General physiology of receptors system. Somatic sensations: the Tactile and Position Senses, Pain, Headache and Thermal sensation.

Learning Objectives

- Specify the components of the afferent and efferent divisions of the nervous system, and explain what is meant by the somatic nervous system.
- Explain why receptors respond to specific stimuli and how the organization of a receptor affects its sensitivity.
- Identify the major sensory pathways.

Learning Objectives

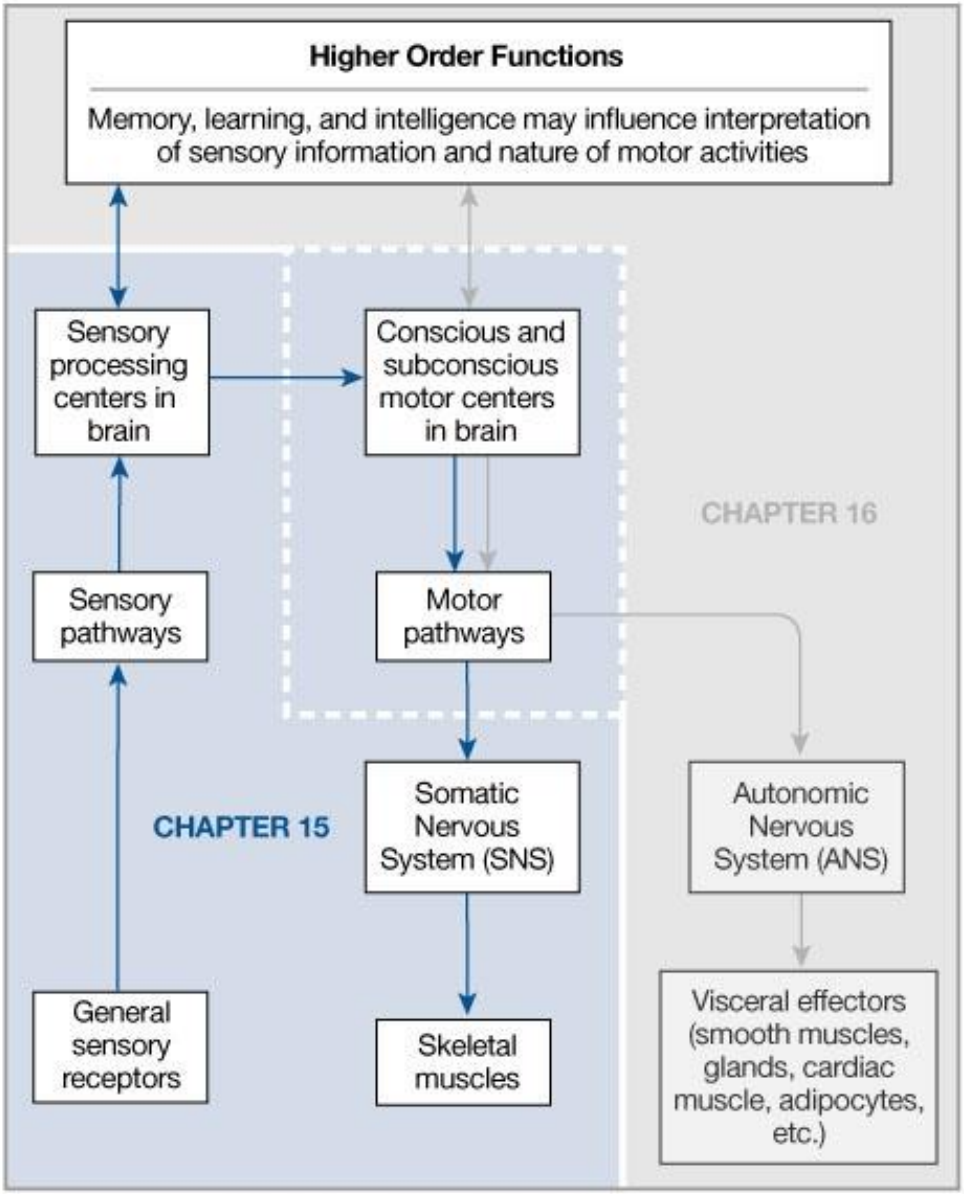
- Explain how we can distinguish among sensations that originate in different areas of the body.
- Describe the components, processes and functions of the somatic motor pathways.
- Describe the levels of information processing involved in motor control.

An Overview of Sensory Pathways and the Somatic Nervous System

Neural pathways

- Afferent pathways
  - Sensory information coming from the sensory receptors through peripheral nerves to the spinal cord and on to the brain
- Efferent pathways
  - Motor commands coming from the brain and spinal cord, through peripheral nerves to effecter organs

An Overview of Neural Integration



Sensory Receptors and their Classification

Sensory receptor

- Specialized cell or cell process that monitors specific conditions
- Arriving information is a sensation
- Awareness of a sensation is a perception

Senses

- General senses involve receptors that are relatively simple
  - Pain
  - Temperature
  - Physical distortion e.g. tissue damage
  - Chemical detection
    - Receptors for general senses scattered throughout the body
- Special senses
  - Located in specific sense organs e.g. light (optical),
  - Structurally complex

Sensory receptors

- Each receptor cell monitors a specific receptive field
- Receptor specificity is due to:
  - The structure of receptor cell
  - Characteristic of receptor membrane
  - The function and structure of accessory cells associated with receptor
  - The tissue that shields the receptor from stimuli
- The larger the receptor field the more dificult it would be to discriminate the exact point of stimuli

Sensory receptors

- Transduction
  - A large enough stimulus changes the receptor potential, reaching generator potential
- Transduction involves:
  - A stimulus alerting the permeability of a receptor membrane
  - Change in the transmembrane potential of receptor
  - The production of a generator potential
  - The generation of action potential that can be processed and interpreted by CNS
- CNS interprets information entirely on the basis of line over which sensory information arrives.

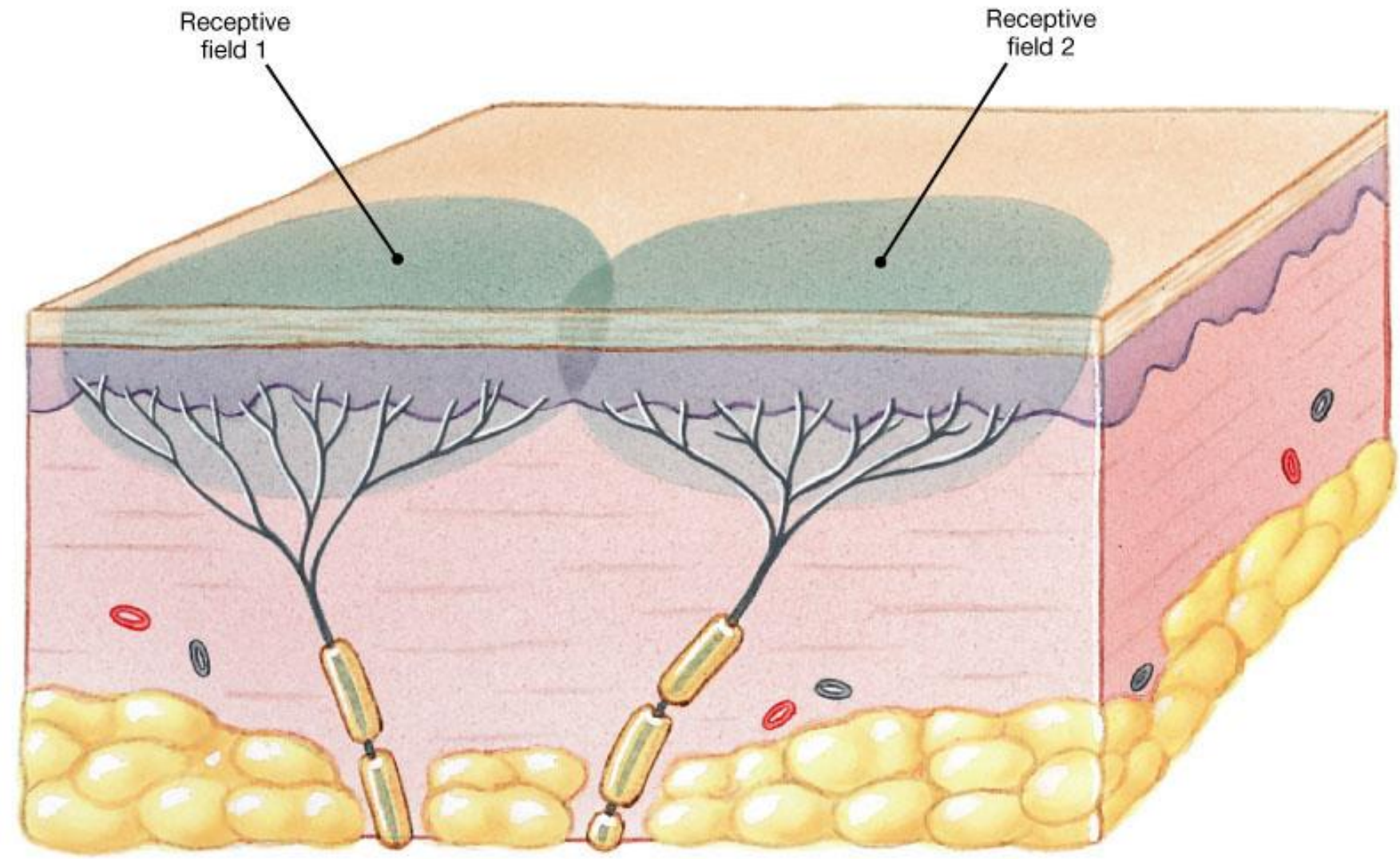
Receptors

- Adaptation
  - Reduction in sensitivity in the presence of a constant stimulus
  - Central adaptation refers to inhibition of nuclei located along a sensory pathway
- Our perception of our environment is incomplete because:
  - Humans do not have receptor for every possible stimuli
  - Transduction converts a real stimuli to neural impulse
  - Abnormal receptors can produce sensation that have no basis in fact.
  - Our receptors have varying ranges of sensitivity

The general senses

- Nociceptor usually have larger receptive field
- Three types of nociceptor
  - Provide information on pain as related to extremes of temperature
  - Provide information on pain as related to extremes of mechanical damage
  - Provide information on pain as related to extremes of dissolved chemicals
- Endorphins can inhibit impulses initiated by nociceptors

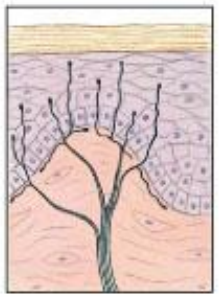
Receptors and Receptive Fields



Thermoceptors and mechaniceptors

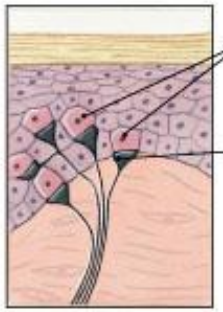
- Thermoceptors are scattered immediately beneath the surface of the skin
- Mechaniceptors
  - Sensitive to distortion of their membrane
    - Tactile receptors (six types)
      - Ruffini corpuscle - respond to deep pressure
      - Root hair plexus – monitors distortion and movements across the body surface.
    - Baroreceptors - monitors change in blood pressure
    - Proprioceptors (three groups) - monitors the position of joints.

Tactile Receptors in the Skin

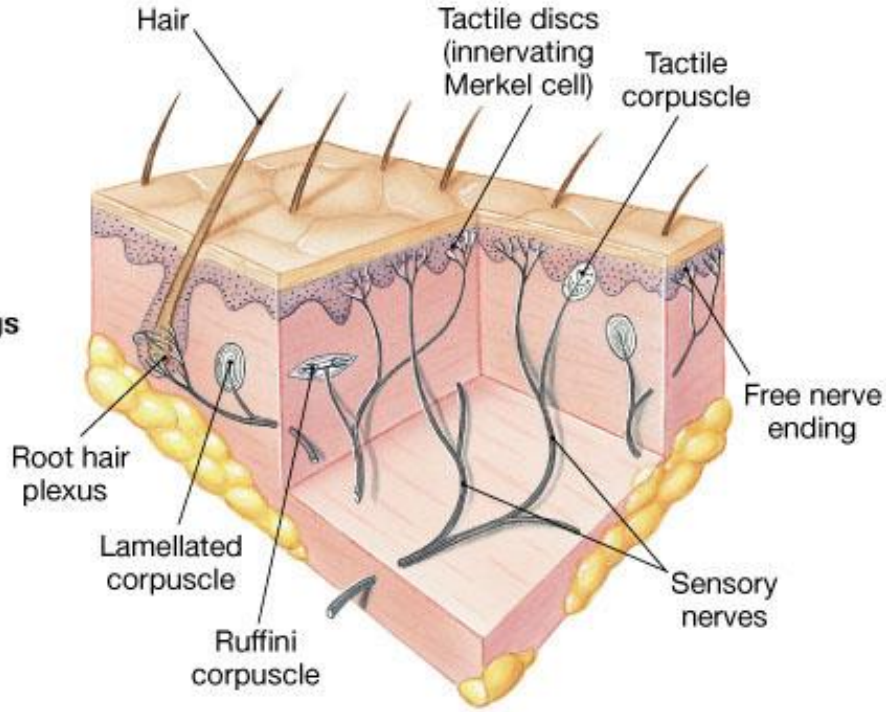


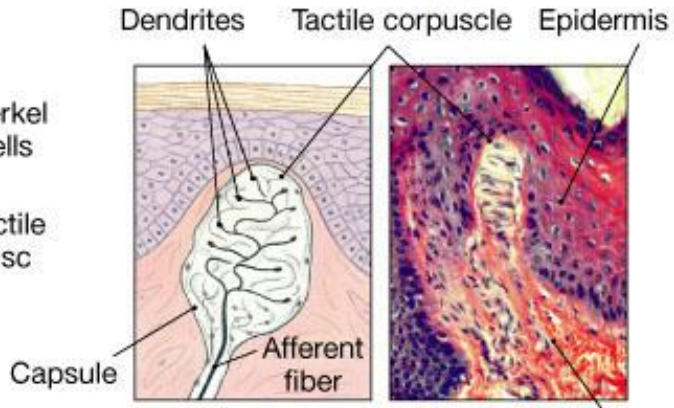
(a) Free nerve endings

(b) Root hair plexus

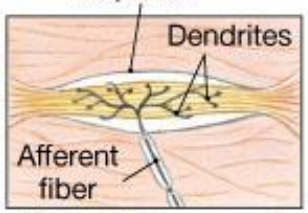


(c) Merkel cells and tactile discs

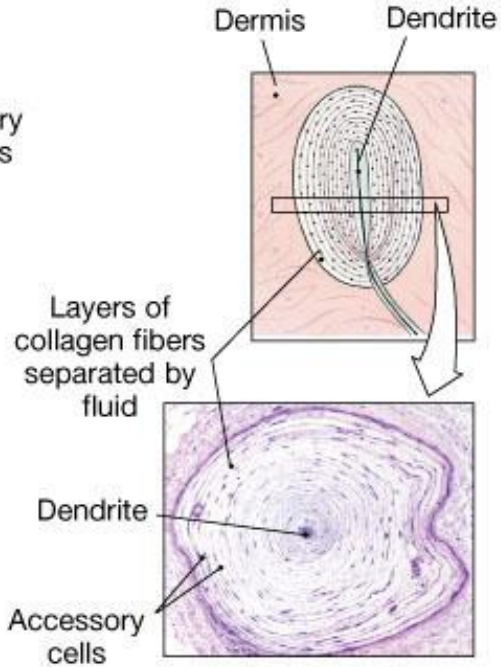




(d) Tactile corpuscle
LM × 330



(f) Ruffini corpuscle

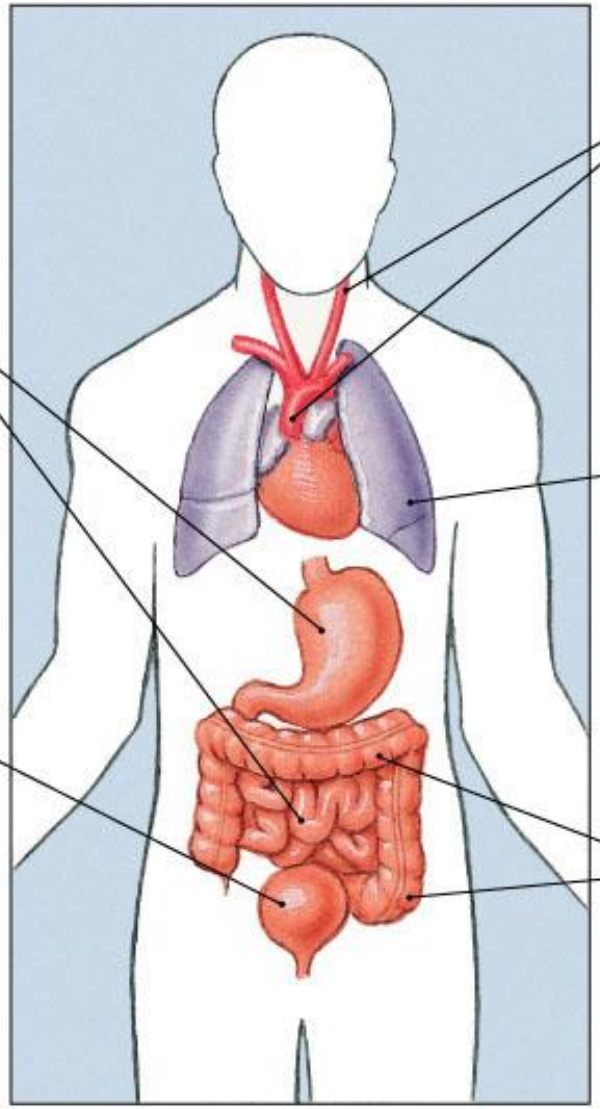


(e) Lamellated corpuscle
LM × 75

Chemoreceptors

- Chemoreceptors are located in
  - Carotid bodies
  - Aortic bodies
  - Special senses of taste and smell
  - Respiratory area of medulla

Baroreceptors and the Regulation of Visceral Function



BARORECEPTORS OF DIGESTIVE TRACT

Provide information on volume of tract segments, trigger reflex movement of materials along tract

BARORECEPTORS OF BLADDER WALL

Provide information on volume of urinary bladder, trigger urinary reflex

BARORECEPTORS OF CAROTID SINUS AND AORTIC SINUS

Provide information on blood pressure to cardiovascular and respiratory control centers

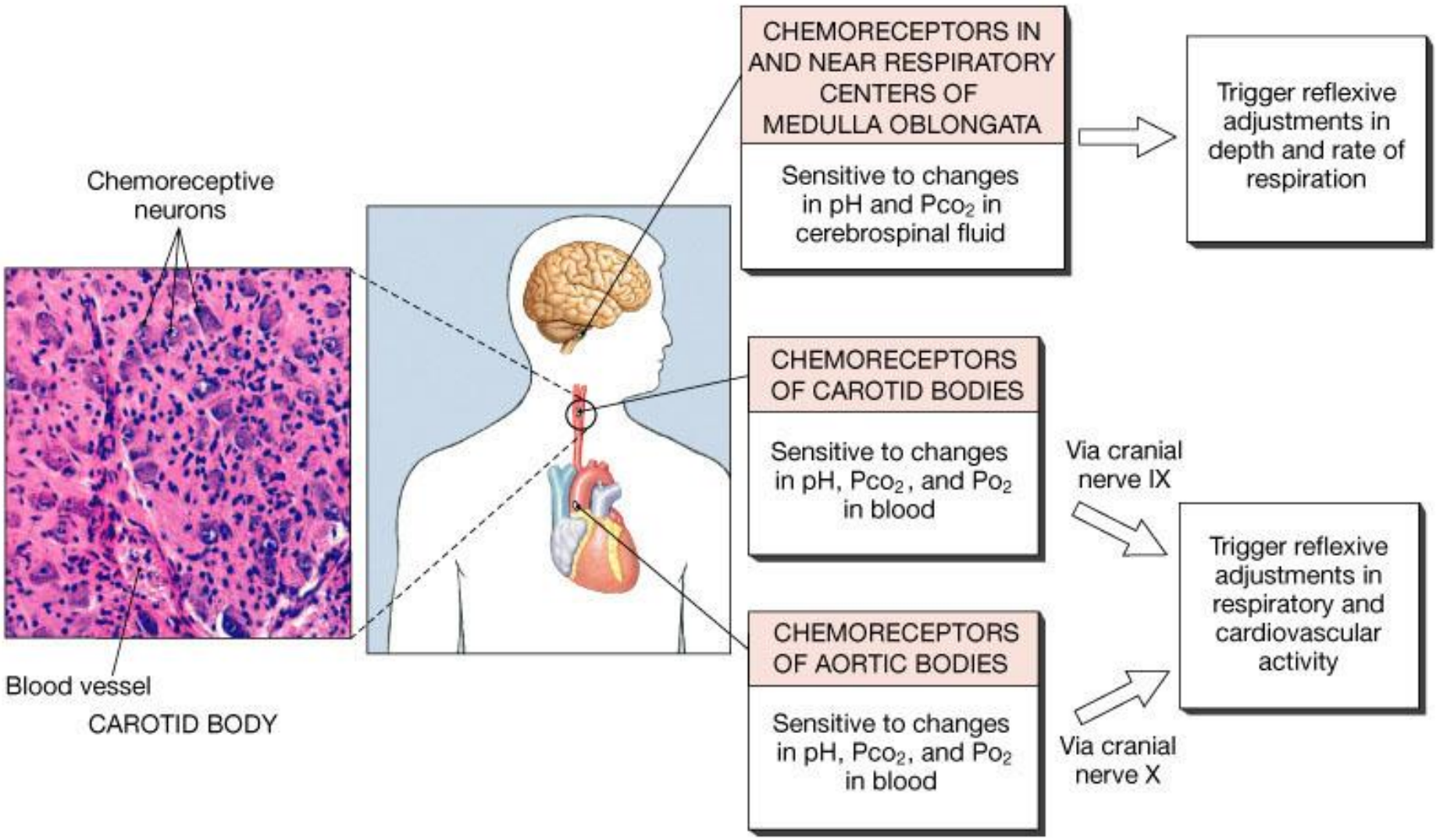
BARORECEPTORS OF LUNG

Provide information on lung stretching to respiratory rhythmicity centers for control of respiratory rate

BARORECEPTORS OF COLON

Provide information on volume of fecal material in colon, trigger defecation reflex

Chemoreceptors



The Organization of Sensory Pathways

First, second, and third order neurons

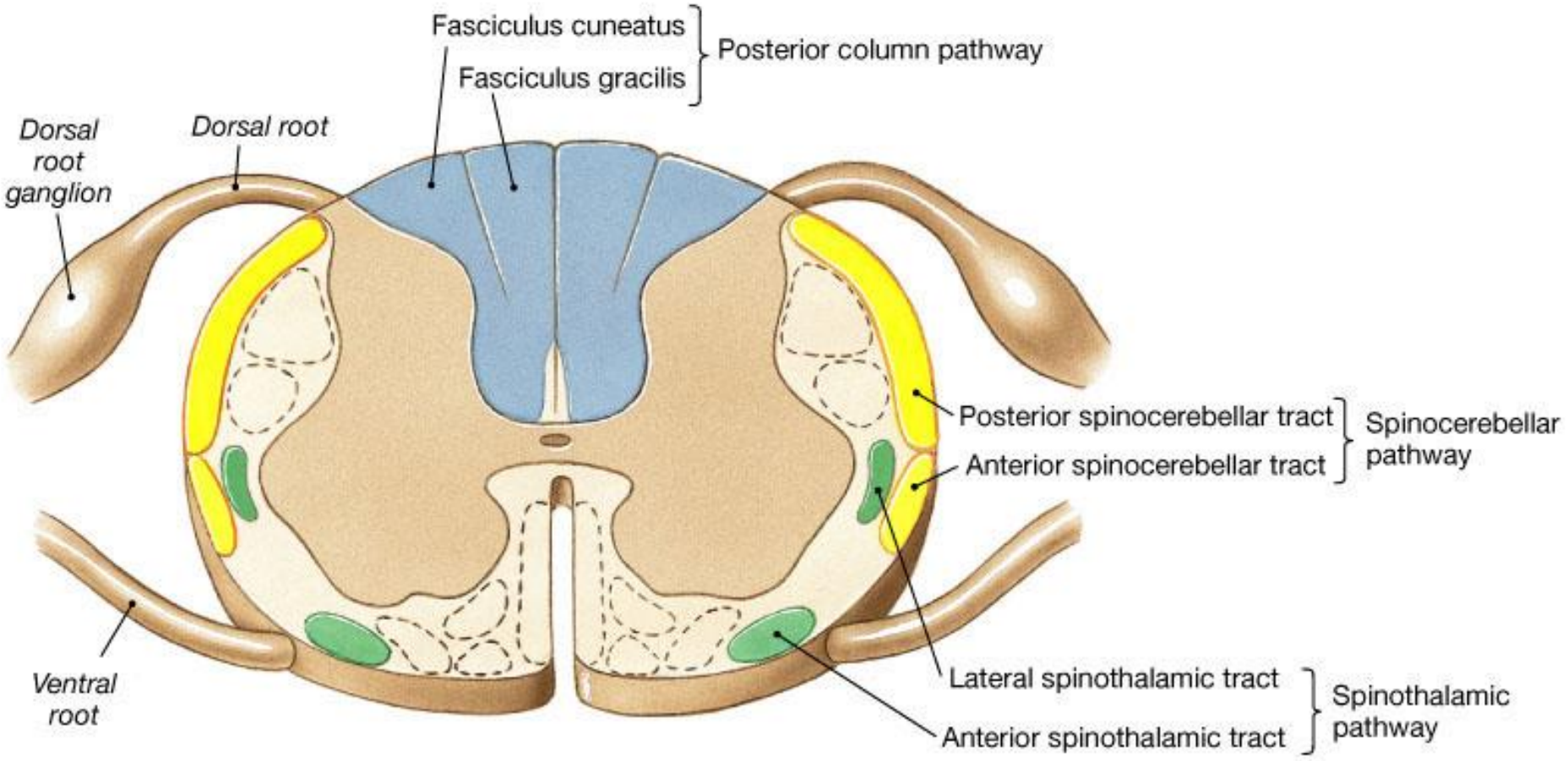
- First order neurons
  - Sensory neurons that deliver sensory information to the CNS
- Second order neurons
  - First order neurons synapse on these in the brain or spinal cord
- Third order neurons
  - Found in the thalamus
  - Second order neurons synapse on these
- Only 1% of incoming sensory impulses actually reach the cerebrum.

Somatic sensory pathways

Tracts (pathways) in the spinal cord carries information

- Three major pathways carry sensory information
  - Posterior column pathway
  - Anterolateral pathway
  - Spinocerebellar pathway
- Sensations that originate in different areas of the body can be distinguished because sensory neurons from each body region synapse in a specific brain region.

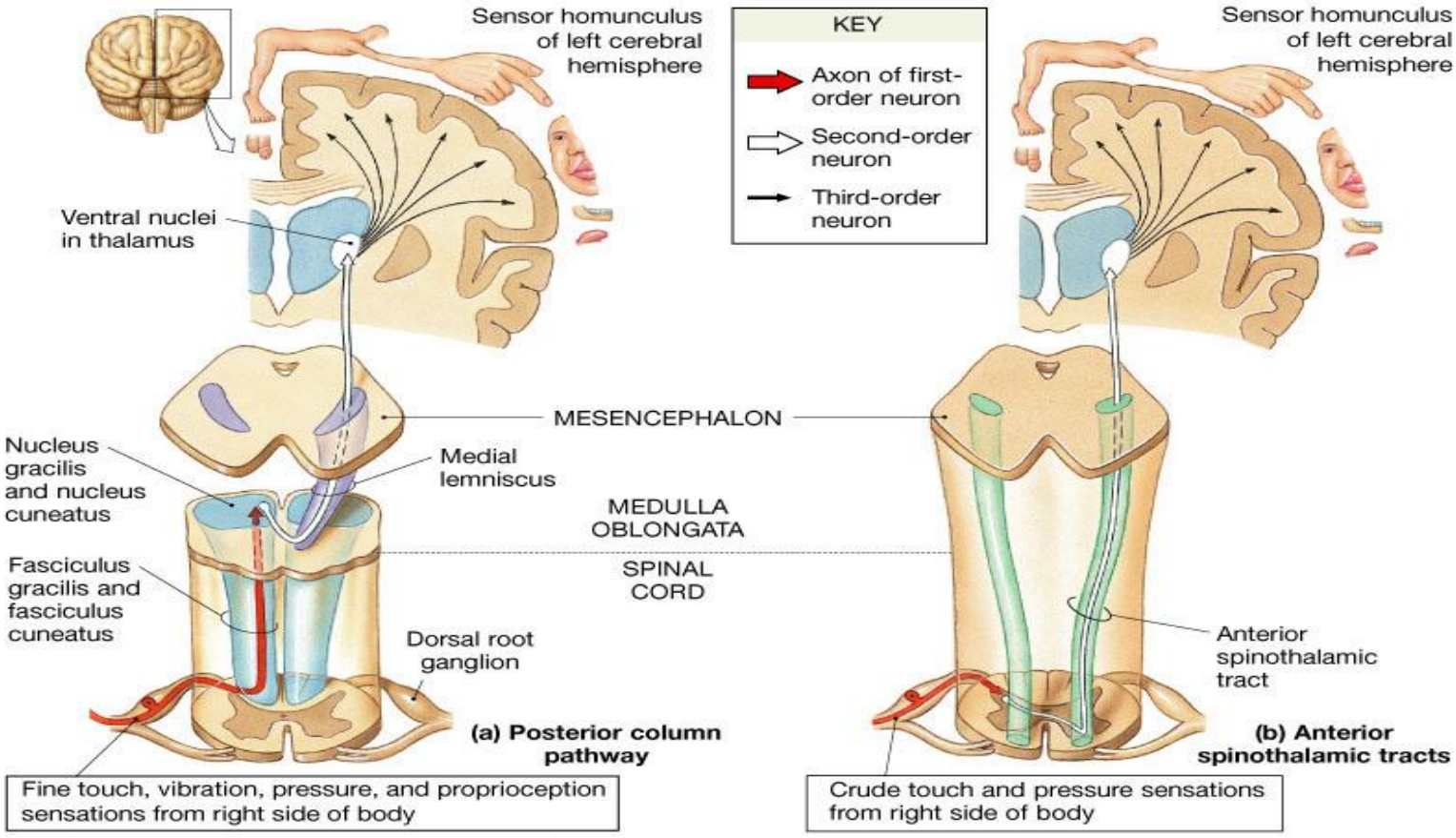
Sensory Pathways and Ascending Tracts in the Spinal Cord



Posterior column pathway

- Posterior column pathway carries sensation of highly localized touch, pressure, vibration.
- Posterior column pathway includes:
  - Fasciculuc cuneatus tract
  - Fasiculum gracili tract - Carries fine touch, pressure and proprioceptive sensations.

The Posterior Column Pathway and the Spinothalamic Tracts

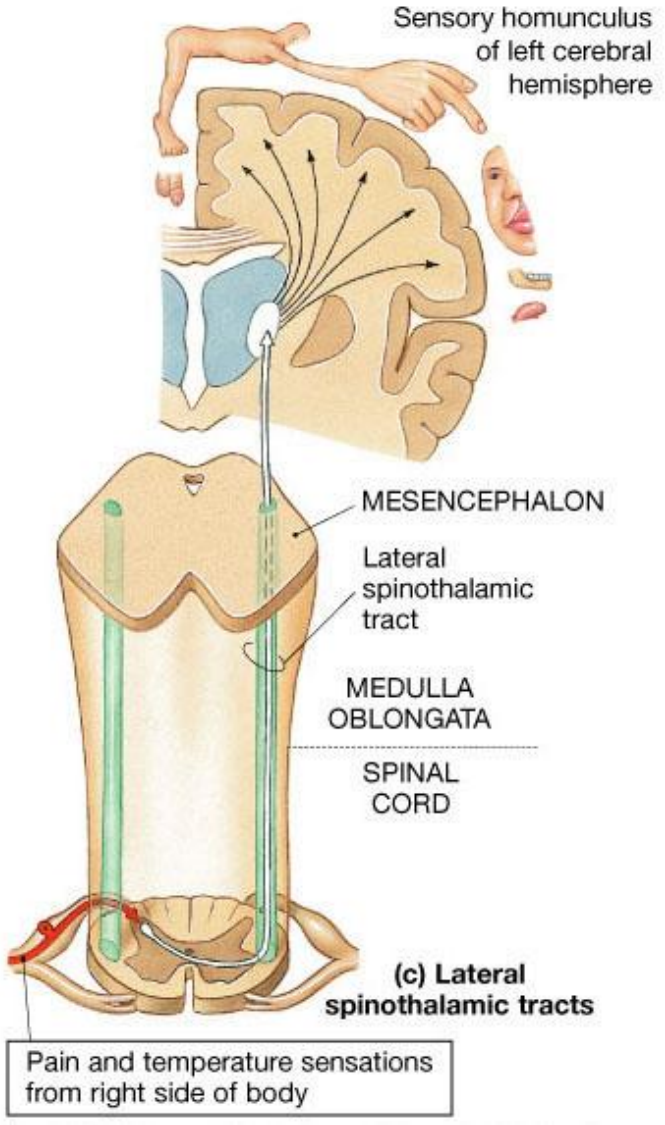


The area of sensory cortex devoted to a body region is relative to the number of sensory receptors.

Anterolateral pathway

- Anterolatheral pathway provide conscious sensations of poorly localized (crude) touch, pressure, pain and temperature
- Anterolatheral pathway includes:
  - Latheral spinothalamic tract – relays information concerning pain and temperature
  - Anterior spinothalamic tract – carry (crude) touch, pressure sensation.

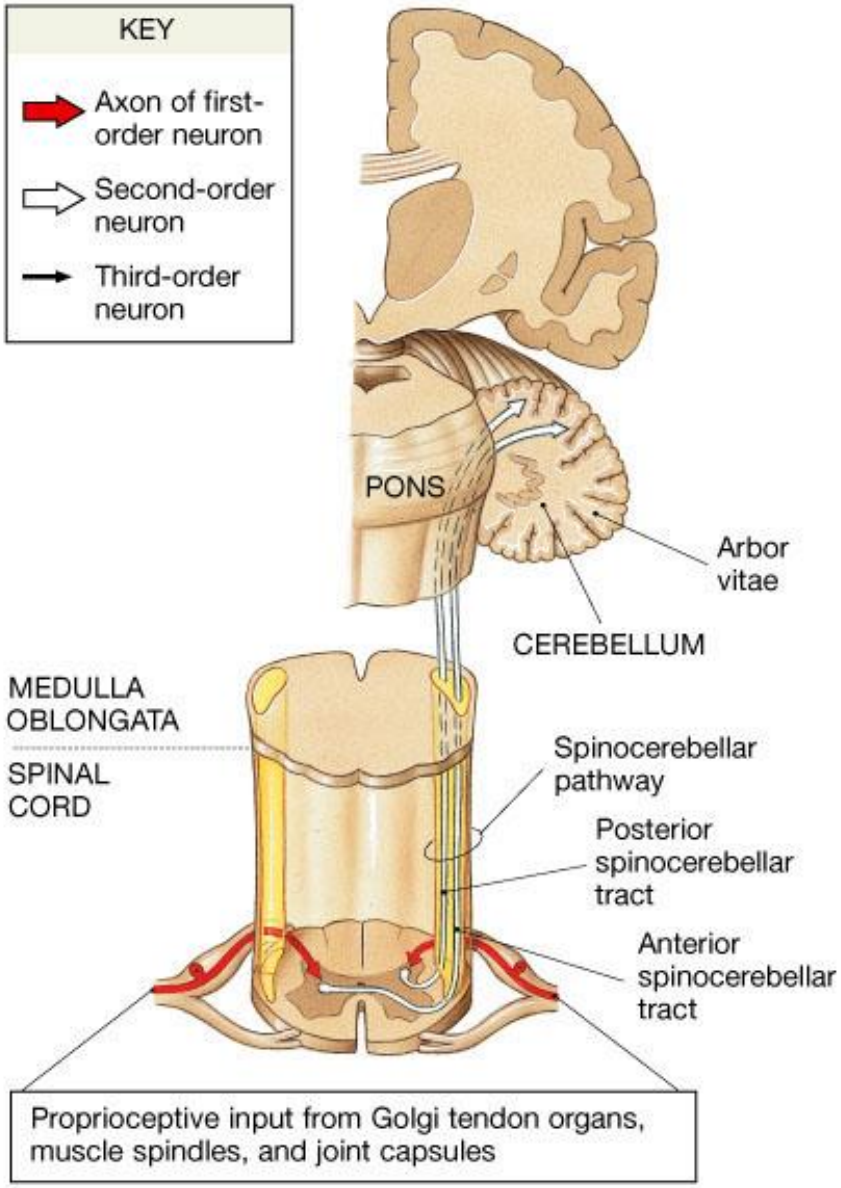
The Posterior Column Pathway and the Spinothalamic Tracts



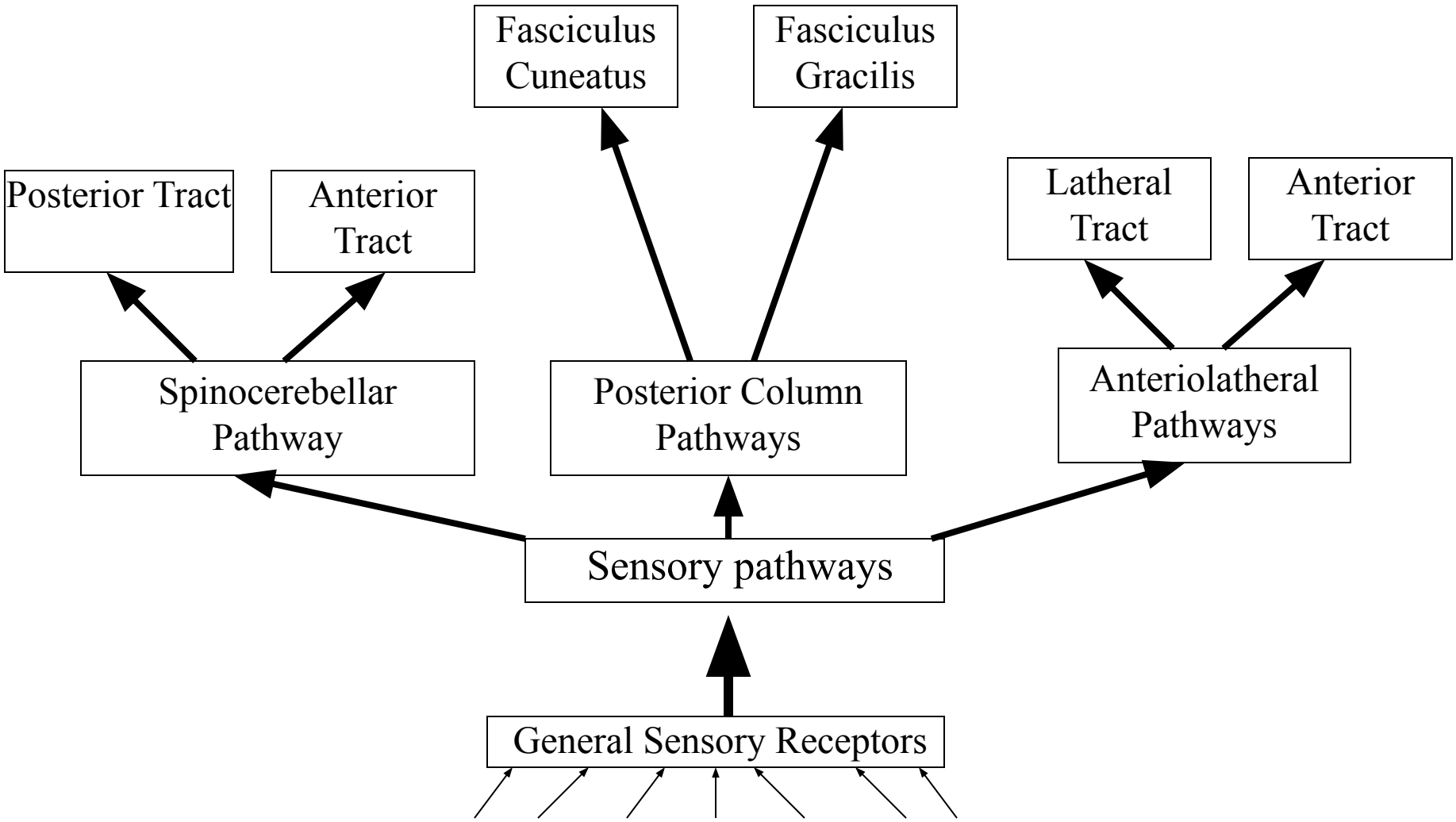
Spinocerebellar pathway

- Spinocerebellar pathway Includes the
  - Posterior spinocerebellar tract – relays information from propioceptors to the CNS
  - Anterior spinocerebellar tract.
- Carries sensation to the cerebellum concerning position of muscles, tendons and joints

The Spinocerebellar Pathway



Summary


Fasciculus Cuneatus
Fasciculus Gracilis
Posterior Tract
Anterior Tract
Latheral Tract
Anterior Tract
Spinocerebellar Pathway
Posterior Column Pathways
Anteriolatheral Pathways
Sensory pathways
General Sensory Receptors

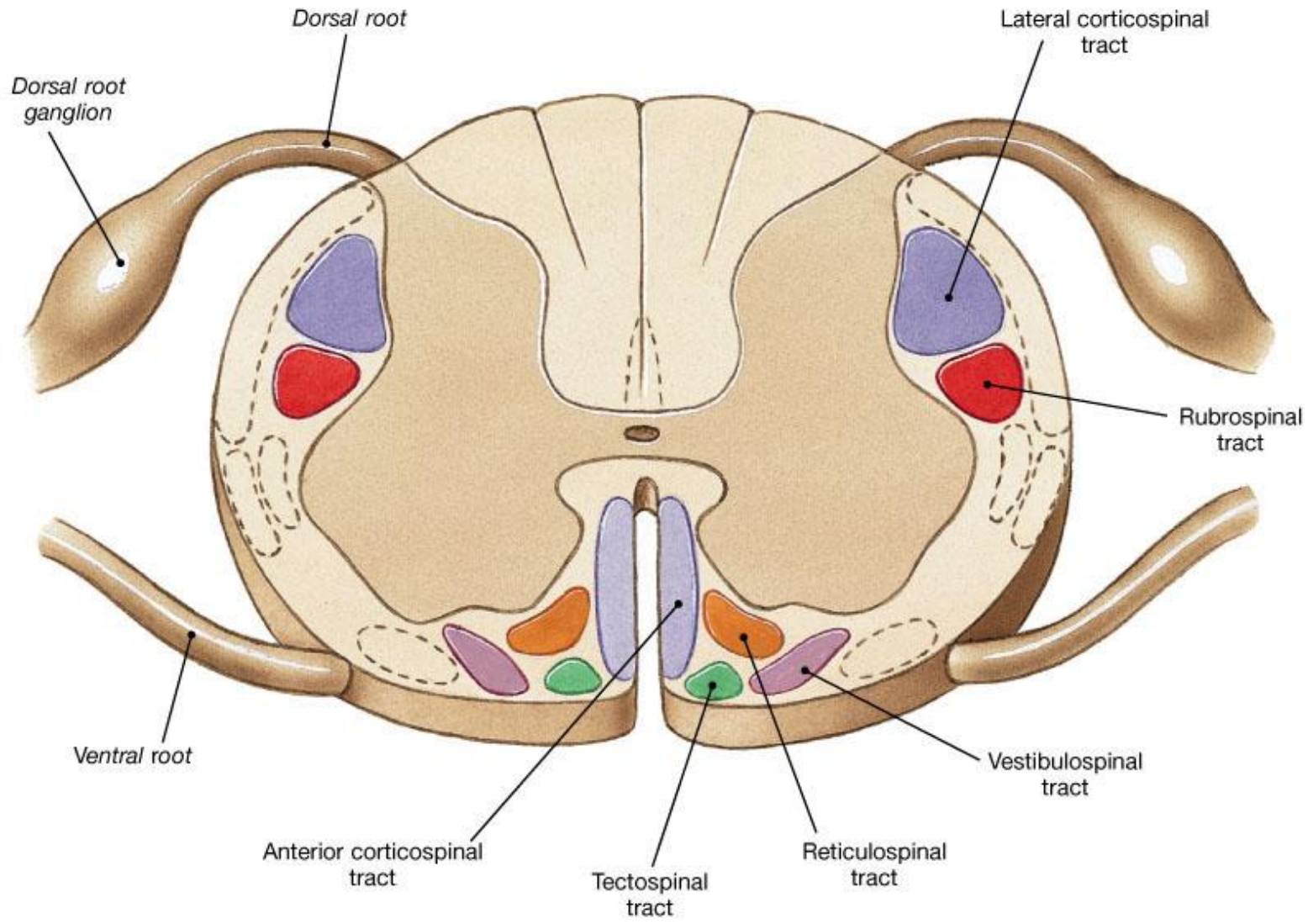
Visceral sensory pathways

- Carry information collected by interoceptors such as nociceptors, thermoceptors, tactile receptors, barocereceptors and chemoreceptors.
- Monitor visceral tissue and organs

Motor Pathway

- **Incoming information is processed by CNS and distributed by the:**
  1. **The Somatic Nervous System (SNS)**
  2. **Autonomic Nervous System (ANS)**
- **SNS also called Somatic motor system controls contraction of skeletal muscle**
- **Motor commands control skeletal muscle travel by:**
  - Corticospinal pathway
  - Medial Pathway
  - Latheral Pathway
- The area of motor cortex that is devoted to a particular region of the body is relative to the number of motor units in the area of the bodt

Descending (Motor) Tracts in the Spinal Cord



The corticospinal pathway

- Corticospinal pathway contain 3 pairs of descending tracts:
  1. Corticobular – provide conscious control over skeletal muscle of eye, jaw, face, neck and pharynx
  2. Latheral corticospinal - regulate voluntary control of skeletal muscle on the opposite side
  3. Anterior corticospinal – regulate voluntary control of skeletal muscle on the same side

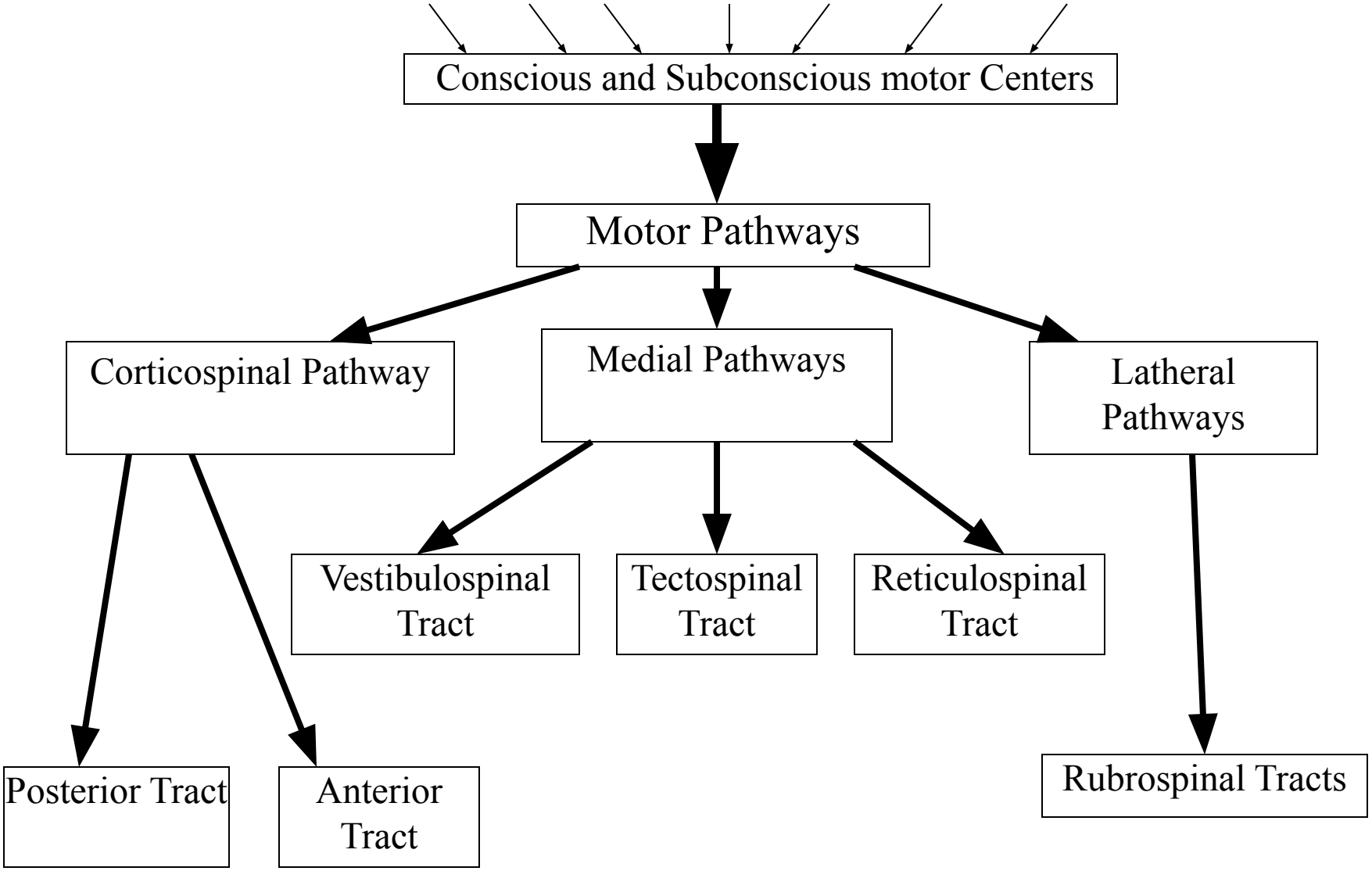
medial and lateral pathways

- The medial and lateral pathways
  - Issue motor commands as a result of subconscious processing
- Medial pathway
  - Primarily controls gross movements of the trunk and proximal limbs
  - Medial Pathway Includes the:
    1. Vestibulospinal tracts – regulates involuntary control of posture and muscle tone
    2. Tectospinal tracts - controls involuntary regulation of eye, head, neck and position in response to visual and auditory stimuli
    3. Reticulospinal tracts – controls involuntary regulation of reflex activity and autonomic function

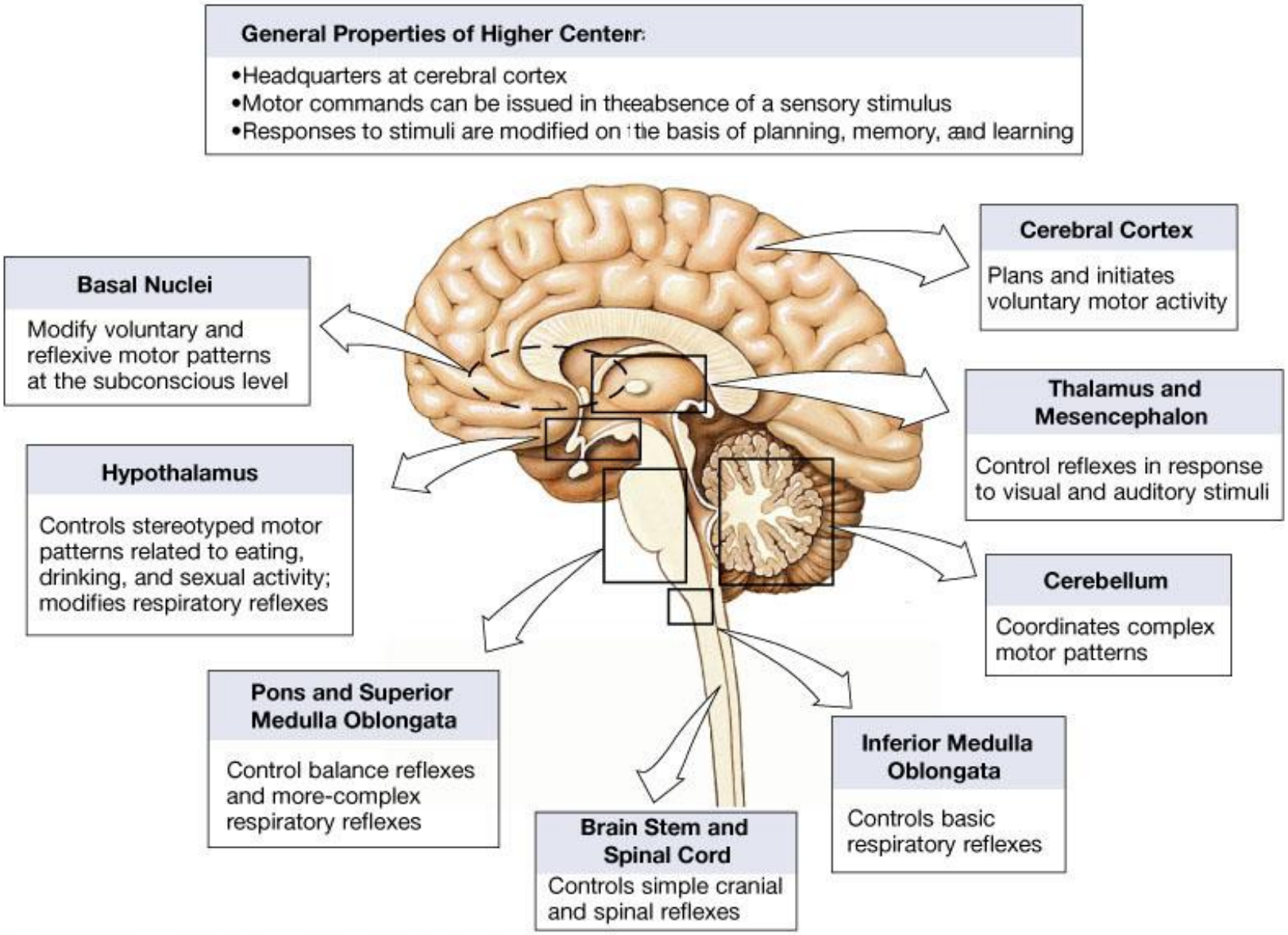
lateral pathways

- Lateral pathway
  - Controls muscle tone and movements of the distal muscles of the upper limbs

Summary


Conscious and Subconscious motor Centers
Motor Pathways
Corticospinal Pathway
Medial Pathways
Latheral Pathways
Vestibulospinal Tract
Tectospinal Tract
Reticulospinal Tract
Posterior Tract
Anterior Tract
Rubrospinal Tracts

Centers of Somatic Motor Control



You should now be familiar with:

- The components of the afferent and efferent divisions of the nervous system, and what is meant by the somatic nervous system.
- Why receptors respond to specific stimuli and how the organization of a receptor affects its sensitivity.
- The major sensory pathways.
- How we can distinguish among sensations that originate in different areas of the body.
- The components, processes and functions of the somatic motor pathways.
- The levels of information processing involved in motor control.