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

Consortium leader

PETER PAZMANY CATHOLIC UNIVERSITY

Consortium members

SEMMELWEIS UNIVERSITY, DIALOG CAMPUS PUBLISHER

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

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BASICS OF NEUROBIOLOGY

Neurobiológia alapjai

DEVELOPMENT OF THE NERVOUS SYSTEM

(Idegrendszer fejlődése)

ZSOLT LIPOSITS

FEATURES OF HUMAN DEVELOPMENT

FROM THE GAMETES TO THE NEWBORN INDIVIDUAL: THROUGH EMBRYONIC AND FETAL LIFE

THE DEVELOPMENTAL SCHEDULE OF THE HUMAN BEING

FORMATION OF THE GERM DISCS: THE BILAMINAR AND TRILAMINAR STAGES

THE MAIN GERM LAYERS PROVIDING THE BASIC TISSUES AND ORGANS OF THE BODY: THE ECTODERM, THE MESODERM AND THE ENDODERM

THE DERIVATIVES OF THE THREE GERM LAYERS OF THE EMBRYO

THE SIMULTANEOUS DEVELOPMENT OF ORGAN SYSTEMS

VULNERABLE STAGES OF THE DEVELOPMENT

GENETIC REASONS OF MALFORMATIONS

ENVIRONMENTAL REASONS OF DEVELOPMENTAL DEFECTS, EPIGENETICS

THE EARLY EVENTS OF NEURAL DEVELOPMENT

FORMATION OF THE NEURAL TUBE FROM THE ECTODERM. THE INDUCTIVE ROLE OF THE NOTOCHORD

THE SONIC HEDGEHOG MORPHOGEN SIGNALING

ANTERIOR AND POSTERIOR NEUROPORES AND THEIR CLOSURE. MALFORMATIONS

DEVELOPMENT OF THE NEURAL CREST AND ITS DERIVATIVES

FORMATION OF SENSORY AND AUTONOMIC GANGLIA. CONNECTIONS WITH THE CENTRAL NERVOUS SYSTEM AND TARGET STRUCTURES.

THE PLACODE PLATE AND ITS DERIVATIVES

THE NON- PROPORTIONAL DEVELOPMENT OF THE NEURAL TUBE

THE EARLY FORMATION OF THE SPINAL CORD

THE EARLY APPEARANCE OF THE BRAIN PRIMORDIUM

CELLULAR DIFFERENTIATION OF THE NEURAL TUBE

PARALLEL TO THE GROWTH OF THE EMBRYO THE NEURAL TUBE GETS THICKER AND ELONGATES

THE CRANIAL END OF THE NEURAL TUBE DEVELOPS MORE INTENSELY RESULTING IN THE PRIMARY BRAIN VESICLES

FROM THE LESS INTENSELY PROLIFERATING CAUDAL PART OF THE NEURAL TUBE THE SPINAL CORD DERIVES

THE EPITHELIAL CELLS LINING THE NEURAL TUBE DIVIDE HEAVILY AND GIVE RISE TO THE CELLULAR CONSTITUENTS OF THE BRAIN AND SPINAL CORD

AT FIRST GLIOBLAST AND NEUROBLAST CELLS DEVELOP

GLIOBLASTS DIFFERENTIATE INTO GLIAL CELLS THAT MAINTAIN THE SELF-RENEWAL CAPABILITY AND ACCORDINGLY DIVIDE FREQUENTLY

IN ADDITION TO PROVIDING ASTROCYTES, OLIGODENDROGLIA AND EPENDYMAL CELLS, GLIOBLAST ALSO FORM RADIAL GLIA CELLS

CELLULAR DIFFERENTIATION OF THE NEURAL TUBE

THE PROCESSES OF RADIAL GLIA CELLS STRETCH THROUGH THE ENTIRE THICKNESS OF THE DEVELOPING NEURAL TUBE IN A PERPENDICULAR ORIENTATION RELATIVE TO THE EPENDYMAL LINING OF THE NEURAL TUBE

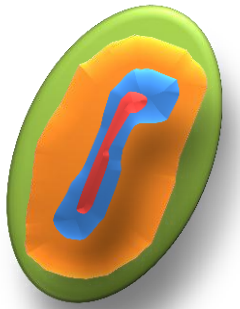
RADIAL GLIA CELL PROCESSES PROVIDE PATHWAYS AND GUIDANCE FOR NEURONS MIGRATING FROM THE EPENDYMAL TO THE MANTLE LAYER

THE MIGRATING NEURONS ARE POSTMITOTIC CELLS INCAPABLE OF DIVIDING

THIS MIGRATORY PROCESS IS CALLED: RADIAL MIGRATION

LAYERS GROWING AROUND THE NEURAL CANAL INCLUDE:

1. EPENDYMAL LAYER
2. MANTLE LAYER. FORMS THE GREY MATTER
3. MARGINAL LAYER. FORMS THE WHITE MATTER



DEVELOPMENT OF THE SPINAL CORD

WITHIN THE FOURTH EMBRYONIC WEEK, THE MANTLE LAYER DIFFERENTIATES INTO VENTRALLY LOCATED BASAL AND DORSALLY POSITIONED ALAR PLATES ON BOTH SIDES

IN THE MEDIAN SAGITTAL PLANE, THE MANTLE LAYER REMAINS THIN FORMING THE FLOOR PLATE VENTRALLY AND THE ROOF PLATE DORSALLY

FROM THE BASAL PLATE THE VENTRAL HORN OF SPINAL CORD DEVELOPS

THE DORSAL, SENSORY HORN DERIVES FROM THE ALAR PLATE

SOMATO-MOTOR NEURONS DEVELOPING IN THE BASAL PLATE GROW AXONS THAT LEAVE THE SPINAL PRIMORDIUM AND ESTABLISH CONNECTIONS WITH STRIATED MUSCLES DEVELOPING IN THE SAME SEGMENT. THIS IS THE EARLY FORMATION OF THE NEUROMUSCULAR JUNCTIONS

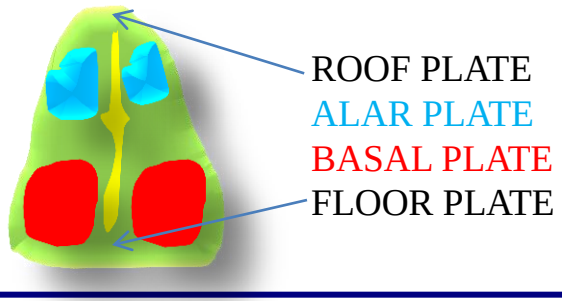
VEGETATIVE MOTOR NEURONS DEVELOPING AT THE LEVEL OF THE SULCUS LIMITANS PROVIDE AXONS THAT COMMUNICATE WITH AUTONOMIC GANGLION CELLS OUTSIDE THE SPINAL PRIMORDIUM

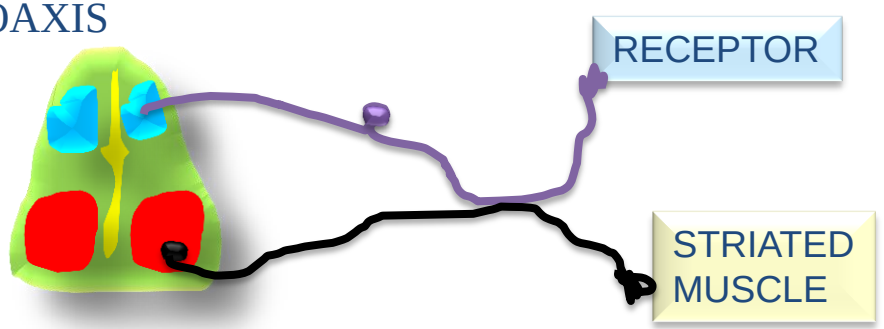
DEVELOPMENT OF THE SPINAL CORD

NEURONS OF THE ALAR PLATE DIFFERENTIATE FURTHER AND ESTABLISH COMPLEX NUCLEI THAT ARE FUNCTIONALLY COUPLED TO THE PROCESSING OF SENSORY INFORMATION

THE SENSORY STIMULI ARE CARRIED TO THE ALAR PLATE BY THE CENTRAL PROCESSES OF EXTERNAL PSEUDO-UNIPOLAR NEURONS. THESE CELLS DIFFERENTIATE FROM THE NEURAL CREST AND ESTABLISH THE SENSORY DORSAL ROOT GANGLIA IN THE SEGMENTS OF THE BODY. THE PERIPHERAL PROCESSES OF THESE SENSORY NEURONS ARE LINKED WITH RECEPTORS

IN THE MARGINAL LAYER, AXON BUNDLES CAN BE FOUND. THEY EITHER BELONG TO SHORT INTERSEGMENTAL CONNECTIONS OR TO MAJOR ASCENDING AND DESCENDING FIBER TRACTS INTERCONNECTING THE SPINAL SEGMENTS WITH OTHER REGULATORY PARTS OF THE NEUROAXIS





DEVELOPMENT OF THE BRAIN. FORMATION OF PRIMARY AND SECONDARY BRAIN VESICLES

FROM THE ROSTRAL PART OF THE NEURAL TUBE THREE BRAIN VESICLES DERIVE: THE PROSENCEPHALIC, THE MESENCEPHALIC AND THE RHOMBENCEPHLIC VESICLES

FURTHER DIFFERENTIATION DIVIDES THE PROSENCEPHALON IN TWO SECONDARY BRAIN VESICLES: THE TELENCEPHALIC AND THE DIENCEPHALIC ONES

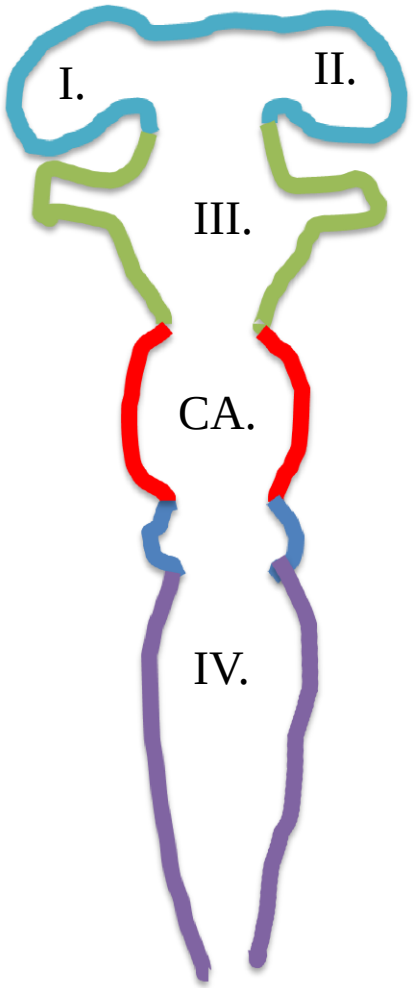
THE MESENCEPHALIC VESICLE MAINTAINS ITS ORIGINAL INTEGRITY WITHOUT SPLITTING INTO PARTS

THE DEVELOPMENT OF THE RHOMBENCEPHALIC VESICLE RESULTS IN THE FORMATION OF THE SECONDARY METENCEPHALIC AND MYELENCEPHALIC VESICLES

FORM THE ORIGINAL CAVITY OF THE PROSENCEPHALON THE LATERAL AND THIRD VENTRICLES, FROM THE CAVITY OF THE MESENCEPHALON THE CEREBRAL AQUE-DUCT AND FROM THAT OF THE RHOMBENCEPHALON THE FOURTH CEREBRAL VENTRICLE DEVELOP

AT THE LEVEL OF THE 4TH VENTRICLE, THREE APERTURES DEVELOP THAT ALLOW THE OUTFLOW OF THE CEREBROSPINAL FLUID INTO THE SUBARACHNOID SPACE

SCHEMATIC ILLUSTRATION OF BRAIN VESICLES AND THEIR DERIVATIVES



PROSENCEPHALIC VESICLE

MESENCEPHALIC VESICLE

RHOMBENCEPHALIC VESICLE

TELENCEPHALON → CEREBRAL CORTEX, BASAL GANGLIA

DIENCEPHALON → THALAMUS, HYPOTHALAMUS, RETINA

MESENCEPHALON → MESENCEPHALON

METENCEPHALON → PONS, CEREBELLUM

MYELENCEPHALON → MEDULLA

FOLDING OF THE BRAIN, COMPARTMENTALIZATION OF THE BRAIN STEM

THE EMBRYO DISPLAYS A CHARACTERISTIC ROSTRO-CAUDAL, C-SHAPED FLEXURE

AT THE END OF THE FIRST MONTH, TWO FLEXURES OF THE BRAIN ARE OBVIOUS. THE CERVICAL FLEXURE OCCURS BETWEEN THE SPINAL CORD AND THE MEDULLA, THE MESENCEPHALIC FLEXURE DEVELOPS AT THE LEVEL OF THE MIDBRAIN. THE CONCAVITY OF BOTH FLEXURES POINTS TOWARD THE VENTRAL PART OF THE BODY

LATER, A THIRD FLEXURE DEVELOPS AT THE LEVEL OF THE RHOMBENCEPHALON, CALLED THE PONTINE FLEXURE. IT FOLDS THE METENCEPHALON BACK TO THE MYELENCEPHALON. THE RHOMBIC LIPS

THE LATERAL OUT-POCKETINGS OF THE TELENCEPHALIC VESICLES ARE ALSO CHARACTERISTIC FEATURES, TOGETHER WITH THE DEVELOPMENT OF THE OPTIC CUP WHICH PROVIDES THE PRIMORDIUM OF THE RETINA

THE BRAIN STEM SHOWS AN ORGANIZATION RESEMBLING THE PATTERN OF THE SPINAL CORD. FROM THE BASAL AND ALAR PLATES CENTERS OF CERTAIN CRANIAL NERVES DEVELOP

DEVELOPMENT OF THE TELENCEPHALON

THE TELENCEPHALIC VESICLES GROW LATERALLY AS BUBBLES ON BOTH SIDES, IN A SPIRAL MANNER SIMILAR TO THE SHAPE OF THE RAM'S HORN. THE DEVELOPING VESICLE PROVIDES THE FRONTAL, PARIETAL, TEMPORAL AND OCCIPITAL LOBES, AS WELL AS, THE INSULA. THESE PARTS GRADUALLY COVER AND HIDE THE DIENCEPHALON. THE CAVITY OF THE TELENCEPHALIC VESICLE IS THE LATERAL VENTRICLE

FROM THE DORSAL PART OF THE WALL OF THE GROWING TELENCEPHALIC VESICLE THE CEREBRAL CORTEX DEVELOPS

FROM THE THICKER, VENTRAL PART OF THE VESICLE THE CORPUS STRIATUM DEVELOPS

THE VENTRAL SURFACE OF THE TELENCEPHALIC VESICLE GETS JUXTAPOSED TO THE DIENCEPHALIC STRUCTURE, THE THALAMUS.

THIS BORDER ZONE IS CROSSED BY AN EXTREMELY MASSIVE AND FUNCTIONALLY CRUCIAL FIBER BUNDLE SYSTEM, THE INTERNAL CAPSULE. IT CONTAINS FIBERS ESTABLISHING COMMUNICATION BETWEEN THE THALAMUS AND THE CEREBRAL CORTEX, AND ALSO MULTIPLE CONNECTIONS AMONG THE CORTEX, THE BRAIN STEM AND THE SPINAL CORD. BOTH ASCENDING AND DESCENDING FIBER TRACTS ARE REPRESENTED IN IT

THE CYTO-DIFFERENTIATION OF THE CEREBRAL CORTEX

VZ: VENTRICULAR ZONE
MZ: MARGINAL ZONE
IZ: INTERMEDIATE ZONE
CP: CORTICAL PLATE
SZ: SUBVENTRICULAR ZONE
SP: SUBPLATE ZONE
EL: EPENDYMAL LAYER
WM: WHITE MATTER
NC: NEOCORTEX
ML: MOLECULAR LAYER