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

***A projekt az Európai Unió támogatásával, az Európai Szociális Alap társfinanszírozásával valósul meg.

BASICS OF NEUROBIOLOGY

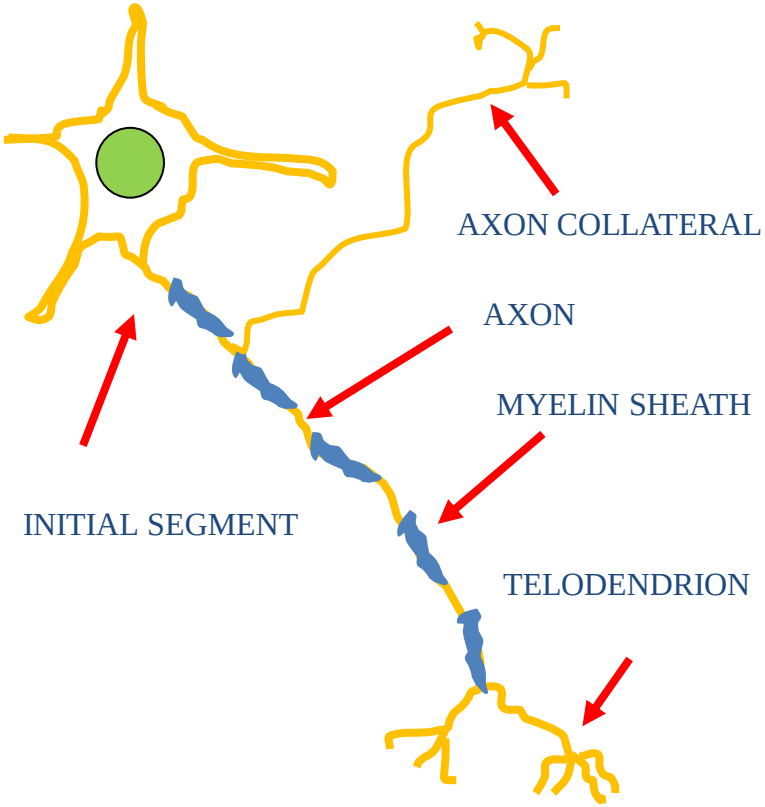
Neurobiológia alapjai

NERVE FIBERS

(Idegrostok)

ZSOLT LIPOSITS

HISTOLOGICAL CLASSIFICATIONS OF NERVE FIBERS



SCHEME OF A NEURON WITH A PROJECTING MYELINATED AXON

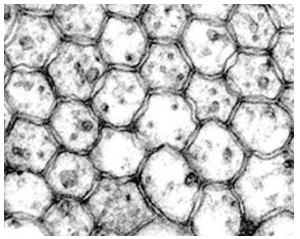
I. NAKED AXONS

II. NON-MYELINATED AXONS

III. AXONS MYELINATED BY OLIGODENDROCYTES

IV. AXONS MYELINATED BY SCHWANN CELLS

NAKED AXONS



THE THINNEST AXONS IN THE NERVOUS SYSTEM

THEIR DIAMETER IS IN THE RANGE OF 0.1-9.1 MICROMETERS

THEY DO NOT HAVE ANY INSULATING SHEATH, THEREFORE, THEIR AXOLEMMA IS IN DIRECT CONTACT WITH THE EXTRACELLULAR SPACE AND FLUID

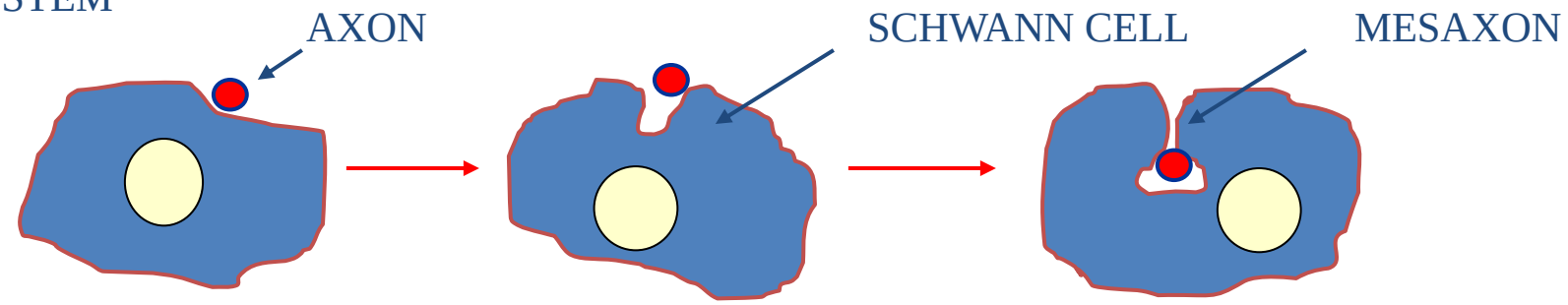
THEY OCCUR IN AXON BUNDLES WITHIN THE CNS

THEIR CONDUCTION VELOCITY IS LOW, ABOUT 0.5-2 m/sec

THE INITIAL AND THE TERMINAL SEGMENTS OF NEURONS ARE NAKED AS WELL

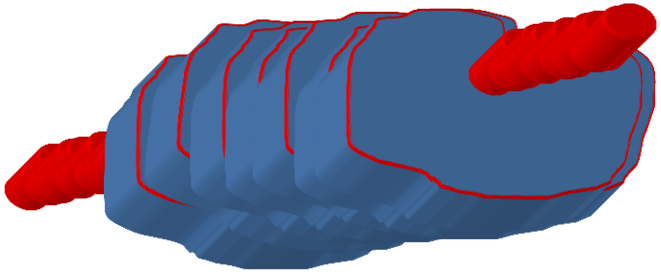
NON-MYELINATED AXONS

DURING DEVELOPMENT THESE AXONS ESTABLISH CLOSE CONNECTIONS WITH SCHWANN CELLS, THE PRINCIPAL GLIAL CELLS OF THE PERIPHERAL NERVOUS SYSTEM



SCHWANN CELLS (LEMMOCYTES) APPEAR ALONG THE COURSE OF THE AXON. THE AXON GRADUALLY GETS INVAGINATED INTO THE SCHWANN CELL WHOSE CELL MEMBRANE ENSHEATHS THE AXON. THE AXON IS SUSPENDED BY THE MESAXON, A DUPLICATE OF THE SCHWANN CELL MEMBRANE

NEIGHBORING SCHWANN CELLS, SITUATED NEXT TO EACH OTHER, WRAP AROUND AND INSULATE THE AXON



NON-MYELINATED AXONS

INDIVIDUAL SCHWANN CELLS ENCLOSE 150-200 MICROMETER SEGMENTS OF THE AXON

A SINGLE SCHWANN CELL HOSTS SEVERAL AXONS IN ITS CELL BODY

FIBERS BELONGING TO THIS CATEGORY ARE:

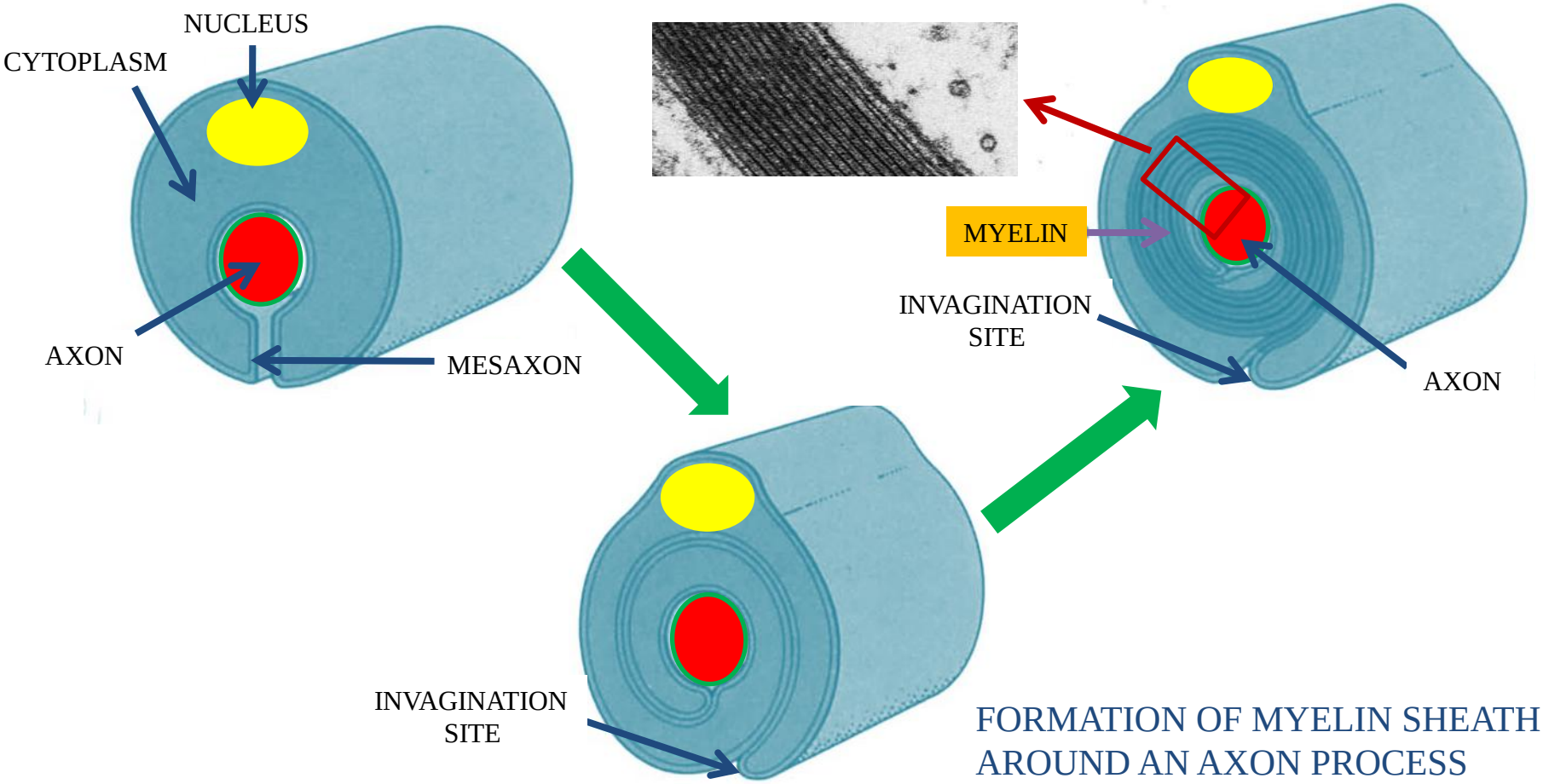
1. POST-GANGLIONIC FIBERS OF THE AUTONOMIC NERVOUS SYSTEM
2. SENSORY FIBERS CARRYING CRUDE TOUCH, TEMPERATURE AND PAIN SENSATIONS

SCHWANN CELLS ARE OBLIGATORY TO THE PROPER FUNCTION OF THE AXON

SCHWANN CELL DERIVES FROM THE NEURAL CREST

THESE NON-MYELINATED FIBERS ARE ALSO CALLED AS REMAK-FIBERS

MYELINATED FIBERS IN THE PERIPHERAL NERVOUS SYSTEM



FORMATION OF MYELIN SHEATH AROUND AN AXON PROCESS

FEATURES OF MYELINATED FIBERS IN THE PNS

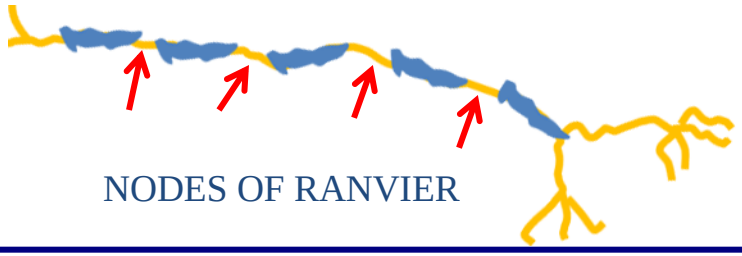
DURING AXONAL OUTGROWTH, THE SCHWANN CELLS ROTATE AROUND THE AXON, THEIR MESAXONS WRAP AROUND THE AXONIC PROCESS RESULTING IN THE FORMATION OF A CONCENTRIC, MULTI-LAMINAR, MEMBRANE STRUCTURE CALLED MYELIN. 80% OF THE MYELIN IS COMPOSED OF LIPIDS, PROTEINS ACCOUNT FOR THE REMAINING 20%.

OUTSIDE THE MYELIN SHEATH , THE COMPRESSED SCHWANN CELL BODIES OCCUR

THE MYELIN INSULATION OF AXONS IS NOT CONTINUOUS, THERE ARE GAPS BETWEEN MYELIN ENCLOSURES BELONGING TO NEIGHBORING SCHWANN CELLS. THESE MYELIN FREE, NUDE SEGMENTS ARE THE RANVIER NODES.

AT THE RANVIER NODES, THE AXOLEMMA HAS ACCESS TO THE EXTRACELLULAR FLUID COMPARTMENT. AT THESE SITES, ION MOVEMENTS BETWEEN THE INTRA- AND EXTRACELLULAR COMPARTMENTS TAKE PLACE

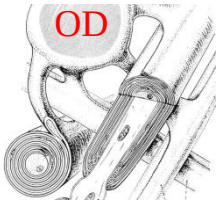
THE MYELIN SHEATH SPEEDS UP THE PROPAGATION OF THE INFORMATION IN THE AXON



NODES OF RANVIER

MYELINATED FIBERS WITHIN THE CNS

SIMILAR TO THE PERIPHERY, THE CNS ALSO CONTAINS MYELINATED FIBERS



IN THE CNS, MYELIN IS FORMED BY THE PROCESSES OF SPECIAL GLIAL CELLS, SO-CALLED OLIGODENDROCYTES (OD)

THEIR PROCESSES WRAP AROUND AXONS. A SINGLE OLIGODENDROCYTE CAN INSULATE ABOUT 50 AXONS

RANVIER NODES ALSO EXIST BETWEEN THE ADJACENT MYELIN INSULATIONS

MYELINATED AXONS PROPAGATE ACTION POTENTIALS IN A SALTATORY MANNER FROM ONE RANVIER NODE TO THE OTHER

DEMYELINATION, THE LOSS OF MYELIN INSULATION OF AXONS DUE TO DYSFUNCTION AND DEGENERATION OF OLIGODENDROCYTES, LEADS TO SEVERE AND DIFFUSE NEURAL DISEASES (SCLEROSIS MULTIPLEX)

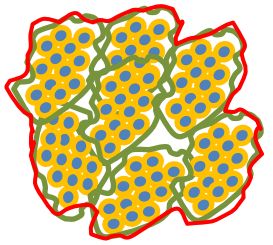
PERIPHERAL NERVES

NEURAL FIBERS COMPOSE BUNDLES THAT FORM PERIPHERAL NERVES

IN PERIPHERAL NERVES, THE INDIVIDUAL NEURAL FIBERS, AS WELL THE FIBER BUNDLES ARE WRAPPED BY CONNECTIVE TISSUE BEING RICH IN COLLAGEN AND RETICULIN FIBERS. THE CONNECTIVE TISSUE COVERINGS ESTABLISH THE ENDO-, PERI- AND EPINEURIUM

PERIPHERAL NERVES HAVE SENSORY, MOTOR OR MIXED PHENOTYPES

STRUCTURALLY THEY ARE COMPOSED OF SCHWANN CELLS, FIBROBLASTS AND AXONS. THEY ARE EMBEDDED IN THE GROUND SUBSTANCE PRODUCED BY FIBROBLASTS. CONNECTIVE TISSUE FIBERS SUPPORT AND HOLD TIGHTLY THIS CABLE LIKE STRUCTURE



TRANSECTED PERIPHERAL NERVES MIGHT REGENERATE

PERIPHERAL NERVES ESTABLISH CONNECTIONS WITH RECEPTOR AND EFFECTOR STRUCTURES

CLASSIFICATION OF NERVE FIBERS

TYPE	ASSOCIATION, FUNCTION	DIAMETER (µm)	CONDUCTING VELOCITY (m/s)	PEAK POTENTIAL (ms)	ABSOLUTE REFRACTORY PERIOD (ms)
Aα	EXTRAFUSAL MUSCLE FIBER PRIMARY MUSCLE SPINDLE FIBER	12-20	70-120	0,4-0,5	0,4-1
Aβ	CUTANEOUS MECHANORECEPTORS SECONDARY MUSCLE SPINDLE FIBER	5-12	30-70		
Ay	INTRAFUSAL MUSCLE FIBER	3-6	15-30		
Ad	PAIN, COLD, TOUCH, PRESSURE	2-5	12-30		
B	PREGANGLIONIC	< 3	3-15	1,2	1,2
C	POSTGANGLIONIC	0,4-1,2	0,5-2	2	2

ACTION POTENTIAL

ACTION POTENTIAL (AP) TRANSMITS SIGNALS FROM THE CELL BODY TOWARD THE AXON TERMINAL

IT IS DUE TO A SUDDEN CHANGE IN THE DISTRIBUTION AND CONCENTRATION OF IONS IN THE INTRA- AND EXTRACELLULAR FLUID COMPARTMENTS SEPARATED BY THE AXON MEMBRANE

AP HAS THREE SUCCESSIVE STAGES:

1. RESTING STAGE. MEMBRANE IS POLARIZED, -70 mV MEMBRANE POTENTIAL
2. DEPOLARIZATION STAGE. SODIUM ION INFLOW, +50 mV MEMBRANE POTENTIAL
3. REPOLARIZATION STAGE. SODIUM CHANNELS CLOSE, OPENING POTASSIUM CHANNELS ALLOW THE OUTFLOW OF K^+ FROM INSIDE

AFTERHYPERPOLARIZATION

REFRACTORY PERIOD

SALTATORY AND WAVE LIKE CONDUCTIONS OF AP