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

NEUROGLIA

(Neuroglia)

ZSOLT LIPOSITS

CLASSIFICATION OF NEUROGLIA

ASTORGLIA

1. PROTOPLASMIC ASTROCYTE
2. FIBROUS ASTROCYTE

OLIGODENDROGLIA

1. INTRAFASCICULAR OLIGODENDROCYTE
2. SATELLITE OLIGODENDROCYTE

MICROGLIA

1. RESTING
2. ACTIVATED

EPENDYMA

1. EPENDYMOCYTE
2. TANYCYTE

SCHWANN CELL

FUNCTIONS OF NEUROGLIA

NEUROGLIA HAS BEEN CONSIDERED IN THE PAST AS THE SUPPORTING TISSUE OF NEURAL STRUCTURES

THE CURRENT VIEW ATTRIBUTES AN EQUALLY IMPORTANT ROLE TO GLIAL AND NEURONAL CELLS

THE MAIN ROLES OF NEUROGLIA INCLUDE:

- GUIDANCE OF NEURON MIGRATION IN EARLY DEVELOPMENT
- ESTABLISHMENT OF THE BLOOD BRAIN BARRIER (BBB)
- FORMATION OF MYELIN
- PARTICIPATION IN BRAIN ENERGY METABOLISM
- PRODUCTION OF EXTRACELLULAR MATRIX
- NEUROTRANSMITTER UPTAKE, THE GLUTAMATE-GLUTAMINE SHUTTLE
- SYNTHESIS OF GROWTH FACTORS AND CYTOKINES
- PHAGOCYTOSIS, NEUROPROTECTION, AGING

WITH THE EXCEPTION OF MICROGLIA, GLIAL CELLS DEVELOP FROM NEUROEPITHEL CELLS

ASTROCYTES

ASTROCYTES HAVE SEVERAL, THIN PROCESSES, CONTAIN GLIAL FIBRILLARY ACIDIC PROTEIN (GFAP) MADE FILAMENTS AND GLYCOGEN

IN THE CNS, THE WHITE MATTER IS RICH IN FIBROUS, WHILE THE GREY MATTER CONTAINS PROTOPLASMIC ASTROCYTES

SILVER IMPREGNATION TECHNIQUES ENABLE THEIR IDENTIFICATION

THEIR PROCESSES FILL THE GAPS AMONG NEURONS, PROJECT TO BLOOD VESSELS TO FORM THE BLOOD-BRAIN BARRIER, SURROUND AND ISOLATE SYNAPSING NEURONAL ELEMENTS AND FORM THE INTERNAL AND EXTERNAL GLIAL LAMINAE

ASTROCYTES ARE COUPLED BY GAP JUNCTIONS, THEY GENERATE SPREADING CALCIUM WAVES

THEY EXPRESS GLUTAMINE-SYNTHETASE, A KEY ENZYME PARTICIPATING IN AMMONIA DETOXIFICATION AND GABA, GLUTAMATE TRANSMITTER INACTIVATION

ASTROCYTES

REGULATION OF EXTRACELLULAR POTASSIUM

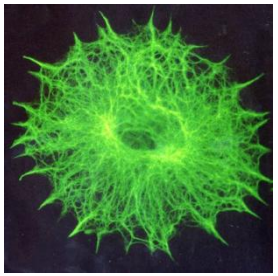
NA^+/K^+ ATPase, K^+/Cl^- CO-TRANSPORT AND THE ACTIVATION OF K^+ CHANNELS

CONTROL OF CALCIUM HOMEOSTASIS.

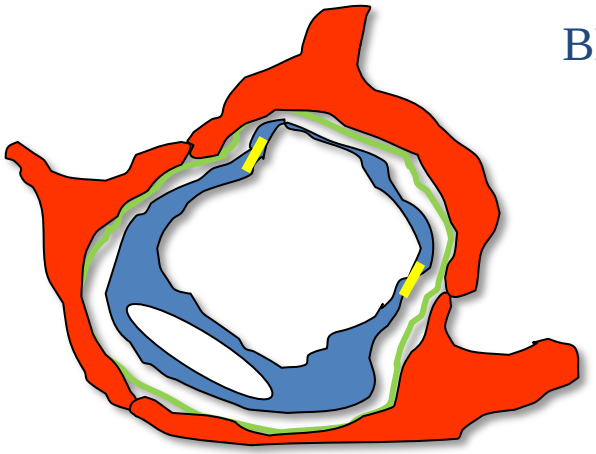
- VOLTAGE-DEPENDENT CA^{++} CHANNELS
- THE NA^+/Ca^{++} EXCHANGER
- NEUROTRANSMITTER RECEPTORS

REGULATION OF pH AND EXTRACELLULAR SPACE VOLUME

PROLIFERATION OF ASTROCYTES, BRAIN TUMORS



FLUORESCENT IMMUNOSTAINING OF AN ASTROCYTE
IN VITRO SHOWS THE GFAP FILAMENTS THROUGHOUT THE CELL



BLOOD-BRAIN BARRIER

CAPILLARY ENDOTHELIUM CELL
TIGHT JUNCTIONS
BASEMENT MEMBRANE
END-FEET OF ASTROCYTES

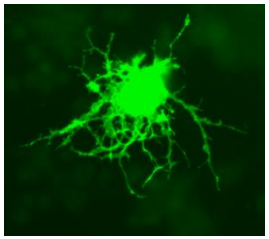
THE POLARIZED ENDOTHELIUM MEMBRANE: LUMINAL AND ABLUMINAL PARTS

TRANSPORTERS FOR SODIUM, AMINO ACIDS AND GLUCOSE

OPENING AND MALFUNCTIONS OF THE BLOOD BRAIN BARRIER CAUSED BY:

HYPERTENSION	HYPEROSMOLARITY
MICROWAVES	RADIATION
INFECTION	TRAUMA
ISCHEMIA	INFLAMMATION

OLIGODENDROGLIA



OLIGODENDROCYTES ARE SMALL-SIZED CELLS WITH NUMEROUS BRANCHING PROCESSES

AT THE ELECTRON MICROSCOPIC (EM) LEVEL, THEY DISPLAY HIGH ELECTRON DENSITY AND A LARGE QUANTITY OF RER AND POLYRIBOSOMES

SATELLITE OLIGODENDROCYTES ARE JUXTAPOSED TO NEURONS AND SUPPORT THEM

INTRAFASCICULAR OLIGODENDROCYTES OCCUR IN AXON BUNDLES OF THE CNS WHERE THEY INTERACT WITH AXONS AND FORM THE MYELIN SHEATH FOR THEM

A SINGLE OLIGODENDROCYTE MAY WORK TOGETHER WITH DOZENS OF AXONS

MYELIN BASIC PROTEIN (MBP) IS A SPECIFIC MARKER OF OLIGODENDROCYTES

MICROGLIA

THEY DEVELOP FROM MESODERMAL, HAEMOPOETIC TISSUE OUTSIDE THE BRAIN

THESE MONOCYTES MIGRATE TO THE BRAIN, SETTLE DOWN AND DIFFERENTIATE TO RESTING MICROGLIA CELLS

THE RESTING MICROGLIA HAS SEVERAL RAMIFYING PROCESSES THAT MOVE CONSTANTLY AND SURVEY THE NEIGHBORING AREA

THE TERM HORTEGA-GLIA IS A FREQUENTLY USED SYNONYM

MICROGLIA CONSTITUTES A LARGE PERCENTAGE (5-20%) OF CELLS IN THE BRAIN

THEY OPERATE AS RESIDENT IMMUNE CELLS OF THE CNS

THEY ARE CAPABLE OF PHAGOCYTOSIS AND REMOVAL OF DAMAGED NEURONS, DEGENERATIVE PLAQUES, AND INFECTIOUS AGENTS

TOGETHER WITH ASTROCYTES, THEY FORM A POWERFUL DEFENSE SYSTEM FOR THE PROTECTION OF THE CENTRAL NERVOUS SYSTEM

ACTIVATED MICROGLIA

THE PHENOTYPE OF THE REACTIVE MICROGLIA DIFFERS FROM THAT OF THE RESTING TYPE. IT HAS A LARGER CELL BODY AND THICKER PROCESSES. IN CASE OF A SEVERE PATHOLOGICAL INSULT THE REACTIVE MICROGLIA CAN TRANSFORM INTO MACROPHAGES

ACTIVATION OF THE CELLS ALSO RESULTS IN THE UP-REGULATION OF THE KNOWN MOLECULAR MARKERS OF MONOCYTE-MACROPHAGE CELLS

THE TRIGGERS OF ACTIVATION: GLUTAMATE RECEPTOR ACTIVATION, CHANGES IN EXTRACELLULAR POTASSIUM LEVEL, LIPOPOLYSACCHARIDES, PRO-INFLAMMATORY CYTOKINES AND NECROSIS FACTORS

THEIR SPECIAL FUNCTIONS INCLUDE:

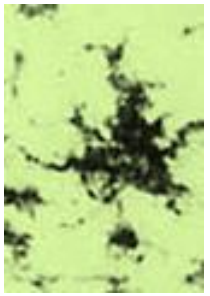
SCAVENGING: CLEANING UP DEBRIS

PHAGOCYTOSIS: ENGULFING CELLULAR ELEMENTS

CYTOTOXICITY: TO RELEASE PROTEASES, CYTOKINES, GLUTAMATE

ANTIGEN PRESENTATION

EXTRACELLULAR SIGNALING



EPENDYMA

NEURAL TISSUE FACING THE CAVITIES OF THE BRAIN AND SPINAL CORD ARE ENLINED BY SPECIAL GLIAL CELLS CALLED EPENDYMA

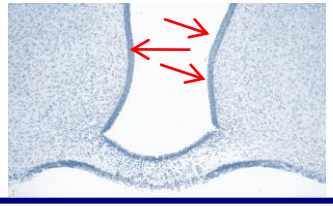
THEY ARE CUBOIDAL OR COLUMNAR IN NATURE CARRYING MICROVILLI AND KINOCILIA ON THEIR VENTRICULAR, APICAL SURFACES

THE KINOCILIA SUPPORT THE FLOW OF CSF, THE MICROVILLI ARE USED FOR ABSORPTION

THEY ARE SITUATED AT THE BORDER OF THE CEREBROSPINAL FLUID AND THE EXTRACELLULAR SPACE LIQUID COMPARTMENTS

TIGHT AND GAP JUNCTIONS OCCUR BETWEEN EPENDYMAL CELLS

A SPECIALIZED FORM OF IT, THE CHOROIDAL EPITHEL COVERS THE SURFACE OF THE CHOROID PLEXUS, THE STRUCTURE PRODUCING THE CSF



CORONAL SECTION OF THE HYPOTHALAMUS SHOWING
THE THIRD VENTRICLE AND ITS EPENDYMAL COVER (ARROWS)

TANYCYTES

TANYCYTES ARE SPECIALIZED EPENDYMAL CELLS COVERING THE FLOOR REGION OF THE THIRD CEREBRAL VENTRICLE

THEY HAVE LONG PROCESSES THE ARCH THROUGH THE BASAL HYPOTHALAMUS AND TERMINATE ON BLOOD VESSEL ON THE VENTRAL BRAIN SURFACE

THEY TRANSPORT SUBSTANCES FROM THE CSF TO THE CIRCU-LATION

THEY CONTAIN TYPE 2 DEIODINASE ENZYME THAT GENERATES THE ACTIVE THYROID HORMONE, TRIIODOTHYRONINE FROM ITS PRO-HORMONE

THE FIGURE DEPICTS TANYCYTES (ARROWS) TRANSPORTING A HORMONE AFTER ITS INJECTION INTO THE VENTRICLE (ASTERISK)