspersed between lipid molecules. Some protrude less, others protrude on both sides (often channels for the transfer of e.g. ions).

- glycoproteins and proteoglycans often protrude above the surface → an essential part of specific molecules = receptors
- integral proteins are able to move by diffusion in the plane of the cell membrane → **capping** => gathering of integral proteins in a certain place of the cytoplasmic membrane
- **fluid mosaic model of membrane structure** – semi-fluid phospholipid bilayer and proteins that make up the "mosaic"

Penetration of substances through the membrane

Substances penetrate the cytoplasmic membrane by several mechanisms:

- **pinocytosis** = „cell drinking“ – fluid is trapped in small invaginations of the cell membrane and travels from the membrane to the interior of the cell in the form of pinocytic vesicles, often merging with lysozomes; on the way ; but sometimes it can travel all the way to the opposite pole of the cell, where it merges with the CM again and releases its contents to the cell surface → transcytosis
- **endocytosis** – the necessary presence of receptors (free or – **coated pits**)
- **phagocytosis** – „cell eating“ – to eat bacteria, fungi, damaged cells, unnecessary components; after the bacterium attaches to the CM, the extracellular processes elongate and embrace the bacterium, then fuse and the bacterium is trapped in a phagocytic vacuole; lysosomes merge with the vacuole and destroy the bacterium
- **exocytosis** – fusion of particles with CM → the membrane is intact and the contents are expelled extracellularly
- membrane transport = during endocytosis the CM segments change into endocytic vesicles and during exocytosis the membrane returns to the surface

Intercellular communication

Signal mediation - the need for cells to communicate with each other – **3 ways of communication:**

1. excretion of a chemical substance;
2. synthesis of signaling molecules and their packaging in CM vesicles → affecting the cell in direct physical contact;
3. the creation of cell connections allowing the mutual exchange of small molecules.

Extracellular [[cell signaling|signaling molecules] mediate three types of communication:

1. ***endocrine signaling*** – hormones are transported to target cells by blood;
2. ***paracrine signaling*** – chemical mediators are quickly metabolized → they only affect the closest cells;
3. ***synaptic signaling*** – action of neurotransmitters only on adjacent nerve cells in special contact areas

Cell surface specialization

- **apical** – microvilli, brush border, cilia
- **lateral** – sealing (zonula occludens), adhesive (zonula adherens and desmosomes) and nexus
- **basal** – (basolateral labyrinth) – transport of water and ions, adhesive – *hemidesmosomes* and focal adhesions.

nucleus

- perfectly ordered DNA (can be partially or completely duplicated with minor defects or completely error-free)
- a spherical or elongated structure located usually in the center of a cell
- between 5–10 µm
- consists of: nuclear membrane, chromatin, nucleolus and nuclear matrix

Nuclear envelope

- in a light microscope as a thin line delimiting the nucleus
- in electron, the nucleus is surrounded by a pair of parallel arranged unit membranes separated by a narrow space = perinuclear cisterna
- **fibrous lamina** – a protein structure closely associated with the inner layer of the nuclear envelope; does not surround perinuclear pores; it is made up of three main polypeptides – components of the nuclear matrix - **lamina**; the chromatin centromere of interphase chromosomes is connected to the fibrous lamina
- polyribosomes are often attached to the outer sheet of the nuclear envelope, and this part of the nuclear envelope is sometimes directly related to the rough endoplasmic reticulem
- round holes are formed around the circumference of the nuclear envelope at the points of fusion of the inner and outer sheets → nuclear poles (= **octamers**, the connection between the nucleus and the cytoplasm, covered by an electrodense layer)

Chromatin

We distinguish 2 types of chromatin:

1. **heterochromatin** – electrodense, visible even in a light microscope (basophilic clusters of nucleoproteins)
2. **euchromatin** – organized structure, only in electron microscope (bright spots)

- the intensity of chromatin staining of nuclei is used to identify different types of cells and tissues in a light microscope
- composed of coiled strands of DNA bound to histones
- the basic structural unit is the nucleosome – from 4 types of histones forming the core, two copies each of **H2A**, **H2B**, **H3** and **H4** wrapped around 166 base pairs; another segment of 48 Bp forms a connecting link between neighboring nucleosomes, and H1 or H5 binds to this chain; the structure of beads strung on a thread
- the largest proportion of DNA, therefore contains the most genetic information
- synthesis of precursors for mRNA, rRNA, tRNA
- cells with lighter nuclei are more active (larger space for transcription)
- **sexchromatin** =in the cells of females of most mammals, it is one of the pair of **X chromosomes**, tightly spiraled, it is inactive; a small lump attached to the nucleus, or in the form of a club-like appendage of nuclei

nucleolus

- latin *nucleolus*, size up to 1 µm
- rich in rRNA and proteins
- in HE staining it is basophilic
- in the electron microscope it has 3 parts – nucleolar organizer, pars fibrosa and pars granulosa
- ***the nucleolar organizers*** (NO) encodes RNA, distributed on 5 pairs of human chromosomes (on acrocentric)
- ***pars fibrosa*** closely related to NO, a 5–10 nm ball of ribonucleoprotein fibers composed of primary transcripts of rRNA genes
- ***pars granulosa*** consists of granules with a diameter of 15–20 nm → maturing ribosomes

Nuclear Matrix

The nuclear matrix is an amorphous substance filling the spaces between chromatin and nucleons

- mainly composed of proteins, metabolites and ions
- the fibrous lamina of the nuclear envelope is also part of it

Events taking place in the core

- transcription, replication
- synthesis of 3 types of RNA

- the control center of all cellular structures and functions

Links

References

- JUNQUIERA, L. Carlos – CARNEIRO, José – KELLEY, Robert O.. *Basics of histology.* 1st edition. 1997. 502 pp. ISBN 80-85787-37-7.

Reference

1. JUNQUIERA, L. Carlos – CARNEIRO, José – KELLEY, Robert O. *Basics of histology.* 1st edition. 1997. 502 pp. pp. 25. ISBN 80-85787-37-7.