Development of Complex Curricula for Molecular Bionics and Infobionics Programs within a consortial* framework**

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**Molekuláris bionika és Infobionika Szakok tananyagának komplex fejlesztése konzorciumi keretben

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BASICS OF NEUROBIOLOGY

Neurobiológia alapjai

CELL ORGANELLES II.

(Sejtalkotók II.)

ZSOLT LIPOSITS

PROKARYOTIC AND EUKARYOTIC CELLS

SUBCELLULAR STRUCTURES OF THE ANIMAL CELLS

- CELL MEMBRANE
- CYTOPLASM
- CELL NUCLEUS
- NUCLEOLUS
- ROUGH ENDOPLASMIC RETICULUM
- SMOOTH ENDOPLASMIC RETICULUM
- GOLGI APPARATUS
- TRANSPORT VESICLES
- LYSOSOMES
- MITOCHONDRION
- CYTOSKELETON
- CILIUM
- CENTRIOLUM

GOLGI COMPLEX

CONSISTS OF STACKED SAUCER-SHAPED FLATTENED CISTERNAE

WEDGED BETWEEN THE NUCLEUS AND THE ENDOPLASMIC RETICULUM SYSTEM

SEVERAL DOZENS OF GOLGI STACKS ARE DISPLAYED IN CELLS

POSSESSES A CONVEX-CONCAVE 3D STRUCTURE

THE CONVEX PART FACES THE ENDOPLASMIC RETICULUM SYSTEMS AND IT IS CALLED: CIS OR FORMING FACE

THE CONCAVE SURFACE TURNS TOWARD THE NUCLEUS AND IT IS CALLED: TRANS OR MATURING FACE

THE GOLGI COMPLEX COMMUNICATES VIA MEMBRANE BOUND VESICLES WITH THE REST OF THE CELL ORGANELLES, MOST NOTABLY WITH THE ENDOPLASMIC RETICULUM

GOLGI COMPLEX

TRANSFER VESICLES BUDDING OFF THE ENDOPLASMIC RETICULUM FUSE WITH THE CIS FACE AND TRANSPORT MACROMOLECULES FOR FURTHER PROCESSING

THE PROCESS OF MACROMOLECULE MATURATION INVOLVES GLYCOSILATION AND PHOSPHORYLATION

THE TAGGING OF MACROMOLECULES ENABLES THEIR SORTING FOR DOMESTIC USE, SECRETION FOR EXTERNAL UTILIZATION OR LOCAL DEGRADATION

LIPOSOMAL VESICLES ARE ALSO BORN IN THE GOLGI COMPLEX

PROTEOGLYCANS, COMPONENTS OF THE EXTRACELLULAR MATRIX, ORIGINATE FROM GOLGI COMPLEX

ELECTRON MICROGRAPH OF THE GOLGI APPARATUS DISPLAYS THE CIS (1) AND TRANS (2) FACES AND SECRETORY VESICLES (3).

TRANSPORT VESICLES

VESICLES BUDDING OF THE GOLGI COMPLEX ARE DIFFERENT IS SIZE, CHEMICAL COMPOSITION, FINAL DESTINATION AND FUNCTION

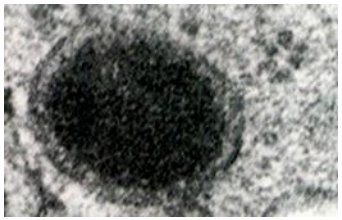
CLASSIFIED INTO THREE CATEGORIES:

1. SECRETORY VESICLES. STORING PROTEINS FOR EXTRACELLULAR USE. TRIGGERED BY RELEASE SIGNALS THEY MOVE TO AND FUSE WITH THE PLASMA MEMBRANE. THE RELEASE MECHANISM IS REGULATED

2. EXOCYTIC VESICLES. CONSTITUTIVE SECRETION MAINTAINING A CONTINUOUS SUPPLY OF PROTEINS TO THE EXTRACELLULAR SPACE BY EXOCYTOSIS

3. LYSOSOMAL VESICLES. CHARACTERISTIC VESICLES CONTAINING PROTEINS AND DEGRADING ENZYMES, INCLUDING ACID HYDROLASE. THEY GET INCORPORATED INTO THE LYSOSOMAL DIGESTIVE MACHINERY

ULTRASTRUCTURAL APPEARANCE OF A LYSOSOMAL VESICLE AT HIGH POWER →



LYSOSOME

MEMBRANE-BOUND, SPHERICAL STRUCTURE, WITH A DIAMETER OF 0.1-1 MICROMETER

CONTAINS SEVERAL KINDS OF DIGESTING ENZYMES INCLUDING LIPASE, NUCLEASE, PROTEASE, AMYLASE

ITS INTERNAL MILIEU IS ACIDIC (pH: 4.8) WHICH IS MAINTAINED BY PUMPING H^+ IONS FROM THE CYTOPLASM VIA CHLORIDE ION CHANNELS AND PROTON PUMPS

FUSION WITH ENDOSOMES RESULTS FIRST IN ENDOLYSOSOMES THEN LYSOSOMES

FUSION WITH INTRINSIC ORGANELLES RESULTS IN AUTOPHAGOLYSOSOMES

FUSION WITH EXTRINSIC MICROORGANISMS RESULTS IN PHAGOLYSOSOMES

AFTER DIGESTION, FROM LYSOSOMES RESIDUAL BODIES ARE FORMED, SOME ENZYMES GET RECYCLED

MITOCHONDRION

MITOCHONDRIA ARE ELONGATED, DOUBLE MEMBRANE COMPOSED, TUBULAR STRUCTURES. THEY UNDERGO SELF REPLICATION

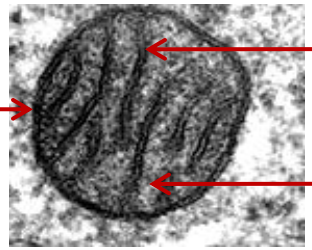
THEY VARY IN NUMBER, SHAPE AND SIZE DEPENDING ON THE CELL TYPE AND ITS METABOLIC ACTIVITY. THEIR LENGTH IS IN THE RANGE OF 0.5-10 MICROMETERS

THE ORGANELLE IS COVERED BY THE OUTER MEMBRANE, THE INNER MEMBRANE IS FOLDED AND SENDS PROJECTING CRISTAE INTO THE ORGANELLES. THE TWO MEMBRANES SURROUND INTERMEMBRANOUS SPACE

THE CAVITY OF THE MITOCHONDRION IS FILLED WITH THE MATRIX SUBSTANCE.

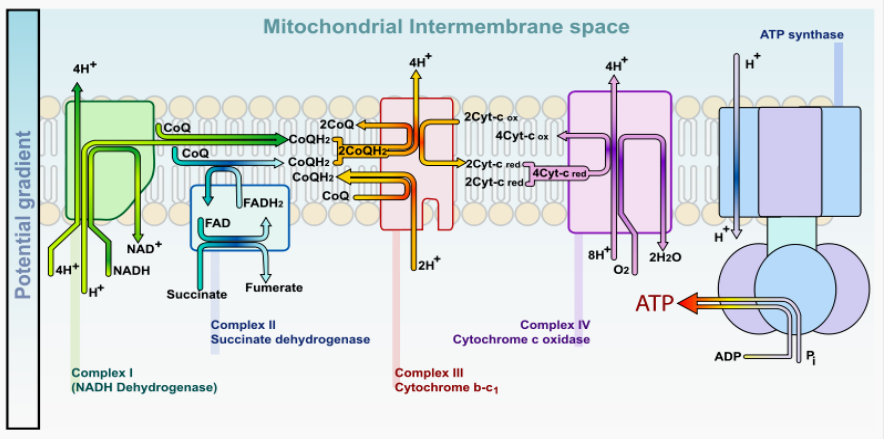
THE MATRIX CONTAINS A CIRCULAR DNA, RNA, RIBOSOMES AND A WIDE ARRAY OF ENZYMES

THEY ARE CONSIDERED AS POWER PLANTS OF THE CELL PROVIDING ATP AS A SOURCE OF CHEMICAL ENERGY.



MITOCHONDRIAL COMPARTMENTS AND THEIR FUNCTIONS

COMPARTMENT	FUNCTIONS
OUTER MEMBRANE	TRANSPORT, FATTY ACID METABOLISM
INTERMEMBRANOUS SPACE	PROTON POOL
INNER MEMBRANE	OXYDATIVE PHOSPHORYLATION, ATP PRODUCTION
MATRIX	PYRUVATE AND FATTY ACID OXYDATION, KREBS CYCLE, STORAGE OF CALCIUM



CYTOSKELETON

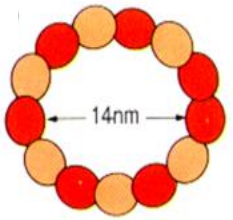
NETWORK OF PROTEIN STRUCTURES FORMING AN INNER SKELETON FOR THE CELL

SHOWS FUNCTION AND ACTIVITY DEPENDENT REMODELLING AND HIGH PLASTICITY

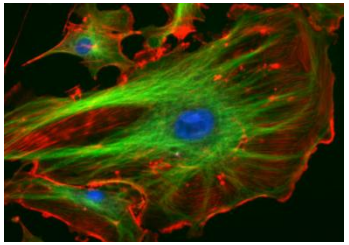
COMPOSED OF MICROFILAMENTS, MICROTUBULES AND INTERMEDIATE FILAMENTS

MICROFILAMENTS.
MADE OF ACTIN. FINE PROTEIN STRANDS (5 nm). EACH FILAMENT CONTAINS 2 TWISTED PROTEIN STRINGS. THEY BIND ATP. IN MUSCLE TISSUE, THEY INTERACT WITH MYOSIN THAT RESULTS IN CONTRACTION

MICROTUBULES
COMPOSED OF ALPHA AND BETA TUBULINS. THE UNITS POLYMERIZE TO BUILD UP THE HOLLOW TUBE. MICROTUBULE-ASSOCIATED PROTEINS (MAP) STABILIZE THE STRUCTURE. DYNEIN AND KYNESIN ATTACHMENT PROTEINS ACT AS MOTORS IN DELIVERY ALONG THE MICROTUBULES. ANTEROGRADE AND RETROGRADE TRANSPORT MECHANISMS IN NEURONS. VITAL STRUCTURE IN CELL DIVISION



CYTOSKELETON



INTERMEDIATE FILAMENTS.

PROTEIN FILAMENTS WITH 10-12 nm DIAMETER.

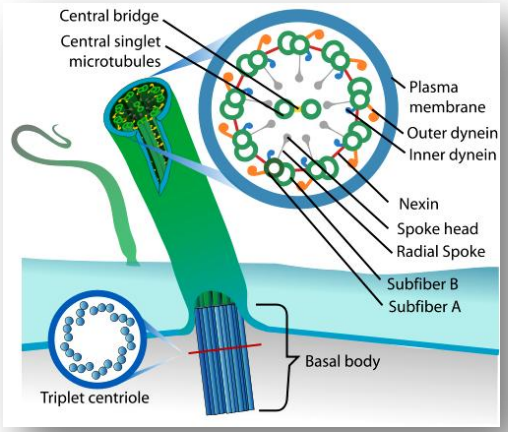
FORM A RELATIVELY STABLE, FIBROUS NETWORK IN CELLS.

THE PROTEIN COMPOSITION OF THE INTERMEDIATE FILAMENTS SEEMS TO BE TISSUE SPECIFIC

INTERMEDIATE FILAMENT	LOCALIZATION
cytokeratins	epithelial cells
desmin	muscle (smooth and striated)
glial fibrillary acidic protein	astrocytes
neurofilament protein	neurones
nuclear lamin	nucleus of all cells
vimentin	mesodermal tissues

CILIUM

CILIUM IS A MEMBRANE COVERED, FINGER LIKE PROJECTION OF THE CYTOPLASM. IT HAS TWO TYPES: KINOCILIUM AND STEREOCILIUM. THE FORMER IS MOTILE. IN THE AIRWAYS, THEY SWIPE THE MUCOUS ON THE SURFACE OF EPITHELIAL CELLS



THE DRAWING DEPICTS THE SUBCELLULAR STRUCTURE OF THE CILIUM. IT ORIGINATES FROM THE BASAL BODY CONTAINING 9 TRIPLETS OF PARALLEL MICROTUBULES. THE CROSS-SECTIONED PART SHOWS THE ARRANGEMENT OF MICROTUBULE DOUBLETS AND THE COUPLED PROTEINS

CENTRIOLE

IT IS COMPOSED OF 9 TRIPLETS OF MICROTUBULES. A PAIR OF CENTRIOLES FORMS THE CENTROSOME, LOCATED IN THE VICINITY OF THE NUCLEUS. THEY ORGANIZE THE GROWTH OF MICROTUBULES (ASTER)