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Introduction to the nervous system
Spinal cord

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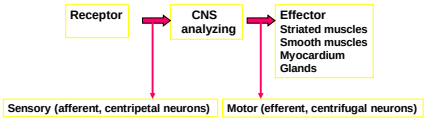
Nervous system

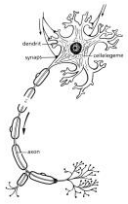
1) Sensory function – changes in the internal and external environment
2) Integrative function – analyse, store and compare informations
3) Motor function – responds to stimuli by initiating contraction and glandular secretion



Nervous system divisions

1) **Central Nervous System (CNS) –** brain, spinal cord
2) **Peripheral Nervous System (PNS) –** cranial nerves (I-XII), spinal nerves (31 pairs), vegetative (visceral or autonomic) system

NEURON



body (perikaryon)

branches :

dendrites (denritic zone)

neurit (axon)

– initial segment

– telodendria

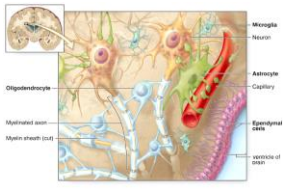
Myelin sheat

Schwann´s cells - PNS

Oligodendrocytes CNS

Nodes of Ranvier, internodal segments

GLIAL CELLS



Macroglie (astrocytes)

BBB, transport

Oligodendroglia

myelin sheath - CNS

Schwann´s cells (peripheral glia)

Myelin sheath - PNS

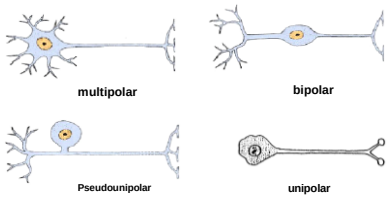
Microglia

fagocytic activity

Ependyma

Covers the ventricles

TYPES OF NEURONS (morphological division)



multipolar

bipolar

Pseudounipolar

unipolar

CENTRAL NERVOUS SYSTEM (brain + spinal cord)

Substantia grisea (grey matter)

Perikaryones + dendrites (neuropil)

cortex

nuclei – (motor – ncl. originis, motorii; sensory – ncl. terminationis)

ganglia – perikarya of neurons outside the CNS

CENTRAL NERVOUS SYSTEM (brain + spinal cord)

Substantia alba (white matter)

bundles of myelinized nerve fibers (neurites and central branches of pseudounipolar neurons)

tractus (tract): 1. connection of two grey matters (e.g. tractus cortico-spinalis)

2. Spread of action potential in homogenous bundle of nerve fibers +

same quality and function of nerve fibers + serial connection of the groups of neurons of approprite pathway (e.g. visual pathway)

fasciculus
funiculus
lemniscus
} mainly heterogenous

FUNCTIONAL TYPES OF AXONS

Afferent

somatosenzory — skin sense, proprioception, pain

viscerosenzory — mechanoception, pain

senzory — afferentation of taste, hearing, vestib. inform.

Efferent

somatomotor — striated muscles

branchiomotor — striated muscles

visceromotor — smooth muscles

sympathetic — myocardium

parasympathetic — glands

COMPARTMENTS OF CNS

Spinal cord

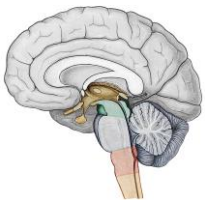
Brain

brainstem

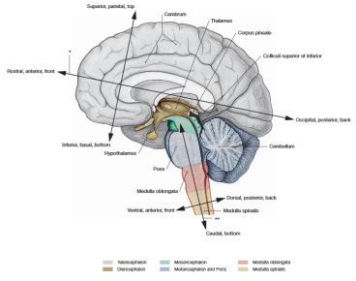
- medulla oblongata
- pons
- mesencephalon (midbrain)
- cerebellum

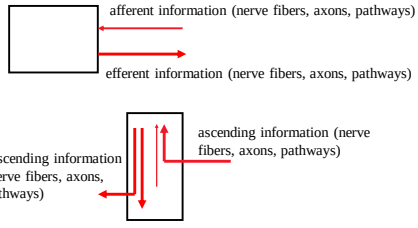
diencephalon

telencephalon (forebrain)

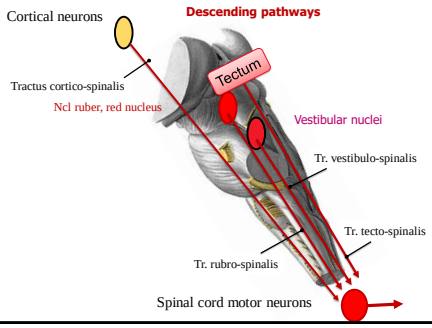


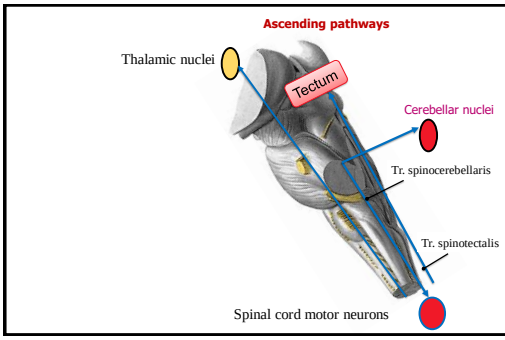
Basic terminology





ipsilateral x contralateral





Development of the nervous system

Diffuse nervous system – jellyfish

Ganglionic nervous system – worms

Tubular nervous system – vertebrates

Neural plate – ectoderm, induction by chorda dorsalis

Neural groove

Neural tube – closed groove

Ganglionic eminence

Alar plate - zones:

somatosensory

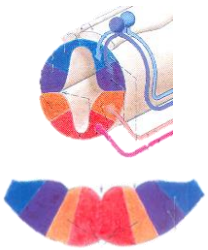
viscerosensory

SULCUS LIMITANS

Basal plate - zones:

somatomotor (branchiomotor)

visceromotor



Brain development

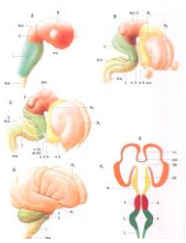
Rhombencephalon

- **Metencephalon (cerebellum, pons Varoli)**
- **Myelencephalon (medulla oblongata)**

Mesencephalon

Prosencephalon

- **Diencephalon**
- **Telencephalon**



MEDULLA SPINALIS (spinal cord)

Cord-like structure, app 40-50 cm, inside the vertebral canal

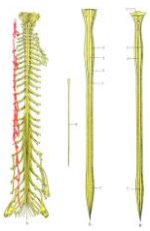
Cranial border – decussatio pyramiduum, the first C spinal nerves

Caudal border – conus medullaris (L1 – L2)

filum terminale (periosteum of the coccyx)

Enlargements

- **intumescentia cervicalis (C3 – Th1)**
- **intumescentia lumbalis (Th12-L4)**



Spinal cord – gross anatomy

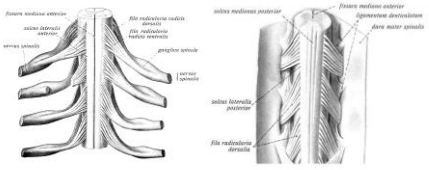
Fissura mediana anterior

Sulcus anterolateralis

Sulcus posterolateralis

Sulcus medianus posterior

Sulcus intermedius



Funiculus ant.

(fissura mediana ant. + sulcus anterolateralis)

Funiculus lat.

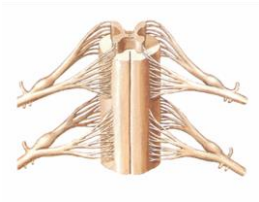
(sulcus anterolat. + posterolat.)

Funiculus post.

(sulcus medianus post. + sulcus posterolat.)

fasciculus cuneatus (lat.)

fasciculus gracilis (med.)



Spinal cord segment – part of the spinal cord from which comes 1 pair of the spinal nerves

sulcus anterolateralis – fila radicularia radicis ventralis – radix ventralis

sulcus posterolateralis – fila radicularia radicis dorsalis – radix dorsalis (ganglion spinale)

radix ventralis + radix dorsalis = nervus spinalis

Nervus spinalis branches to anterior and posterior branches – rami ventrales + rami dorsales

Rami ventrales nervorum spinalium – form plexuses (ventral side of the trunk + extremities)

Rami dorsales nervorum spinalium – segmental organisation, innervation of the back

Spinal nerves (nervi spinales)

31 pairs of spinal nerves

- **8 cervical**
- **12 thoracic**
- **5 lumbar**
- **5 sacral**
- **1 coccygeal**

Through appropriate vertebral foramen

S5 + Co - hiatus sacralis

below L2 - cauda equina

Chipault´s rule

upper C – same spinal cord segments

lower C – spinal cord segment + 1

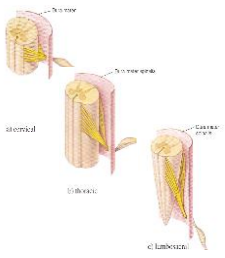
upper Th – spinal cord segment + 2

lower Th – spinal cord segment + 3

Th_{10-12} – lumbar segments L_{1-5}

Th_{12}-L_1 – epiconus- segment L_5-S_2

L_{1-2} – conus- segment S_{3-5}



Structure of the spinal cord

phylogenetically old

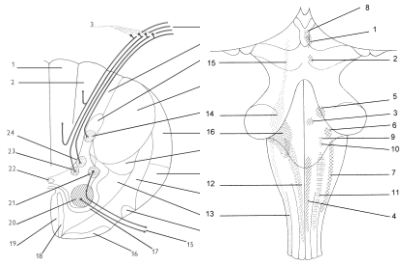
morphologically the simplest part of the CNS

Centers of the visceral reflexes (defecation, micturition, erection)

Basic processing of afferentation from the limbs

Transmission of afferentation to the higher parts of the CNS

Transmission of motor information to the periphery



Substantia grisea medullae spinalis

Letter H

Similar to neural tube

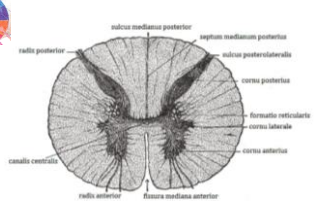
Cornu anterius (columna ant.)

Cornu posterius (columna post.)

Cornu laterale (columna lat.)

Canalis centralis

Commisura ant. et post.



SOMATOSENSORY NUCLEI AND PATHWAYS

1. Protopathic sensation

phylogenetically old (low myelinated, rich connections in the lower parts of CNS)

carry not precisly localized pain, temperature

2. Epicritic sensation

phylogenetically young (highly myelinized, direct)

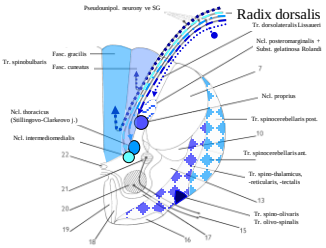
precise localization – discriminative sensation

3. Proprioception

from locomotor system (muscles, tendons)

carry information to the cerebellum (tone, coordination, balance)

Common features: **1st neuron – DRG; information via thalamus to the cortex (directly/indirectly)**



SOMATOMOTOR NUCLEI AND PATHWAYS

1. Pyramidal tract, voluntary

phylogenetically young (highly myelinated, fast conduction), from the cortex, precise information

2. Extrapyramidal tracts, involuntary

phylogenetically old (low myelinited),

nuclei in different parts of the CNS (BG, ncl. olivaris…)

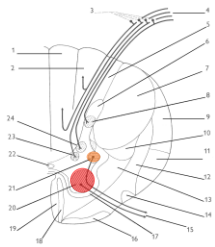
reflex motion

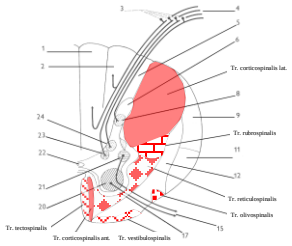
automatic motion

control feedback circuits

Common features:

the last neurons - ncll. motorii / motor nuclei of the cranial nerves





INTERNEURONS

1. Connect appropriate parts of the CNS

e.g. ncll. apicales

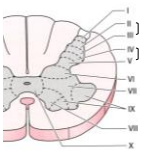
2. Facilitatory and inhibitory functions

e.g. substantia gelatinosa Rolandi

3. Centres of reflexes

visceral reflexes in the spinal cord

Rexed laminae



I **ncl. apicalis**
II, III **substantia gelatinosa Rolandi**
IV, V **ncl proprius**
VI **ncl. thoracicus**
VII **ncl. intermediomedialis, ncl. intermediolateralis**
IX **Medial motoneurons**
VIII **Lateral motoneurons**
X **zona centralis, interneurons**

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