Lecture 13 - Anatomical Substrates for Somatic Sensation -- Martin

Objective

Learn organization of spinal systems for discriminative mechanosensations (touch, limb position sense), pain, and thermal sensations

1. General organization of dorsal column-medial lemniscal (DCML) and anterolateral systems (ALS)

DCML-single anatomical path

Components of anterolateral system:
- Spinothalamic tract
- Spinoreticular tract
- Spinomesencephalic (or tectal) tract

2. Peripheral somatic sensory receptors

Dorsal root ganglion neuron
Receptive field organization
Mechanoreceptors
Nociceptors

3. Peripheral nerves: axonal diameters and action potential conduction velocities

Fiber density spectrum
- A-α, A-β, A-δ, C

4. Dermatomes and dermatomal overlap

5. Central projections of primary afferent fibers

- Large diameter fibers—deep dorsal horn, intermediate zone, ventral horn; ascending projection to medulla
- Small diameter fibers—predominantly superficial dorsal horn

Relevant reading: chapter 22 in "Principles" and chapter 5 in "Neuroanatomy"

6. Overview of ascending systems:

System	Modality	Submodal	Receptor	Myelin	Diameter	AP cond	Fiber type
DC-ML							
	Touch	superficial	Merkel, Meissner	++	Large	Fast	II Aβ
		deep pres.	Ruffini	++	Large	Fast	II A β
		vibration	Pacinian	++	Large	Fast	II Aβ
	Position sense	static & dynamic	Spindle	+++	Very large	Very fast	II Aα, β
Anterolat. system							
	Pain	sharp, pricking	Bare	+/0	Med, small	slow, very slow	III, IV A δ, C
		dull, burning	Bare	+/0	Med, small	slow, very slow	III, IV Aδ δ, C
	Thermal	cold	Bare	+/0	Med, small	slow, very slow	III, IV A δ, C
		warmth	Bare	+/0	Med, small	slow, very slow	III, IV A δ, C

(Crude touch: not a modality; clinically tested residual form of touch after DC-ML damage)

7. Somatotopic organization of ascending pathways in the spinal cord white matter

8. Dorsal column-medial lemniscal system

Organization of dorsal column-medial lemniscal pathway
- Locations of pathway neurons
- Level of decussation

• Ascending branch of dorsal root ganglion neuron
• Cuneate and gracile tracts & nuclei
• Ventral posterior nucleus
- VPL—back of head, limbs and trunk
- VPM—face, oral cavity

9. Primary somatic sensory cortex

• Cytoarchitectonic areas 1, 2, 3a, and 3b
• Intracortical projections: 3a/b➠1➠2➠posterior parietal lobe; motor cortex
• Input layer: 4
• Efferent projections of cortical layers:
    layers 2,3➠ipsilateral and contralateral cortex
    layer 4➠layers above and below 4
    layer 5➠brain stem, spinal cord, striatum
    layer 6➠ventral posterior nucleus

10. Anterolateral system—Pain, temperature, itch

•spinothalamic and spinomesencephalic: laminae 1, 5
•spinoreticular: more diffuse
•Diverse thalamo-cortical targets for different functions:
    -**Ventral posterior nucleus** (lateral and medial divisions; VPL, VPM). Projects to **postcentral gyrus**; may be more important in crude touch than pain
    -**Ventral medial posterior nucleus (VMPo)**. Projects to the **insular cortex**; may be the key relay for pain in humans; insular pain representation is more consistently activated in brain imaging studies when subjects receive painful stimuli
    -**Medial dorsal nucleus**. Projects to the **cingulate gyrus**; involved in the emotional aspects of pain
    -**Intralaminar nuclei**. Projects broadly to parietal and frontal lobes; involved in arousal