Motor
And
Somatosensory systems
Fundamentals

- white matter (myelinated tracts)
- Gray matter (cells and synapses)
- Dorsal root ganglion - cells for sensory input
- Ventral root has output (motor) axons
- Unit of behavior is reflex
- Sensory to brain
- Motor output comes from brain
- that is what this outline is about
Summary

• central sulcus
• post-central gyrus (somatosensory projection)
• pre-central gyrus (motor area)
• Many other aspects of
• "localization of function" for cerebral cortex
• auditory area, visual area, Broca's area (speech)
• cerebellum, an area devoted to motor coordination.
Somesthesia

- very compelling sense
- submodalities (qualities such as pain vs. hot),
- von Frey (around 1900) - punctate sensitivity
- Muller's (mid-1800's) "doctrine of specific nerve energies"
Modern view

- nerve type and adaptation
- central projection
- axon type A myelinated, C unmyelinated
- pathway [dorsal columns = lemniscal vs anterolateral = spinothalamic.]
Free nerve endings vs. encapsulated

- Free nerve endings for pain, temperature and crude touch
- Pacinian corpuscle - rapid adaptation
- Lowenstein - peel to show layers adaptation
- Very sensitive, very large receptive field
- Vibration - 250 - 300 Hz
Vater-Pacini corpuscle  H&E  Med
C - peripheral capsule; L - surrounding lamellae; arrow - nerve containing core
Other receptors

- Meisner's corpuscles not as fast as Pacinian
- encapsulation is with Schwann cell layers
- most common receptors of fingers, palms and soles
- smaller receptive field
- "feeling" - active touch - would use fast as finger moves across textured surface
- Merkel's disks slow small receptive field
- light touch finger tips, lips and genitals
- static discrimination of shape
And finally

- Not in diagram
- Ruffini slow - large receptive field - sensitive to stretching in deep skin, ligaments and tendons
- Krauss in lips and genitals (dry vs mucous skin)
Hot and cold

- a person can feel a difference of 0.01°C
- relation to body temperature
- cold have additional peak at high temp - paradoxical cold - pins and needles
- cold related to menthol
- hot related to capsaicin
Nociceptors

- mediators of pain are in sting venoms
- tissue damage substances:
  - serotonin (platelets), prostaglandins, leukotrienes, histamine from mast cells, substance P, bradykinin from blood borne precursor
- enzyme from injury, receptor is chemoreceptor
- not in brain, surgery, local anesthesia
- mapping studies in humans by Penfield
Axons of third-order neurons

Cerebral cortex

Medial lemniscal tract (axons of second-order neurons)

Medulla oblongata

Fasciculus cuneatus (axons of first-order sensory neurons)

Joint stretch receptor (proprioceptor)

Spinal cord

Fasciculus gracilis (axons of first-order sensory neurons)

Touch receptor
Lemniscal system localized touch

- Lower limbs medial fasciculus gracilis.
- Upper limbs lateral fasciculus cuneatus.
- Ipsilateral projection
- First nucleus is in lower medulla
- Cross-over, medial lemniscus
- Next nucleus is in the thalamus.
more

• projection to the brain
• processing - lateral inhibition
• sharpen spatial localization
• If you tap your forearm, there are big waves but you feel localized touch.
spinothalamic for pain and temperature

- synapse and decussation at entry point.
- separate tracts in spinal cord.
- lateral portion is for pain and temperature.
- The ventral (anterior) part is for gross tactil.
- Hence the nomenclature "anterolateral."
- Touch can inhibit pain (a hard touch to a door knob makes an electric shock less annoying)
also

- half spinal cord injury:
- contralateral spinothalamic loss below injury
- ipsilateral loss of lemniscal
- Brown-Sequard syndrome include motor (ipsilateral impairment)
- referred pain for viscera is interesting:
- bladder stretch receptors - pain to genitals
- heart attack in neck and left arm
Pyramidal system corticospinal tract

- 75-90% crosses
- 10 to the 6th axons
- goes through pyramids on ventral medulla
- lateral and anterior pathways
- Initiation of voluntary motor movements
- output for face and upper body via facial nerve (and trigeminal, vagus, accessory, hypoglossal)
Basal ganglia (nuclei)

• huge parts of cortex feed basal ganglia
• (and cerebellum).
• Extrapyramidal (lies outside the pyramids)
• caudate + putamen = striatum
• (striated because strands of internal capsule make it look striated)
• putamen + globus pallidus = lentiform nucleus [lens shaped]
The globus pallidus is a relay nucleus for the caudate and putamen and so is the subthalamus.
To VA/VL complex of thalamus to motor cortex
Huntington’s

- (1872) disease (chorea) choreoathetosis
- Dominant late onset -
- many interesting genetic counseling issues.
- Folk singer Woodie Guthrie died of it
- family tree Venezuela near lake Maracaibo
- On post-mortem, degeneration of putamen and caudate is observed.
- It is on short arm of chromosome 4
• 1983 and since: cloning -
• CAG repeat (polyglutamine repeat),
• 15-34 (normal) -> 42-66 (Huntington's)
• Other trinucleotide repeat diseases: fragile X syndrome, myotonic dystrophy, and others
• sometimes they get worse from generation to generation (anticipation)
• Huntingtons is the opposite of Parkinsons
• circuit has thalamus increasing excitation to cortex.
Cerebellum

- Dysmetria (cannot approach target), ataxia, intentional tremor if cerebellar damage
- cerebellum highly developed in electric fish
- cerebellum is involved in rhythmic activity, practiced motor control, and plasticity
- An additional decussation makes it so that cerebellum controls the ipsilateral side of the body.