CNS anatomy summary

Sensory and motor tracts

SENSORY TRACTS

Tract	Receptors	Modality	Route	Decussation	Termination
Post. column - medial lemniscus	Most receptors except free nerve endings	1.Fine touch and pressure 2. Conscious proprioception	**1.** 1st order neurons enter the spinal cord and ascend **ipsilaterally** as fasciculus gracilis [medial] and cuneatus [lateral] in the posterior white column **2.** They synapse with 2nd order neurons in the lower part of medulla oblongata in nucleus gracilis and cuneatus. **3.** The fibres crossover creating an arch [internal arcuate fibres] the ascend close to the midline forming medial lemniscus. **4.** They reach the thalamus and synapse with 3rd order neurons in VPL **5.** 3rd order neurons pass through internal capsule -> corona radiata -> cortex [somatosensory area S1, postcentral gyrus 312]	In the lower part of medulla oblongata - primary sensory decussation	primary somatosensory area S1
Lateral spinothalamic tract	Free nerve endings	Pain and temperature	**1.** 1st order neurons enter the spinal cord -> dorsal grey horn -> lamina 1,2 [substantia gelatinosa] and synapse there with the nuclei of 2nd order neurons **2.** 2nd order neurons crossover anterior to the central canal and ascend **contralaterally** in the anterolateral white column **3.** They reach the thalamus and synapse with 3rd order neurons in VPL **4.** 3rd order neurons -> internal capsule -> corona radiata -> S1	In the spinal cord	primary somatosensory area S1 or widespread cortical region [next page]
Anterior spinothalamic tract	Free nerve endings	crude touch and pressure	1. 1st order neurons enter the spinal cord -> dorsal grey horn -> lamina 3,4, and synapse with 2nd order neurons 2. 2nd order neurons crossover anterior to the central canal amd ascend **contralaterally** in the anterolateral white column 3. They reach the thalamus and synapse with 3rd order neurons in VPL 4. 3rd order neurons -> internal capsule -> corona radiata -> S1	In the spinal cord	primary somatosensory area S1
Spinotectal tract [spinovisual reflexes]		Spinovisual reflexes	1.1 1st order neurons enter the spinal cord and synapse with 2nd order neurons 2. 2nd order neurons crossover and ascend **contralaterally** in the anterolateral white column	At tbe level of spinal cord	Superior colliculus (vision)
Posterior spinocerebellar	Most receptors except free nerve endings	muscle and joint sensations [unconscious proprioception]	1. 1st order neurons enter the spinal cord -> base of the dorsal grey horn [lamina 7 - nucleus dorsalis / Clark's nucleus] and synapse with 2nd order neurons 2. 2nd order neurons ascend in the posterolateral part of the *lateral* white column **ipsilaterally** until they reach inferior cerebellar peduncle	NO DECUSSATION	inferior cerebellar peduncle in the cerebellar cortex
Anterior spinocerebellar	Most receptors except free nerve ending	muscle and joint sensations [unconscious proprioception]	1. 1st order neurons enter the spinal cord -> base of the dorsal grey horn [lamina 7 - nucleus dorsalis / Clark's nucleus] and synapse with 2nd order neurons 2. 2nd order neurons -> *majority* ->crossover to the other side but	Majority -> crossover in the spinal cord and cross back in the cerebellum Minority -> no crossing	superior cerebellar peduncle in the cerebellar cortex

			cross back in the cerebellum, *minority* -> ascend **ipsilaterally**		

Pain

Fast pain	Slow pain
Aδ fibres , few synapses	C fibres , many synapses
sharp, pricking, acute, electric and short-lived	dull, difficult to describe, chronic, and worsens with time
well-localised	poorly-localised [too many synapses]
Laminae 1,5	Laminae 1,2
less emotional	emotional and autonomic responses
spinothalamic [VPL]	spinoreticular [VPL & intraluminal nucleus]

- Pain fibres terminate in " Widespread cortical region"
  1. Reticular formations [in the core of the brain stem] -> awareness of the pain
  2. Cingulate gyrus -> emotional aspect of pain
  3. Insular gyrus -> autonomic response
- Pain according to origin
  1. Cutaneous -> from the skin
  2. Deep somatic / Intermittent claudication -> muscle pain during exercise, common in diabetics
  3. Visceral pain -> from internal organs
- Referred pain -> pain from an internal organ felt elsewhere [on the skin].
  - Convergence theory: pain fibres from the skin [to postcentral gyrus] and autonomic from internal organs [to insular gyrus] synapse with the same 2nd order neurons, so the brain gets confused o.O about the origin of the pain and sends signals to the skin instead.
- Pain control ->
  1. Gating theory: activation of the larger, mechanical Aβ fibres [touch or pressure] inhibits the transmission of pain signals.
  2. Descending control [VIP]: spinoreticular fibres stimulate periaqueductal grey matter in midbrain which in turn send fibres to nucleus Raphe magnus.NRM fibres produce serotonin which stimulates fibres that secret enkephalins and endorphins in substantia gelatinosa [lamina 1,2] and inhibit or reduce the secretion of substance P.

NOTES

1. Sensory areas in the cortex - postcentral gyrus [31a] -> 3a: muscle spindle afferents, 3b&1: cutaneous afferents, 2: golgi tendon organs and joints
2. Lateral inhibition -> if a stimulus activates more than one receptor, the receptor activated the most inhibits the transmission from the other less activated receptors
3. **Spinal** lemniscus -> anterior and lateral spinothalamic tracts & spinotectal tract.

4. Receptive field -> an area of the skin that receives sensation from a single nerve fibre. The greater the density of receptors, the smaller the receptive field [e.g. the hand] and vice versa.
5. Labelled line theory -> one fibre carries information from **one** type of receptors.

MOTOR TRACTS

Tract	Route	Decussation	Function	Notes
PYRAMIDAL TRACTS				
Anterior corticospinal tract	1. Corona radiata -> internal capsule -> brainstem [middle ⅗ of **crus cerebri** [*basis pedunculi*] -> pons 2. Fibres scatter between the pontine nuclei and then descend to the medulla oblongata where they recollect again forming the **pyramid**. 3. In the lower part of the medulla -> majority crossover [LATERAL corticospinal] and minority descend ipsilaterally [ANTERIOR corticospinal] and crossover in the spinal cord.	In the spinal cord	They cross to the **medial part of the anterior horn** and supply medial [axial] muscles	
Lateral corticospinal tract		In the lower part of medulla oblongata	Descend in the lateral funiculus to the **lateral part of the anterior horn** and supply the lateral muscles	Fibres synapse with alpha and gamma motor neurons Most fibres end up in the cervical region
Corticonuclear tract [corticobulbar]	Fibres descend from the lower ¼ of the cortex to a motor nucleus [functions as the anterior horn] and synapse.	**BILATERAL** !! Each nerve on each side receives fibres from **both sides**. *Exceptions -> the part of the facial nerve [7th] that supplies lower facial muscles, anf the part of the hypoglossal [12th] that supplies genioglossus muscle*.	Muscles of the head and neck	They are considered pyramidal tracts ***functionally***.
EXTRAPYRAMIDAL TRACTS				
Rubrospinal tract	Fibres arise deep in the cerebellum [*globose-emboliform-rubral pathway*] Descend from red nucleus -> spinal cord in the **LATERAL** white column	Early crossover, at the level of the nucleus*	Facilitates activity of flexors [skilled muscles] and inhibit activity of extensors	Rubro - red Synapse with alpha and gamma interneurons
Reticulospinal tract	In the Pons: Pontine reticulospinal tract -> descend in the **ANTERIOR** white column	Do NOT crossover	activate axial and proximal limb extensors -> stand upright	Tonically active fibres -> constantly firing but they under inhibition by the cortex - Decortication -> removes the inhibitory effects

	In the Medulla Oblongata -> Medullary reticulospinal tract -> descend in the **LATERAL** white column	Some fibres cross, some fibres do not	inhibit axial and proximal limb extensors	NOT tonically active Normally under stimulation
Vestibulospinal tract	Fibres descend from vestibular nuclei in the brainstem[pons and MO] and descend in the **ANTERIOR** white column	Do NOT cross	Facilitate the activity of extensor muscles and inhibit the activity of flexor muscles [similar to pontine reticulospinal]	receive afferent fibres from: 1. inner ear [vestibule] -> balance 2. deep cerebellar nucleus [fastigil] -> position and gravity
Tectospinal tract	Fibres descend in the **ANTERIOR** white column close to the anterior median fissure and the majority of the fibres terminate in the anterior grey horn in the upper cervical segments of the spinal cord [head and neck]	Mainly cross	Reflex movement of the head & neck in response to visual [special sensory] stimulus	Tectum -> the posterior aspect of midbrain

NOTES

- 3% of upper motor neurons synapse *directly* with lower motor neurons [no interneurons], they originate from **Giant cells of Betz** and are responsible for **very fine** movement.
- Lateral motor system -> lateral corticospinal tract + rubrospinal tract

* The nuclei in the cerebellum -> Dentate, Emboliform, Globose & Fastigial -> Don't Eat Greasy Food