PHYSIOLOGY

SHEET NO. 3

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❖ Anterolateral system (SPINOTHALAMIC PATHWAY SYSTEM)

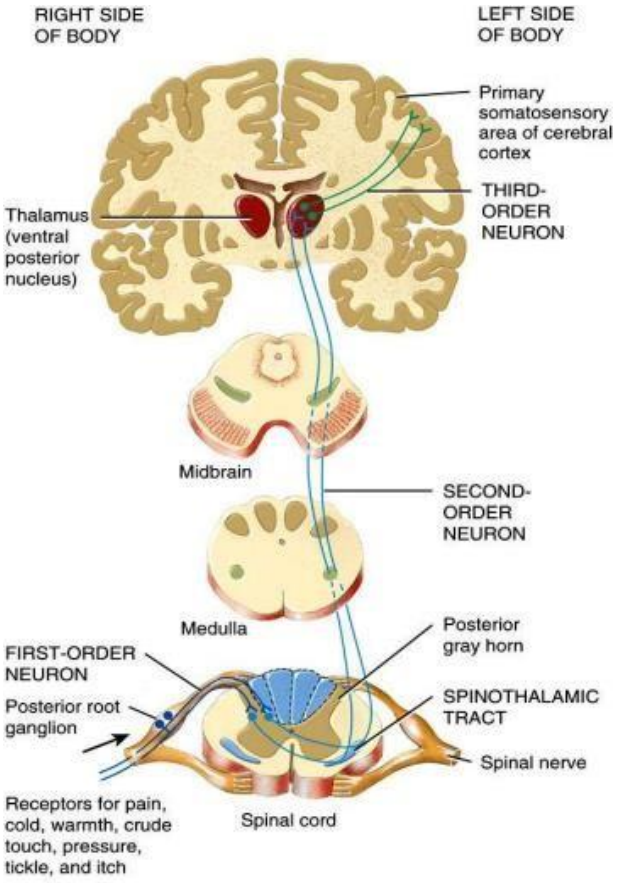
- ✓ This tract ascends in the anterior and lateral columns of spinal cord.
- ✓ Smaller myelinated and unmyelinated fibers for slow transmission (0.5-40 m/sec) (Aδ and C fibers).

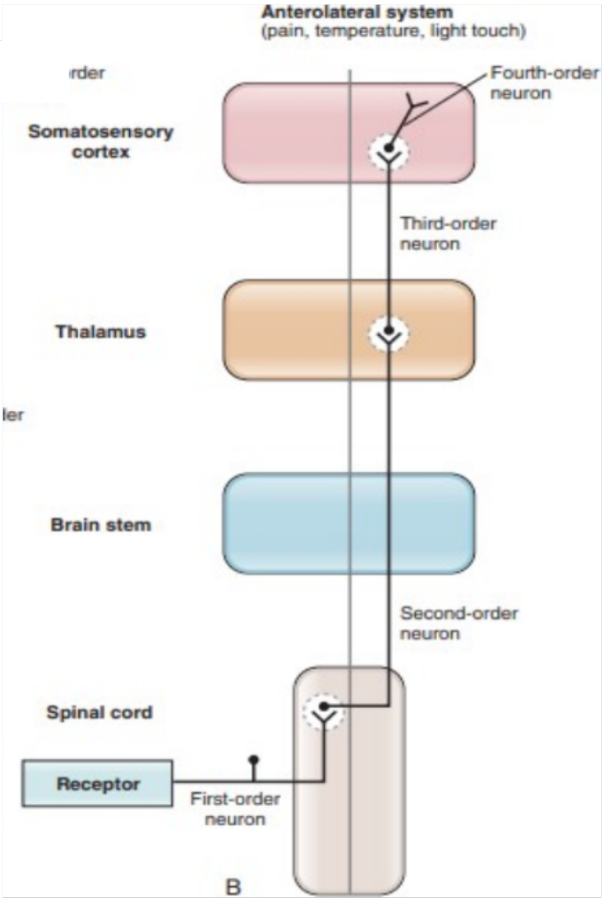
- ✓ Low degree of spatial and temporal orientation because of the slow conducting fibers and there is a lot of divergence.

- Transmits a broad spectrum of modalities; remember the dorsal column system transmits one kind of modalities which is mechanoreceptive sensations that depend on mechanical receptors, in the anterolateral system transmits different sensations and modalities.

- ✓ Modalities: Pain, thermal sensations, crude touch and pressure (poorly localized), tickle and itch, sexual sensations.

- ➢ Pain is very important sensation because it's protective in nature. If you feel pain it means that you can end the damage by stopping the damaging stimuli.





Pathway of anterolateral tract:

i. The afferent neurons (1st order neurons) enter the spinal cord to the posterior horn and their cell bodies located in the dorsal root ganglia.

ii. In the posterior horn the 1st order neuron synapses with 2nd order neuron, usually the 2nd order neuron goes one or two segments up or down then crosses (decussates) to the other side of spinal cord, the crossing occurs anterior to the central canal.

iii. The 2nd order neuron ascends either in anterior or lateral column of spinal cord to reach the ventrobasal part (VPL, VPM) of the thalamus. (for pain it goes to intralaminar nuclei).

iv. In the thalamus, the 2nd order neuron synapses with the 3rd order neuron, then the 3rd order neuron goes to postcentral gyrus (primary somatosensory area).

- So, this system conveys nerve impulses for crude touch (poorly localized), crude pressure, pain, cold, warmth, itch, and tickle (important for sexual sensations) from the limbs, trunk, neck, and posterior head to the postcentral gyrus of the cerebral cortex.

- **Note**: modality is the type of sensation.

Comparison between the two systems

1- Dorsal column is well localized, compared to anterolatetral.
2- Dorsal column has better temporal and spatial faithfulness (i.e speed of transmission 30-120 m/sec compared to 8-40 m/sec for the anterolatetral). Remember, the higher the speed of transmission the higher degree of spatial orientation.
3- Dorsal column has better intensity gradation (more than 100 compared to less than 20 for anterolateral)>> less differences between stimuli because it transmits the signal faster.
4- Repetitive stimuli only confine to dorsal column tracts because it transmits signals at a higher speed.
5- Modalities, anterolateral system transmits a broad spectrum modalities of sensation.
6- The crossing level; the 2nd order neuron in dorsal column system decussates at the level of brain stem (medulla oblongata) while in the anterolateral system decussates at the level of spinal cord.

Trigeminothalamic Pathway

- ✓ Special for sensations from the face area. It transmits all kinds of sensations [fine & crude].
- ✓ Conveys nerve impulses for most somatic sensations from the face, nasal cavity, oral cavity and teeth to the cerebral cortex.
- ✓ The afferent neuron goes to the nuclei of trigeminal nerve to synapse and then crosses to the other side and goes to the VPL in the thalamus and finally to the somatosensory cortex (post central gyrus).

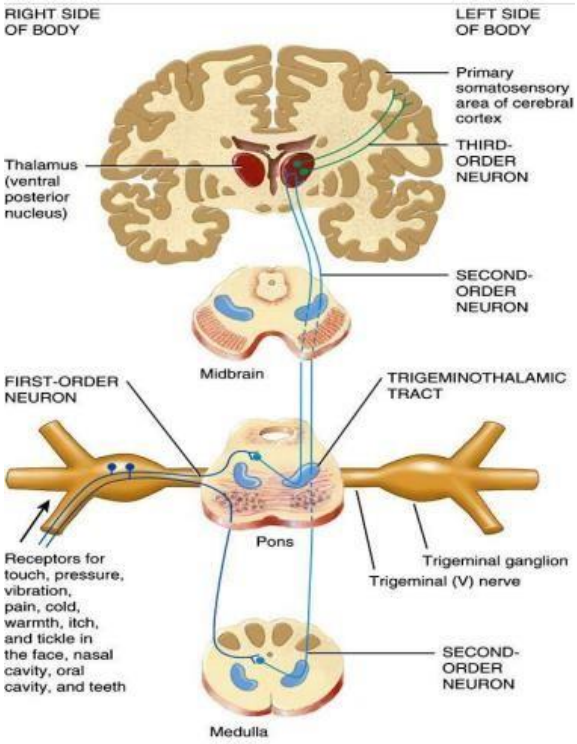


Figure 16.07 Tortora - PAP 12/e

➢ Why is it important to know the level of crossing?

- ✓ In dorsal column tract, If the damage/transection is below the level of medulla, the loss of sensation is ipsilateral (at the same side of damage).
- ✓ In anterolateral tract, If the damage is below the level of medulla, the loss of sensation is contralateral (at the opposite side of damage).
- ✓ If the damage is above the level of medulla, the loss of sensation is contralateral (at the opposite side of damage) in both systems.

Somatic Sensory Cortex

- Located in the postcentral gyrus.
- Highly organized distinct spatial orientation.
- Each side of the cortex receives information from the opposite side of the body .
- Unequal representation of the body.

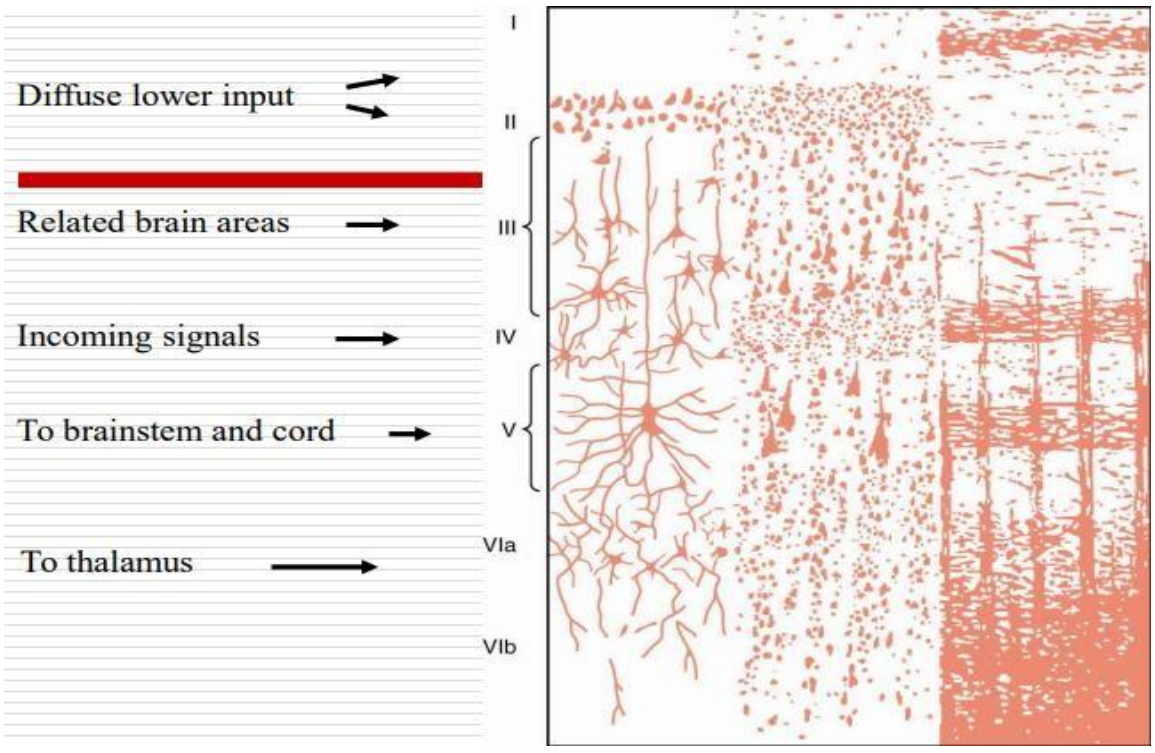
- lips have the greatest area of representation followed by the face and the thumb (large number of receptors).
- trunk and lower body have the least area (less number of receptors).

Cellular Organization of the Cortex

- Six separate layers of neurons with layer I near the surface of the cortex and layer VI deep within the cortex.
- Incoming signals enter layer IV and spread both up and down.
- Layers I and II receive diffuse input from lower brain centers.
- Layer II and III neurons send axons to closely related portion of the cortex presumably for communicating between similar areas.
- Layer V and VI send axons to more distant parts of the nervous system, layer V to the brainstem and spinal cord, layer VI to the thalamus.
- Within the layers, the neurons are also arranged in columns.
- Each column serves a specific sensory modality (i.e., stretch, pressure, touch).
- Different columns interspersed among each other.

- interaction of the columns occurs at different cortical levels which allows the beginning of the analysis of the meaning of the sensory signals.

Cellular Organization of the Cortex



Function of the Somatic Sensory Cortex

- Destruction of somatic area I results in:
  - ✓ Loss of discrete localization ability.
  - ✓ Inability to judge the degree of pressure.
  - ✓ Inability to determine the weight of an object.
  - ✓ Inability to determine the shape or form of objects, called Astereognosis.
  - ✓ Inability to judge texture.

Somatic Association Areas

- ✓ Located behind the somatic sensory cortex in the parietal area of the cortex.
- ✓ Association area receive input from somatic sensory cortex, ventrobasal nuclei of the thalamus (ventroposteriolateral-VPL-and ventroposteromedial-VPM-), visual and auditory cortex.
- ✓ Function is to decipher sensory meaning; it has a high level of interpretation by knowing where is this area compared to the other areas and forming 3D position of the sensation.
- ✓ Loss of these areas results in the inability to recognize complex objects and loss of self (Amorphosynthesis), the patient is unable to form the shape of the objects.

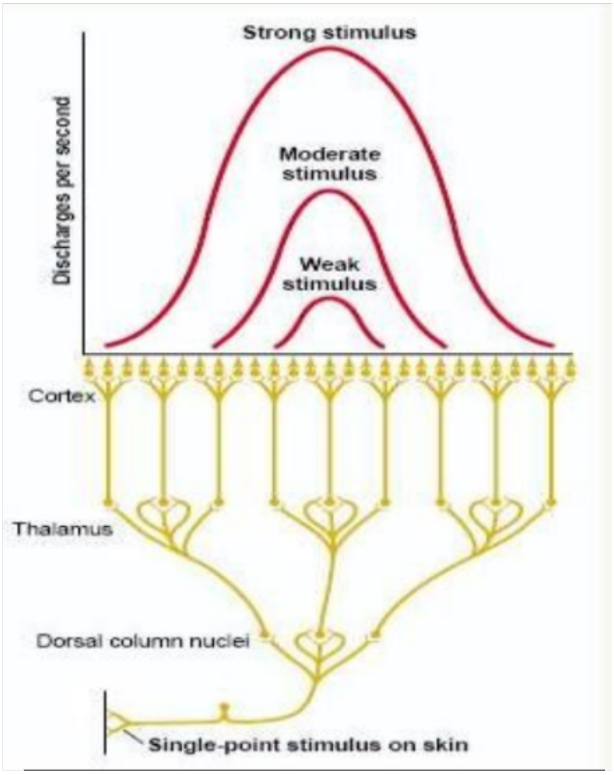
Special Aspects of Sensory Function

- ✓ Thalamus has some ability to discriminate tactile sensation because some of a neurons end in the thalamus.
- ✓ Thalamus has an important role in the perception of pain and temperature, so if there is a damage of postcentral gyrus still person can feel pain and temperature but very little regarding tactile sensations.
- ✓ Corticofugal fibers
  - Descending fibers from the cortex back to the sensory relay areas of thalamus, medulla and spinal cord.
  - These fibers are inhibitory, they can suppress the sensory input (negative feedback).
  - Function to decrease the spread of a signal and sharpen the degree of contrast and adjust the sensitivity of the system.

Coding for the intensity of the stimulus as percieved at the cerebral cortex.

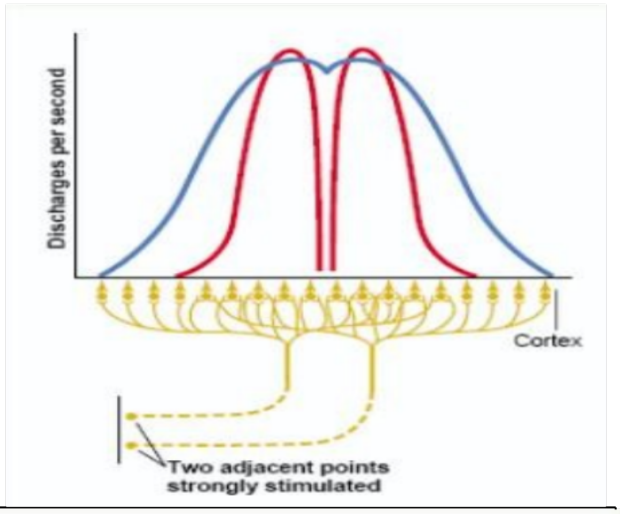
- If the stimulus is weak it's able to stimulate the central part of the cerebral cortex cells>> weak stimulus.
- If the stimulus is strong it's able to diverge to stimulate larger number of cortical cells>> moderate stimulus.
- If the stimulus is very strong it's able to stimulate a very high number of cortical cells>> strong stimulus.

❖ So, coding for intensity of the stimulus is percieved as number neurons that are stimulated and the number of impulses.



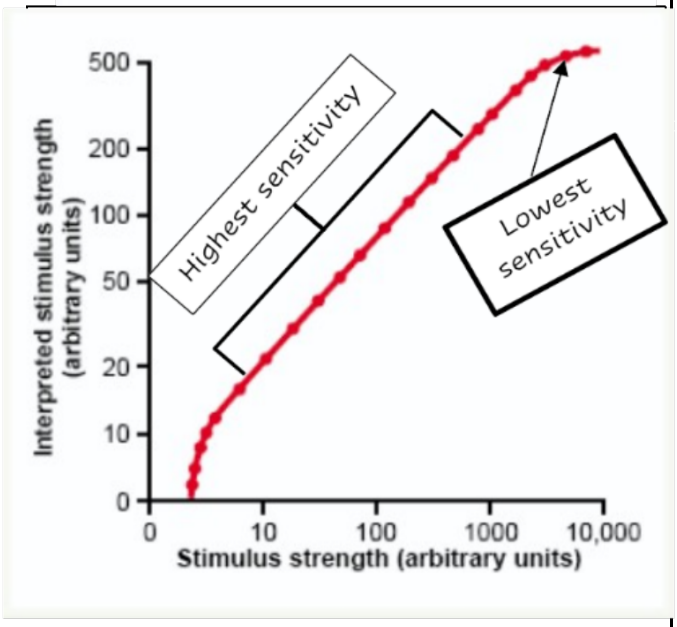
Processing of two-points discrimination at the cerebral cortex: the use of lateral inhibition.

- We have two stimuli and an inhibition between them so you feel the two stimuli as two peaks.



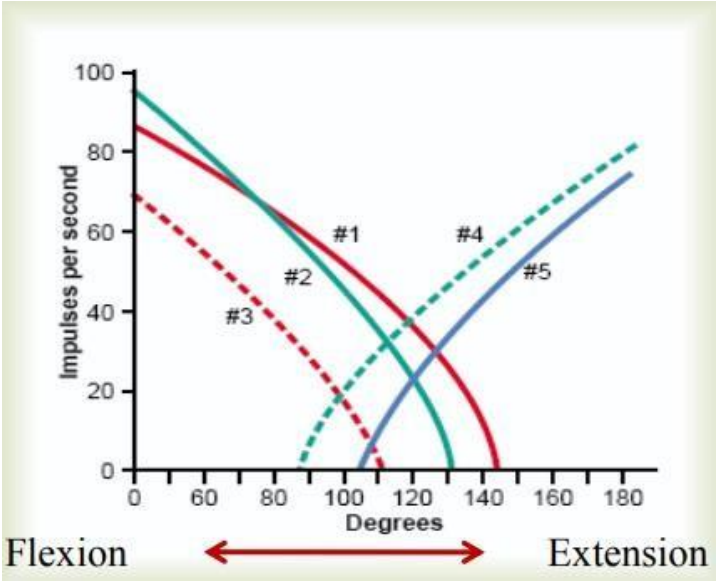
Graphical demonstration of the relation between actual stimulus strength and the interpreted stimulus strength (power law).

- a stronger stimulus is perceived as stronger, due to the higher number of impulses.
- The red curve represents the number of impulses.
- Note that the power law does not hold at either very weak or very strong stimulus strength.
- Note that the highest sensitivity area is in the middle.
- Corticofugal fibers brings down the stimulus from the plateau [low sensitivity area] to the high sensitivity are.



Processing of position sense

- When you're extending the limb (moving to higher degree of extension) the impulses of some neurons in the thalamus (1,2,3) decreases, on the other hand the impulses of neuron 4 and 5 increases >> the system knows this is an **extension**
- The opposite happens regarding to **flexion**.



- When you change the angle of the joint, some neurons transmit more impulses while other neurons transmit less impulses; this combination of the number of impulses in these neurons(maybe 100 neurons), your system will interpret it as **flexion** or **extension**.

Good luck