

CENTRAL NERVOUS SYSTEM

spinal cord and brain

SPINAL CORD

- is developmentally the oldest part of CNS
- is long about 45 cm in adult
- fills upper 2/3 of vertebral canal

cranial border: at level of foramen magnum

caudal border: at level of L1 vertebra – **medullary cone**

- **filum terminale** made by pia matter (ends at level of S2 vertebra)
- spinal roots below L1 vertebra form **cauda equina**

enlargements:

- **cervical enlargement** (CV – ThI): origin of nerves for upper extremity – brachial plexus
- **lumbosacral enlargement** (LI – SII): origin of nerves for lower extremity – lumbosacral plexus

Spinal segment is part of spinal cord where 1 pair of spinal n. exits.

Spinal cord consists of 31 spinal segments and 31 pairs of spinal nn.: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal.

Spinal nn. leave spinal cord through intervertebral foramina.

Dermatome is part of skin innervated by 1 spinal nerve.

external features:

- **anterior median fissure**
- **anterolateral sulcus** – exits of anterior roots of spinal nn. (lateral to anterior median fissure)
- **posterolateral sulcus** – exits of posterior roots of spinal nn. (lateral to posterior median sulcus)
- **posterior median sulcus**

internal features:

White matter: consists of fibres of neurons

- **anterior funiculus** (between anterior median fissure and anterolateral sulcus)
- **lateral funiculus** (between anterolateral and posterolateral sulci) in thoracolumbar and sacral parts of spinal cord
- **posterior funiculus** (between posterolateral sulcus and posterior median sulcus)
is divided to:
 - gracile fasciculus – medial one
 - cuneate fasciculus – lateral one, both for sensory tracts of fine sensation

White matter of spinal cord contains fibres of ascending and descending nerve tracts.

Grey matter: consists of bodies of neurons, in horizontal section forms horns, spatially columns

- **posterior horn** – is slimmer than anterior one, contains afferent nuclei and neurons in Rexed spinal laminae I – VI, conveys sensory information
- **lateral horn** – in thoracolumbar and sacral parts of spinal cord, contains autonomic nuclei in Rexed spinal lamina VII, serves visceral function
- **anterior horn** – is larger than posterior one, contains efferent nuclei and motoneurons in Rexed spinal laminae VIII – IX, has motor function
- **central grey matter** – interneurons, around central canal: Rexed spinal lamina X

Central canal

– runs along length of entire spinal cord, is filled by cerebrospinal fluid

BRAIN

Rhombencephalon (hindbrain)

- Myelencephalon (Medulla oblongata)
- Metencephalon (Pons + Cerebellum)

Mesencephalon (midbrain)

Prosencephalon (forebrain)

- Diencephalon
- Telencephalon (Cerebrum)

BRAIN STEM

Brain stem

- Medulla oblongata (bulb of spinal cord)
- Pons
- Midbrain

Medulla oblongata

- from **pyramidal decussation** (crossing of anterior corticospinal tracts)
- to **bulbopontine sulcus** (transverse groove between medulla oblongata and pons)

external structures:

– ventrally:

- **anterior median fissure** terminates cranially in **foramen cecum**
- **pyramid**: contains fibers of anterior corticospinal tract
- **anterolateral sulcus**: exit of hypoglossal n. (CN XII) above 1st anterior spinal root
- **olive**
- **posterolateral sulcus**: in craniocaudal direction exit of glossopharyngeal n. (CN IX), vagus n. (CN X), accessory n. (CN XI)
- **inferior cerebellar peduncle**: connects medulla oblongata and cerebellum

– dorsally:

- **posterior median sulcus**
 - gracile fasciculus (medial) – **gracile tubercle**, gracile ncl.
 - cuneate fasciculus (lateral) – **cuneate tubercle**, cuneate ncl.
gracile ncl. and cuneate ncl. contain 2nd neuron of tract of fine sensation
- Posterior surface of medulla oblongata forms lower part of rhomboid fossa.

internal structures:

Grey matter of medulla oblongata has nuclei of cranial nn., reticular ncl., gracile and cuneate ncl.

White matter of medulla oblongata contains fibres of ascending and descending tracts.

Pons

- basilar part (ventrally): contains fibres of corticopontine tracts and pontine ncl.
- pontine tegmentum (dorsally): contains nuclei of cranial nerves and reticular ncl.

external structures:

– ventrally:

- **bulbopontine sulcus** (medullopontine sulcus):
 - is lower border of pons and upper border of medulla oblongata
 - exit of abducent n. (CN VI) above pyramid
 - laterally in **pontocerebellar angle** (pontocerebellar trigone):
exits of facial n. (CN VII) - medially and vestibulocochlear n. (CN VIII) - laterally

- **trigemino-facial line:** forms lateral border of pons, between exits of trigeminal n. (CN V) and facial n. (CN VII), border between pons and middle cerebellar peduncle
 - **basilar sulcus:** groove on ventral surface of pons made by both corticospinal tracts
basilar a. runs in basilar sulcus
 - **middle cerebellar peduncle:** connects pons to cerebellum
 - pontine ncll. lie in ventral part of pons
- dorsally: posterior surface of pons forms upper part of rhomboid fossa

internal structures:

Grey matter of pons is made by nuclei of cranial nerves, pontine and reticular ncll.

White matter of pons contains fibres of nerve tracts.

Rhomboid fossa

- is made by posterior surfaces of medulla oblongata and pons, forms floor of fourth ventricle
- nuclei of cranial nerves and reticular ncll. lie under rhomboid fossa not in rhomboid fossa!

structures:

- **median sulcus of rhomboid fossa:** connects central canal to cerebral aqueduct
- **median eminence** (motor nuclei): laterally to median sulcus of rhomboid fossa
- **sulcus limitans:** laterally to median eminence
divides motor and sensory nuclei of CN
- superior part
- inferior part
- medullary striae of rhomboid fossa (border between medulla oblongata and pons)

Midbrain

- located between pons and diencephalon, through mesencephalon runs **cerebral aqueduct**
- **superior cerebellar peduncle:** connect mesencephalon to cerebellum

parts of midbrain:

- **cerebral peduncle** (anteriorly to cerebral aqueduct) contains:
 - **cerebral crus** – *white matter*, tracts
interpeduncular fossa = posterior perforated substance between cerebral crura
exit of **oculomotor n.** (CN III)
 - **tegmentum of midbrain** – *grey matter*, nuclei: **substantia nigra** (close to crus cerebri) and **red ncl.** control of motor functions, failure: Parkinson's disease
- **tectum** (posteriorly to cerebral aqueduct):
 - **superior colliculi** – subcortical centre of visual reflexes
 - **inferior colliculi** – subcortical centre of acoustic reflexes
 - exit of **trochlear n.** (CN IV) from superior medullary velum

RETICULAR FORMATION

- developmentally old part of CNS, extends from cervical of spinal cord to diencephalon
- ascending reticular activating system - role in promoting arousal and consciousness
- formed by small **reticular ncl.** with different functions arranged in network
- centre for important vital reflexes: controls cardiovascular and respiratory systems
- regulates sleep-wake cycle and autonomic functions
- centre of reflexes: vomiting, chewing, licking, sucking, swallowing, micturition

CEREBELLUM

- located below tentorium cerebelli, in posterior cranial fossa, in cerebellar fossae
- **superior** et **inferior** surfaces
 - **vermis**: middle unpaired part
 - **hemisphere**
 - **anterior lobe**
 - **posterior lobe** - tonsil
 - **flocculonodular lobe** - flocculus

external features:

foliae of cerebellum

fissurae of cerebellum:

- **primary fissure**: between anterior lobe and posterior lobe
- **posterolateral fissure**: between posterior lobe and flocculonodular lobe
- **horizontal fissure**: between superior et inferior surfaces of cerebellum

internal features:

- **cerebellar cortex**: *grey matter*, has 3 layers
- **arbor vitae** (tree of life): *white matter*
- **cerebellar nuclei**: paired structures from *grey matter*, are located in white matter of cerebellum, are involved in efferent cerebellar tracts
 - dentate ncl.** – is the largest cerebellar nucleus, located most laterally

cerebellar peduncles:

superior, middle, and inferior cerebellar peduncles

DIENCEPHALON

- located above and in front of midbrain
- **hypothalamic sulcus**: border between sensory and motor parts of diencephalon between thalamus and hypothalamus

parts of diencephalon

- thalamus with metathalamus
- epithalamus
- hypothalamus with neurohypophysis and thalamus opticus

Hypophysis is through infundibulum (stalk) attached to hypothalamus in anterior part of diencephalon.

main structures of diencephalon:

anteriorly: mammillary bodies, infundibulum, optic chiasma

posteriorly: pineal body, posterior commissure, pulvinar of thalamus

Thalamus

- above hypothalamic sulcus, the largest portion of diencephalon, sensory
- Aaaaa to consciousness', receives all sensory information (except olfactory)

Medial surface of thalamus – forms lateral wall of 3rd ventricle:

- **interthalamic adhesion** (intermediate mass) – no function
- **tenia thalami** – separates medial and posterior surfaces of thalamus
- **medullary stria of thalamus** – runs in tenia thalami - leads olfactory stimuli to habenular ncl.

Dorsal surface of thalamus:

- **terminal sulcus** – between thalamus and caudate ncl.
terminal stria (connects amygdala with hypothalamus)

- **anterior tubercle of thalamus**
- **pulvinar**
- **metathalamus**: medial geniculate body – auditory pathway connected with superior colliculus
lateral geniculate body – visual pathway, connected with inferior colliculus

Nuclei of thalamus:

- Anterior group: anterior ncl. of thalamus – limbic part of thalamus
- Medial group: mediodorsal ncl. – personality
- Lateral group: ventral posteromedial ncl. – receives sensory information from head
ventral posterolateral ncl. – receives sensory information from body and limbs
posterior ncll. of thalamus = medial and lateral geniculate ncll.
- Reticular ncll.: rostral part of reticular formation, connected by cerebral cortex

Epithalamus

– dorsomedially to thalamus, connected with limbic system

structures:

- **medullary stria of thalamus** connects hypothalamus and septum verum to habenular ncll.
- **habenular trigone**
- **habenular commissure**, habenular ncll.
- **epiphysis** = pineal body - produces melatonin (for sleeping)
- **posterior commissure** - connects superior colliculi

Hypothalamus

- located below hypothalamic sulcus
- is the highest centre of autonomic nervous system: anterior hypothalamus controls parasympathetic system, posterior hypothalamus controls sympathetic system
- controls endocrine activity
- takes part in functioning of limbic system
- has medial and lateral parts

structures:

- **mammillary body**
- **infundibulum** (stalk of hypophysis) and neurohypophysis
- **thalamus opticus**: optic nerve (HN II), optic chiasma, optic tract

Nuclei of hypothalamus:

- supraoptic and paraventricular ncll. – synthesize vasopressin and oxytocin via hypothalamo-hypophyseal system

TELENCEPHALON

= cerebrum – two cerebral hemispheres

- cerebral cortex – *grey matter*
- medullary body – *white matter*
- basal ganglia – groups of *grey matter* located inside of white matter of telencephalon
- rhinencephalon (olfactory cortex) and limbic system
- lateral ventricles

Surfaces: superolateral, medial, and inferior surfaces

Margins: superior, medial, and inferior margins

Lobes: frontal, parietal, occipital, temporal lobes, and insula

Poles: frontal, occipital, and temporal poles

Cerebral cortex

– *grey matter*, the youngest part of CNS

Gyri and sulci of cerebral cortex:

Superolateral surface of telencephalon

- central sulcus
- lateral sulcus

Frontal lobe

- precentral gyrus
precentral sulcus
- superior frontal gyrus
superior frontal sulcus
- middle frontal gyrus
inferior frontal sulcus
- inferior frontal gyrus

Parietal lobe

- postcentral gyrus
postcentral sulcus
- superior parietal lobule
intraparietal sulcus
- inferior parietal lobule

Occipital lobe

- occipital gyri and sulci

Temporal lobe

- superior temporal gyrus – transverse temporal gyri
superior temporal sulcus
- middle temporal gyrus
inferior temporal sulcus
- inferior temporal gyrus

Insula – is separated lobe of telencephalon located in depth of lateral sulcus

Medial surface of telencephalon

- medial frontal gyrus
- paracentral lobule
- precuneus
parietooccipital sulcus
- cuneus
- calcarine sulcus
- cingulate sulcus
- cingulate gyrus
sulcus of corpus callosum
corpus callosum – rostrum, genu, trunk (body), splenium
- septum pellucidum (between corpus callosum and fornix)
- fornix – column, body, and crus of fornix
- paraterminal gyrus
- subcallosal area

Inferior surface of telencephalon

- straight gyrus
olfactory sulcus – olfactory bulb – olfactory tract – medial and lateral olfactory striae
olfactory trigone – anterior perforated substance
- optic n. (CN II) – optic chiasma – optic tract
- orbital gyri – orbital sulci

- hippocampal sulcus
- parahippocampal gyrus – lingual gyrus
- collateral sulcus
- medial occipitotemporal gyrus
- occipitotemporal sulcus
- lateral occipitotemporal gyrus

Functional cortical areas – grey matter

- Brodmann's cytoarchitectonic map (1907)
- motor and sensory Homunculus
 - motor areas – in frontal lobe
 - sensory areas – in parietal, occipital, and temporal lobes

Cerebral cortex is responsible for thinking and conscious awareness.

Cortical areas

- primary: exact function, somatotopic organisation
- secondary: close to primary areas, less detail organisation, gnostic function
- association (tertiary): close to secondary, analysis and synthesis of information individual consciousness and personality
- primary motor area is located in precentral gyrus
- premotor (secondary) area is located in front of precentral gyrus
- Broca's speech centre is in tertiary (association) motor cortex in inferior frontal gyrus
- primary sensory area is located in postcentral gyrus
- primary cortical centre of vision is located in occipital lobe around calcarine sulcus
- primary cortical centre of hearing is located in transverse temporal gyri
- primary olfactory cortex is located in parahippocampal gyrus
- Wernicke's speech area is in tertiary (association) cortex in superior temporal gyrus posteriorly

Dominance of hemisphere

- left hemisphere – analytic thinking, logic, mathematic, languages, science
 - for right-handers and 1/2 of left-handers
- right hemisphere – holistic thinking, intuition, creativity, music, art
 - for 1/2 of left-handers

Medullary body

- *white matter*, myelinated nerve fibers, have origin or/and termination in cerebral cortex
 - **internal capsule** – between basal ganglia and thalamus
 - **corpus callosum** is the largest commissural tract, connects both hemispheres
 - spatially as
 - **forceps minor** (from genu of corpus callosum) – anteriorly
 - **forceps major** (from splenium of corpus callosum) – posteriorly
 - in median section:
 - rostrum, genu, trunk (body), splenium

Basal ganglia

- masses of *grey matter*, initiation and control of voluntary movements
- inhibition of involuntary activity, revision of information from primary motor cortex
 - **caudate ncl.**
 - lentiform ncl. = **globus pallidus + putamen**
 - **claustrum**
 - **amygdaloid body** (amygdala)

Bundles of *white matter* separate basal ggl.:

- **internal capsule** – V shaped in horizontal section: anterior limb, genu and posterior limb
anterior limb: between caudate ncl. and lentiform ncl.
posterior limb: between thalamus and lentiform ncl.
- **external capsule** – between putamen and claustrum
- **extreme capsule** – between claustrum and cortex of insula

Rhinencephalon

= olfactory system, important connection with limbic system (hippocampus)

– is only sensory system connecting cerebral cortex without interpolation in thalamus!

olfactory bulb – olfactory tract – medial and lateral olfactory striae – olfactory trigone –
anterior perforated substance – parahippocampal gyrus

Medial olfactory stria runs to septum; to contralateral olfactory tract through anterior commissure.
Lateral olfactory stria is directed to amygdala, olfactory cortex and orbitofrontal cortex.

Limbic system

- functional system of cortical and subcortical neurons
- not only parts of telencephalon, but also parts of diencephalon and mesencephalon
- connections with hypothalamus, expresses by ANS (redness, pallor, sweaty hands, dry mouth)

Limbic lobe: septum – cingulate gyrus – parahippocampal gyrus – amygdala

- border (limbus) between cortical areas and subcortical nuclei
- between mind and consciousness on the one hand and instincts and unconscious on other hand

Main functions of limbic system:

- somatic: food, sex
- autonomic: digestion, heart beating, blood pressure
- sensitive: emotions, behaviour, learning, memory

To limbic system belong parts of:

telencephalon:

cortical areas: hippocampal formation, septum, olfactory cortex

limbic association cortex: orbitofrontal cortex, cingulate and parahippocampal gyri

subcortical: amygdala, basal ggl.

diencephalon: thalamus – anterior ncl., mediodorsal ncl. (associating ncl., personality)

hypothalamus – mammillary body

epithalamus – habenular ncl. (connection with olfactory system)

mesencephalon: reticular formation

Hippocampus – learning, memory

pes hippocampi, hippocampal digitations

Septum verum (septum) – positive emotions, pleasure, releases serotonin (like drugs, sex)

Septal area: paraterminal gyrus + subcallosal area

Amygdala (amygdaloid body) – negative emotions

- is located in anterior part of temporal lobe in parahippocampal gyrus
- negative emotions: aggression, anger, anxiety, fear
- unconscious memory from early childhood when hippocampus is still immature

Papez circuit

basic connections of limbic system, starts and ends in hippocampus

- hippocampus
- fornix
- mammillary body
- anterior ncl. of thalamus
- cingulate gyrus
- hippocampus

Fornix is biggest efferent pathway of hippocampus, connects it with mammillary body and septum.
Stria terminalis is efferent pathway of amygdala, connects amygdala with septum and hypothalamus.

VESSELS AND DURAL SINUSES

Vessels of spinal cord

Arteries:

spinal brr. from surrounding arteries (as vertebral a.) – through intervertebral foramens to vertebral canal, give off anterior et posterior radicular aa.:

anterior spinal a. (in anterior median fissure) – for anterior 2/3 of spinal cord, for *grey matter*

posterior spinal aa. (in posterolateral sulci) – for posterior 1/3 of spinal cord, for *white matter*

Veins:

spinal vv. – internal vertebral venous plexuses in epidural space open to
external vertebral venous plexuses – open to surrounding veins

Arteries of brain

Brain is supplied by branches from vertebral a. and internal carotid a., which create arterial circle of Willis

vertebral aa. – from both vertebral aa. is formed one basilar a.

basilar a. supplies *brain stem* and *cerebellum* and divides in two terminal branches:

posterior cerebral aa. – posterior communicating aa.

internal carotid a. divides in terminal branches:

- anterior cerebral a. – anterior communicating a.
- middle cerebral a.

From arterial circle of Willis exit:

cerebral aa. – for *cerebral cortex*

- **posterior cerebral a.** – supplies mostly inferior surface of hemisphere and *pons*
- **middle cerebral a.** – supplies mostly superolateral surface of hemisphere
- **anterior cerebral a.** – supplies mostly medial surface of hemisphere

central aa. – for *deep structures of midbrain, diencephalon, and telencephalon*

anterior communicating a. (one): connects two anterior cerebral aa.

posterior communicating a. (two): between posterior and middle cerebral a.
or between posterior cerebral a. and internal carotid a.

Function of cerebral arterial circle of Willis:

- provides multiple paths for blood to supply brain if any of arteries are constricted

Veins of brain

– have no valves

Superficial vv. – in subarachnoid space, drain cerebral cortex connected by superior and inferior anastomotic vv.

- superior cerebral vv.
- middle cerebral vv.
- inferior cerebral vv.

Deep cerebral vv. – drain deep structures of brain

- **internal cerebral vv.** – 2 internal cerebral vv. form great cerebral v.
- **basal v.** – drains brain stem, opens to great cerebral v.
- **great cerebral v.** – below splenium of corpus callosum, opens to straight sinus

Dural sinuses

– between two layers of dura matter, open to internal jugular v., impressions in skull

Confluence of sinuses – junction of sinuses:

- **superior sagittal** sinus (unpaired) from above – begins in foramen cecum
- **straight** sinus (unpaired) – from **inferior sagittal** sinus, the shortest sinus
- **occipital** sinus (unpaired) – from below
- **transverse** sinus (paired) – laterally

Internal jugular v. originates in jugular foramen from **sigmoid** sinus.

Cavernous sinus (unpaired) – around sella turcica, is clinically important due to spreading infections from face and teeth.

VENTRICULAR SYSTEM

– is filled by cerebrospinal fluid made by choroid plexus (produced by pia matter)

Central canal

– *cranially* opens into 4th ventricle, *caudally* expands into terminal ventricle

4th ventricle

– unpaired ventricle in rhombencephalon, surrounded by medulla oblongata, pons and cerebellum
cranially: continuation to cerebral aqueduct, *caudally*: continuation to central canal

borders:

- floor: rhomboid fossa (posterior parts of medulla oblongata and pons)
- roof: superior medullary velum – between superior cerebellar peduncles
cerebellum – **fastigium** (highest point in roof of 4th ventricle)
inferior medullary velum – between inferior cerebellar peduncles
lower part of roof contains choroid plexus of 4th ventricle
- lateral recesses of 4th ventricle extend to lateral apertures of 4th ventricle (paired)

In lower part of roof of 4th ventricle:

- median aperture (unpaired) opens into subarachnoid space to cisterna magna
- lateral aperture (paired) open to subarachnoid space in pontocerebellar angle

Cerebral aqueduct

– unpaired, runs through midbrain, connects 4th and 3rd ventricles, contains cerebrospinal fluid

3rd ventricle

– unpaired ventricle located in diencephalon and partially in telencephalon

– is in direct connection with 4th ventricle through cerebral aqueduct

– is in direct connection with lateral ventricles through interventricular foramina

borders:

- roof: choroid tela and choroid plexus of 3rd ventricle
- anteriorly: lamina terminalis, anterior commissure
- floor: hypothalamus – optic chiasma, infundibulum, mammillary bodies
- posteriorly: epithalamus – posterior commissure, habenular commissure
- laterally: hypothalamus and medial surface of thalamus – medullary stria, interthalamic mass, hypothalamic sulcus, interventricular foramen, column of fornix

Interventricular foramen

– paired, connects 3rd and lateral ventricles

Lateral ventricle

– paired, in both hemispheres, in 4 lobes of telencephalon, *parts:*

- anterior (frontal) horn
- central part (in parietal lobe)
- posterior (occipital) horn
- inferior (temporal) horn – in bottom of inferior horn lies hippocampus

lateral ventricles are separated each other by **septum pellucidum**

COVERINGS OF CNS

Brain

Dura matter

– tough fibrous membrane, toughly adherent to skull

– forms duplicatures in skull cavity:

- **falx cerebri** – between two cerebral hemispheres
- **falx cerebelli** – between two cerebellar hemispheres
- **tentorium cerebelli** – between cerebellum and occipital lobe
- **sellar diaphragma** – covers sella turcica, separates hypothalamus and hypophysis, has opening only for stalk of hypophysis (infundibulum)

Arachnoid matter

– soft translucent membrane, has no vessels no nerves, covers surface of brain except of sulci

arachnoid granulations – protrude to dural sinuses for absorption of cerebrospinal fluid

subarachnoid space – between arachnoid and pia matters, filled by cerebrospinal fluid and vessels

subarachnoid (cerebral) cisterns – extension of subarachnoid space, filled by cerebrospinal fluid
the biggest is cisterna magna

Pia matter

– thin, highly vascular membrane closely adherent to brain surface,

– follows brain surface, gyri, and sulci,

– creates **choroid plexus** (in all ventricles produces cerebrospinal fluid)

Coverings and spaces of spinal cord

epidural space: contains fatty tissue, internal vertebral venous plexuses

- **dura matter** – dural sac
- **arachnoid matter**

subarachnoid space: contains cerebrospinal fluid

- **pia matter**

NERVE PATHWAYS

= nerve tracts, *white matter*, myelinated nerve fibers in brain and spinal cord

- **Association tracts:** connect various areas in same hemisphere, ipsilaterally
 - long intracortical fibers: connect lobes in one hemisphere
 - short subcortical fibers: between two neighbouring gyri, U-fibers
- **Commissural tracts:** connect same areas between two hemispheres, contralaterally
 - corpus callosum, anterior commissure, posterior commissure, habenular commissure, commissure of fornix
- **Projection tracts:** connect areas of various levels of CNS, brain cortex with other areas in CNS, cortical areas and subcortical areas, **run through internal capsule**

Ascending fibers = sensory = afferent = corticopetal = directed to upper centers

direct sensory tracts – conscious information

general sensory tracts: from skin and movement system

special sensory tracts: from specialised sensory organs

indirect sensory tracts – unconscious information

Descending fibers = motor = efferent = corticofugal = directed to lower centers

direct motor tracts – conscious motor activity of skeletal muscles

indirect motor tracts – phylogenetically old, unconscious movements

Ascending projection tracts

DIRECT SENSORY TRACTS: conscious information, run **through thalamus** (except olfactory tract)

General sensory tracts – from skin and locomotor system

system of 3 neurons:

1st neuron is inside of sensory ganglion of spinal or cranial nerve

2nd neuron crosses

3rd neuron terminates in sensory cerebral cortex

- superficial sensation = exteroception from skin:
 - epicritic (fine) sensation: fine touch, discriminative sensation, vibration
 - protopathic (crude) sensation: touch and pressure, pain and temperature
- deep sensation – proprioception: sensation from joints, tendons, and muscles

Direct sensory tracts from neck, trunk, and limbs – general sensation:

- **Dorsal column tract** = main sensory pathway
 - Spino-bulbo-thalamo-cortical tract – epicritic and proprioceptive sensation
- **Anterolateral system** = spinothalamic tracts, spinoreticular and spinotectal tracts
 - Anterior spinothalamic tract – protopathic sensation: touch and pressure,
 - Lateral spinothalamic tract – urgent pain and temperature
 - Spinoreticular tract – slow and diffuse pain
 - Spinotectal tract (has only 2 neurons) – spinovisual reflexes

Direct sensory tract from head – general sensation:

- **Trigeminothalamic tract** – orofacial epicritic and protopathic sensation
 - orofacial proprioception

Special sensory tracts

- Visual tract
- Acoustic (auditory) tract
- Vestibular tract
- Gustatory (taste) tract
- Olfactory tract

INDIRECT SENSORY TRACTS: unconscious information, system of 2 neurons

- coordination of movement, posture, and balance, **termination in cerebellum**
- Posterior spinocerebellar tract: information from lower half of body
- Cuneocerebellar tract: information from upper half of body

Descending projection tracts

DIRECT MOTOR TRACTS

- conscious motor activity of skeletal muscles

Motor tracts to muscles of neck, trunk, and limbs, to muscles of head

- **Corticospinal (pyramidal) tract** – the youngest pathway phylogenetically
upper motoneuron: in precentral gyrus of cerebral cortex
lower motoneuron: in anterior horn of spinal cord
 - **Lateral corticospinal tract:** 80% of fibers cross in pyramidal decussation, run in lateral funiculus of spinal cord to muscles of limbs
 - **Anterior corticospinal tract:** 20% of fibers cross in anterior commissure of spinal cord run in anterior funiculus of spinal cord to muscles of trunk

Motor tract muscles of head

- **Corticobulbar (corticobulbar) tract** – facial expression, chewing, speech
upper motoneuron: in cerebral cortex; *lower motoneuron:* in nuclei of cranial nerves
lower motoneuron: in motor nuclei of cranial nerves

INDIRECT MOTOR TRACTS

- extrapyramidal tracts, old pathways phylogenetically, unconscious motor activity

more upper motoneurons: ncl. ruber, substantia nigra, reticular formation, vestibular ncl., tectum;

one lower motoneuron: in motor nuclei of anterior horn of spinal cord
in motor nuclei of some cranial nerves

- **basal ganglia** modifying system – receives information from sensory cerebral cortex, modulates unconscious motor activity from cerebral cortex, involuntary reflexes
- **cerebellum** controlling system – coordinates postural, supporting, and locomotor mechanism

Rubrospinal tract – controls flexors

Vestibulospinal tract – controls extensors, supports posture
maintains balance of body and head

Reticulospinal tract – influences reflex activity and muscle tone

Tectospinal tract – movement of head and neck to visual and auditory stimuli