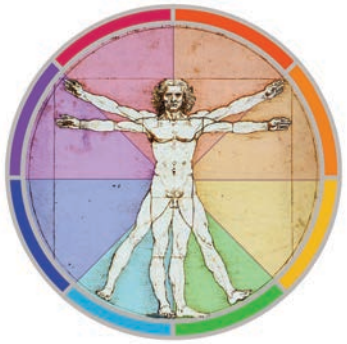
HUBS191 Lecture Material

This pre-lecture material is to help you prepare for the lecture and to assist your note-taking within the lecture,

it is NOT a substitute for the lecture !

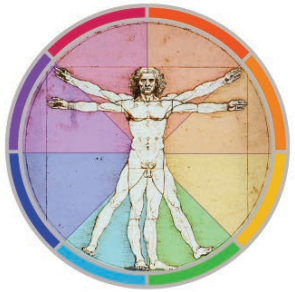


Please note that although every effort is made to ensure this pre-lecture material corresponds to the live-lecture there may be differences / additions.

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

HUBS 191

Dr Phil Heyward
Department of Physiology



Three lectures on 'systems neurophysiology'

Lecture 28: Somatic sensory nervous system

Sensory Receptors and the Somatosensory Cortex

Lecture 29: Somatic motor nervous system

Voluntary and Reflex Control of Movement

Lecture 30: Autonomic nervous system

Sympathetic and Parasympathetic Nervous Systems

Lecture 28 Objectives

After you have revised this lecture you should be able to:-

- Define somatic sensation and special senses
- State four types of information that describe a sensory stimulus and use examples to explain how these are encoded by sensory systems
- Briefly describe the specific structures that enable sensations of touch, changes in muscle length, and pain
- Describe the two major somatosensory pathways
- Describe the primary somatosensory cortex

Organizational plan of the nervous system

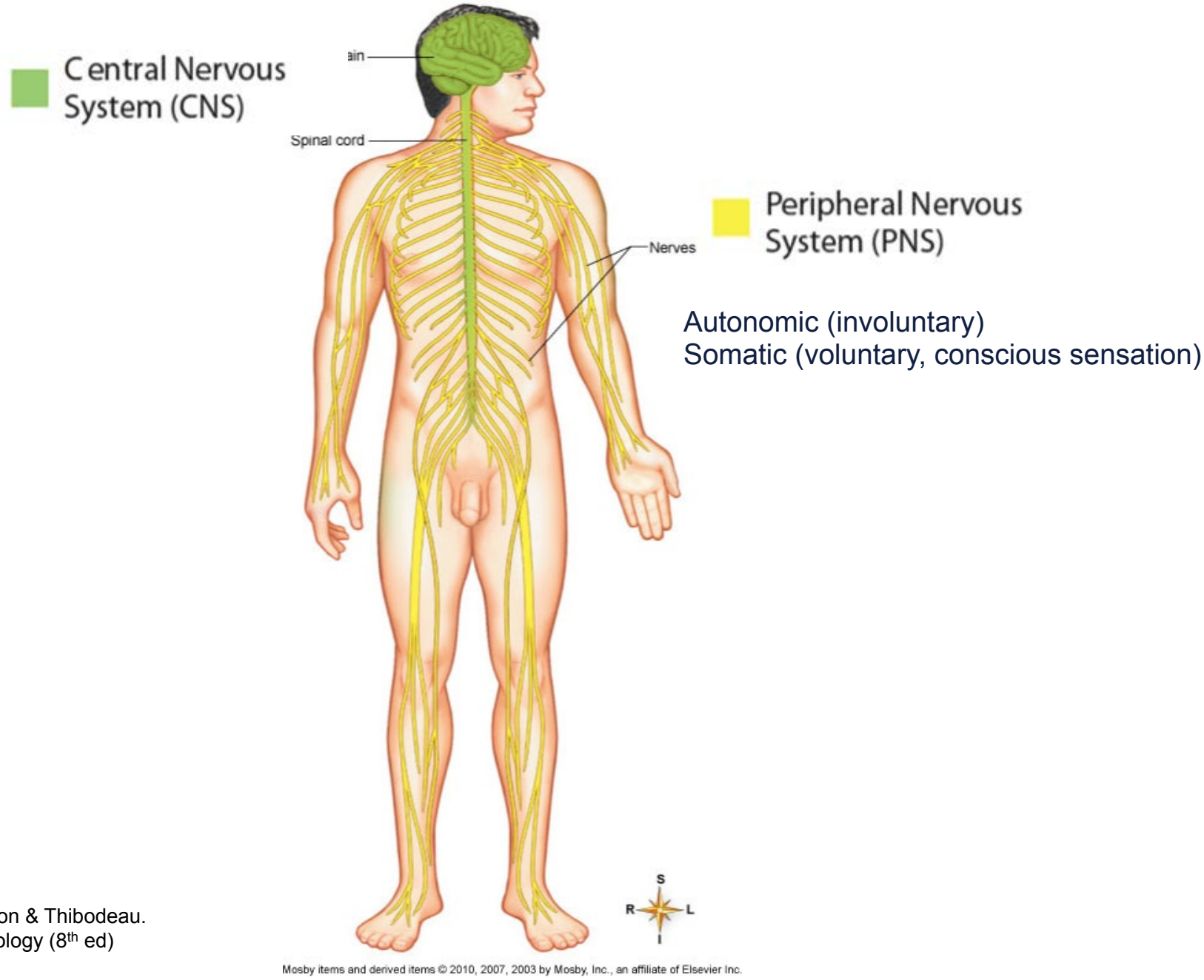


Figure 13-1. Patton & Thibodeau. Anatomy & Physiology (8th ed) Elsevier, 2013

Organizational plan of the nervous system

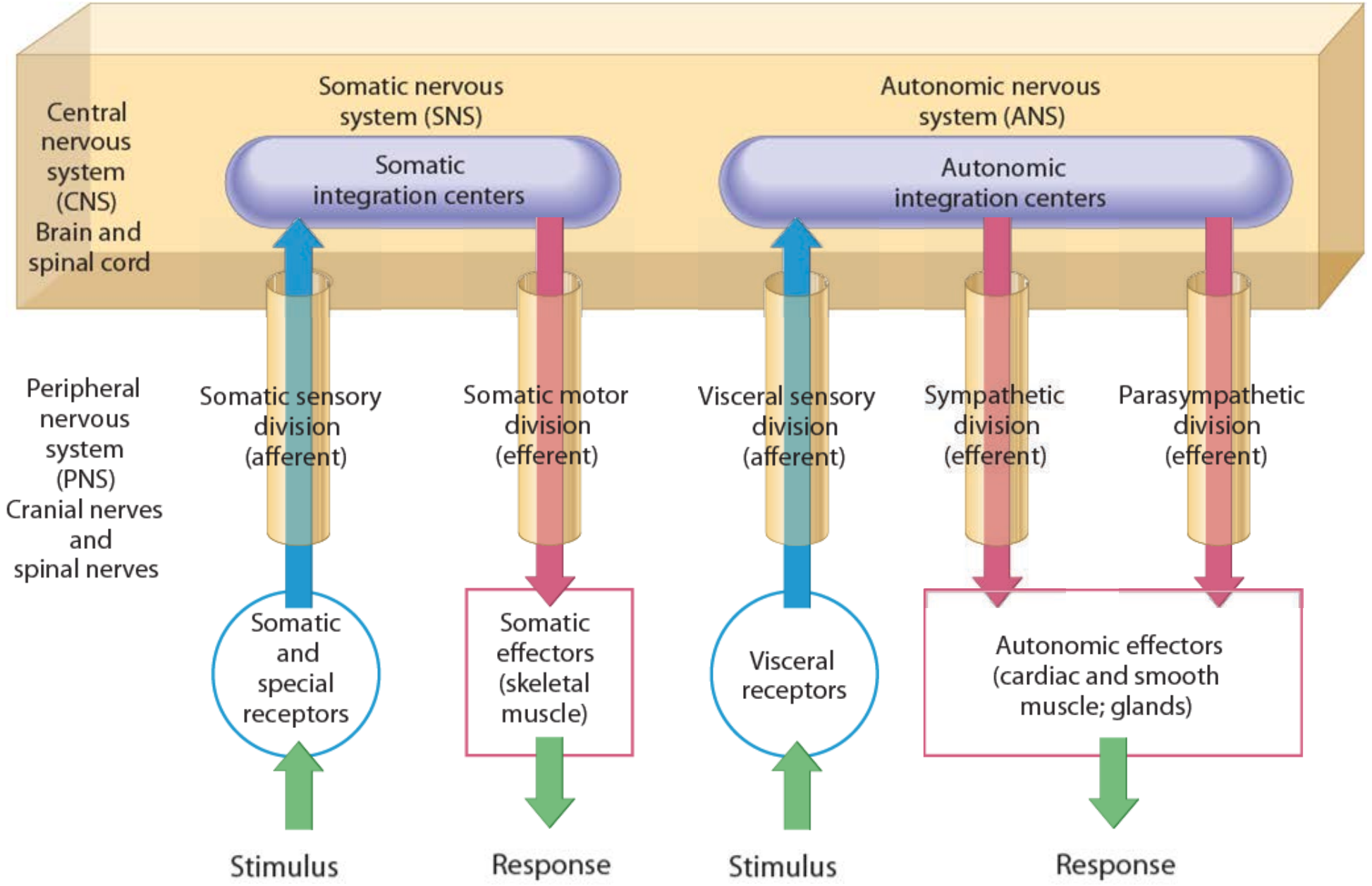
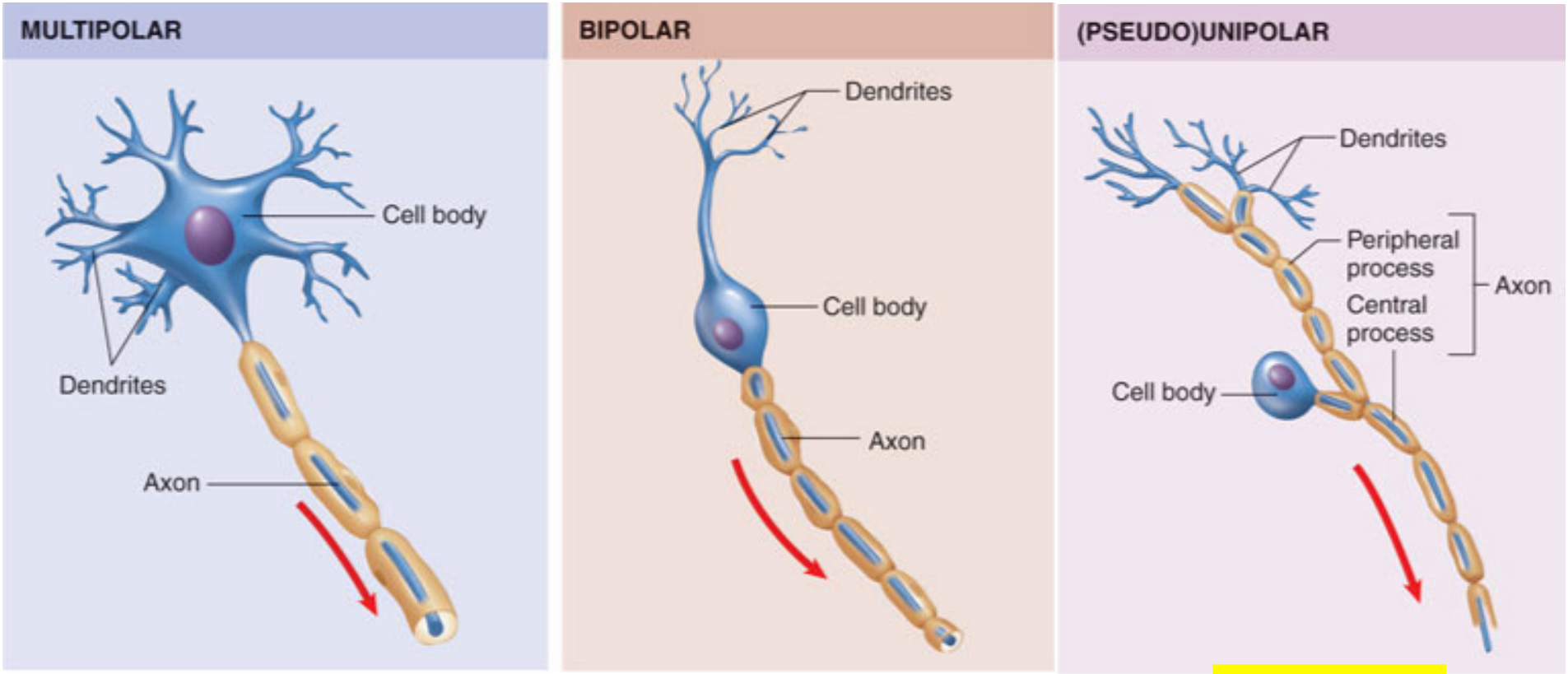


Figure 12-2. Patton & Thibodeau. Anatomy & Physiology (7th ed) Elsevier, 2010

Neurons have various forms:



Sensory neurons

Figure 13-9. Patton & Thibodeau. Anatomy & Physiology (8th ed) Elsevier, 2013

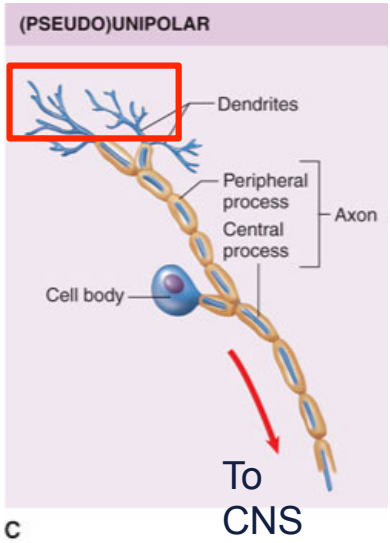
Somatic vs. special senses

- **Special senses**
  - Vision
  - Hearing
  - Taste
  - Smell (& pheromones)
  - Vestibular (balance)
- **Somatic & visceral sensations**
  - Touch
  - Pain
  - Warm & cold
  - Body position

Inputs to the CNS

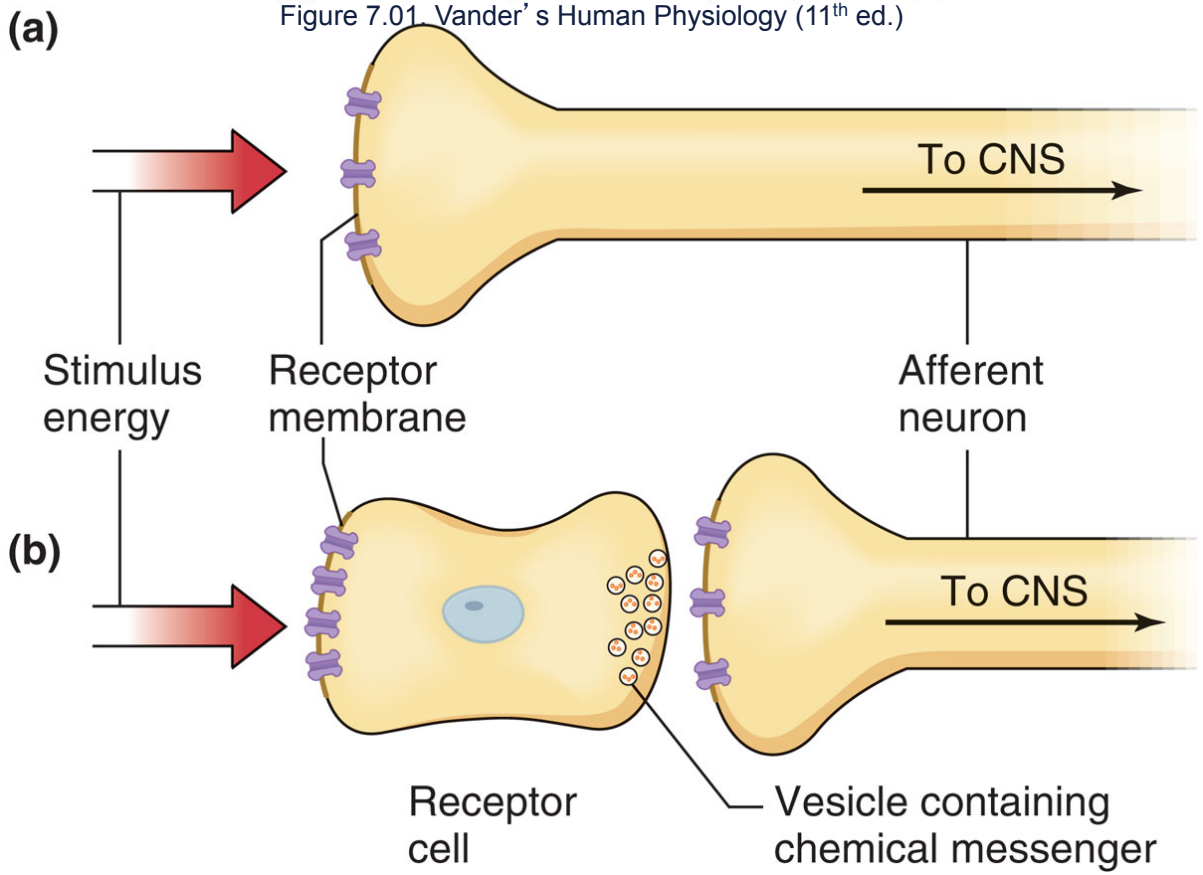
- Direct (e.g. hypothalamic temperature sensing)
- Endocrine (e.g. control of food intake)
- Nervous
  - Somatic
  - Visceral
  - Special

Sensory receptors



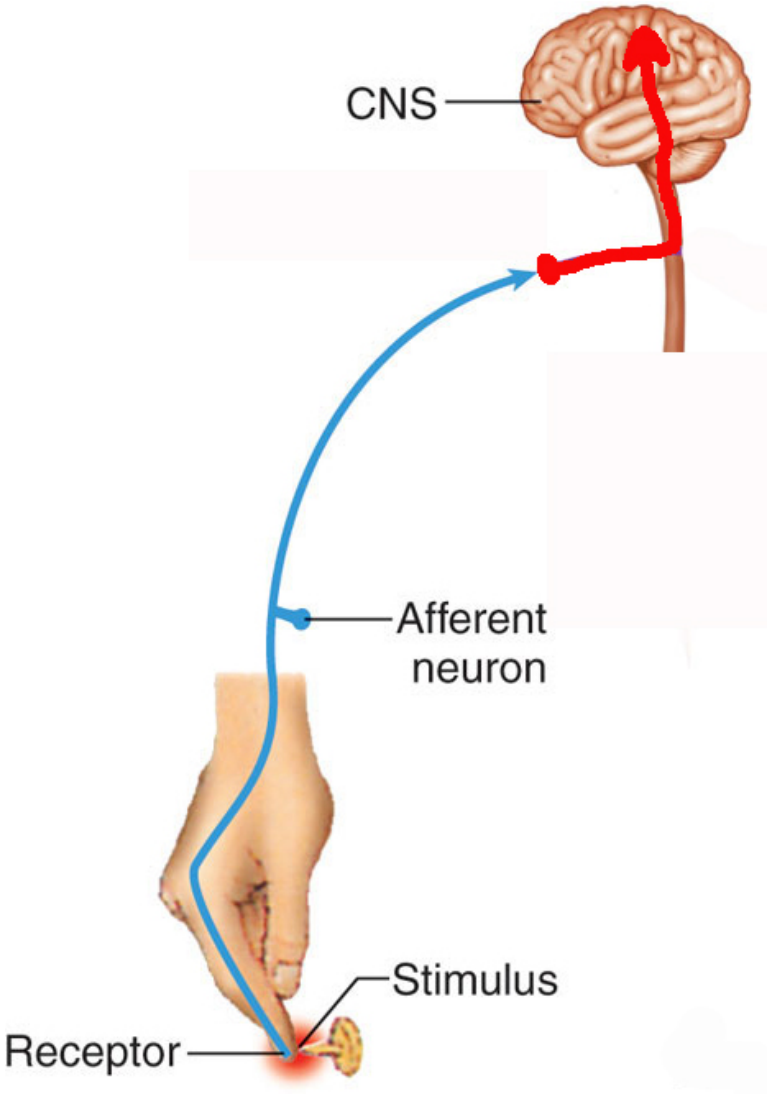
Sensory ending of an afferent neuron
or
Specialized receptor cell

Figure 7.01, Vander's Human Physiology (11th ed.)



Highly sensitive to a particular stimulus

Conscious sensations



- **Integration centre**
  - Cerebral cortex
  - Conscious sensation and perception
- **Afferent neurons**
  - Peripheral nerve
  - Tract or pathway
- **Sensory receptor**
  - Sensory stimulus converted into action potentials
  - TRANSDUCTION

Sensory information coding:

4 types of information that describe a sensory stimulus

- Modality
  - Type of sensory receptor activated
- Intensity
  - Frequency of action potential firing in afferent neuron
- Duration
  - Duration of action potential firing in afferent neuron
- Location
  - Location of sensory receptor(s) activated, ‘mapped’ in brain

Stimulus modality: proprioception

(body position, posture)

- Length receptors
  - **Muscle spindles**
    - Stretch reflex
    - Shortening of muscle
  - Posture
- Tension receptors
  - **Golgi tendon organ**
    - Tension reflex
    - Relaxation
  - Protects from tearing

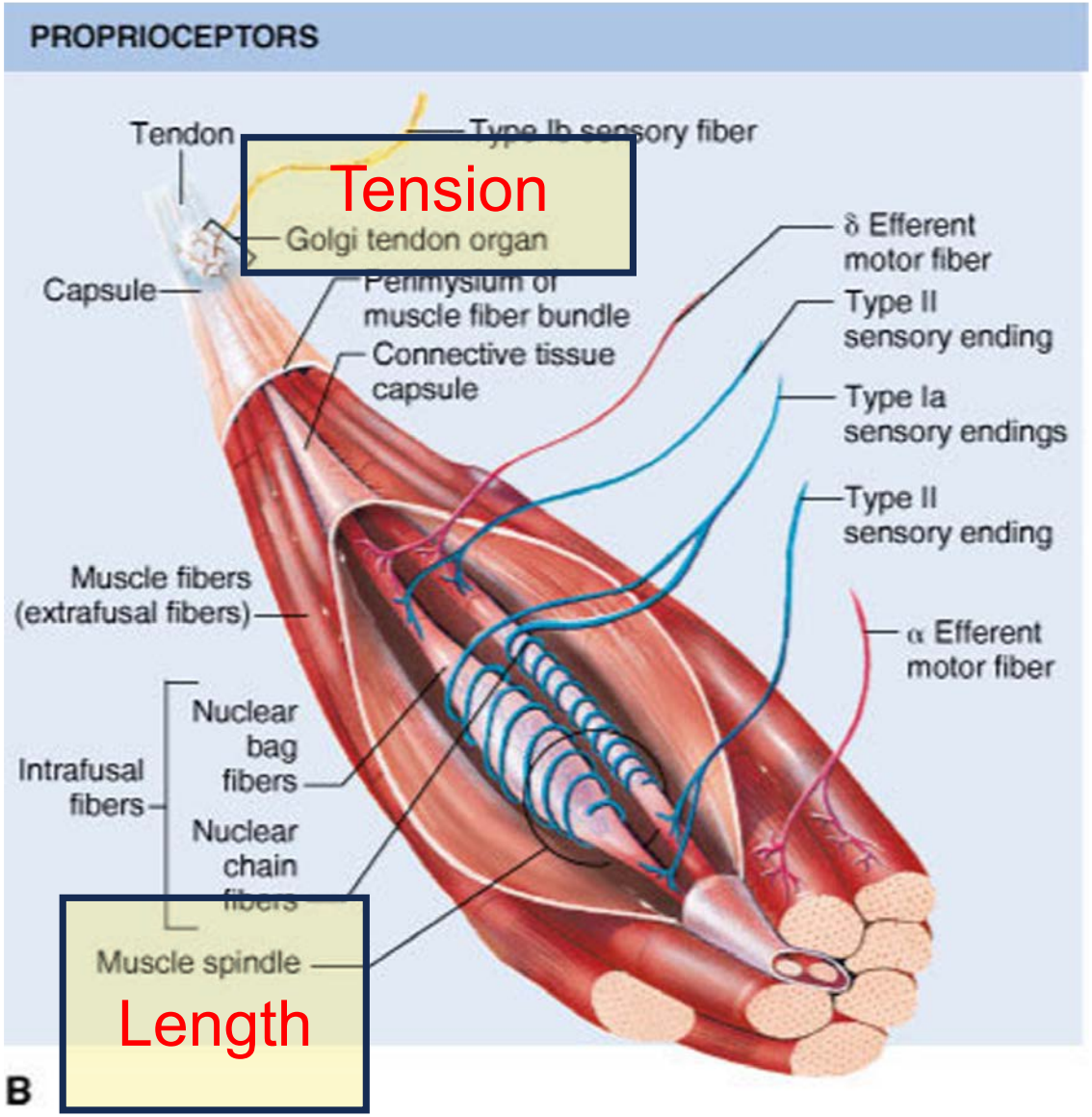
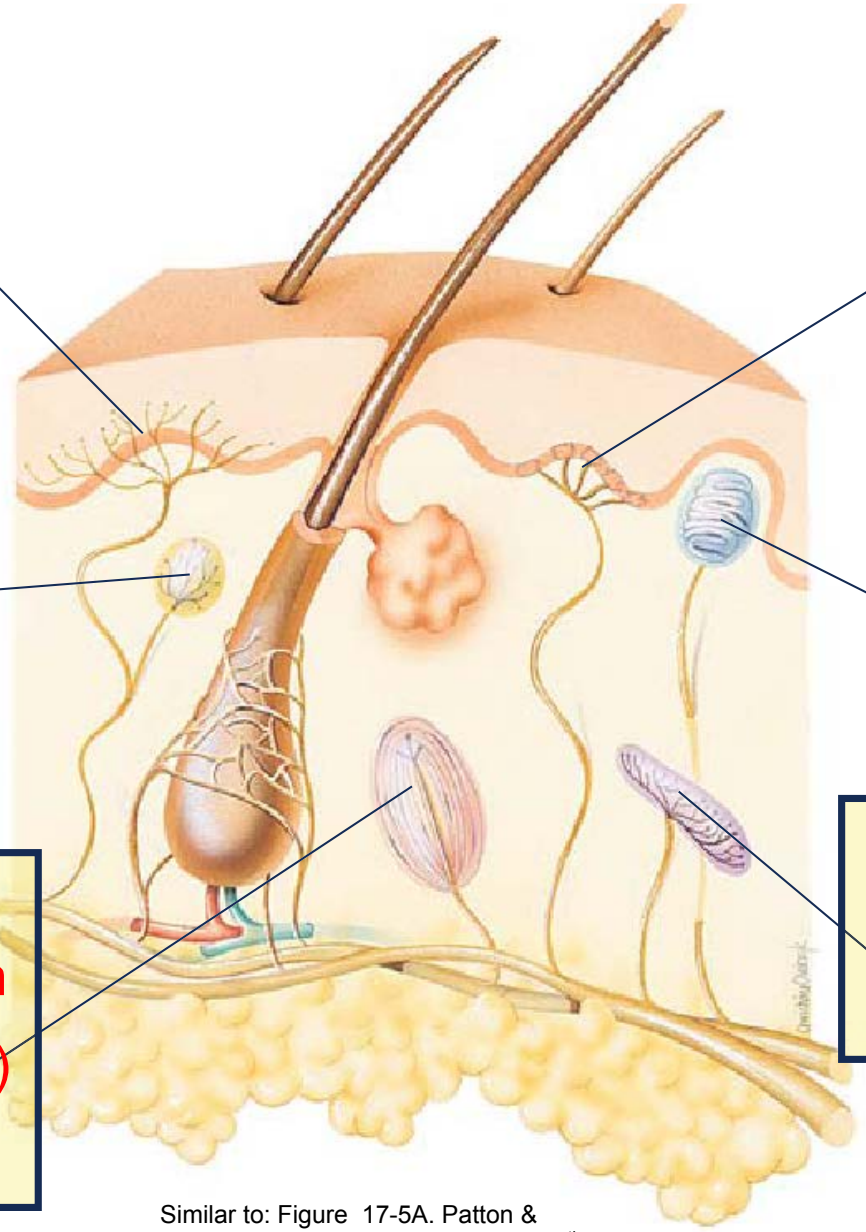


Figure 17-5. Patton & Thibodeau. Anatomy & Physiology (8th ed) Elsevier, 2013

Stimulus modality: touch



Pain
Free nerve endings

Touch
(light pressure)
Merkel endings
(Merkel's disc)

Touch
(textural sensation)
Krause's end bulb

Touch
(low frequency vibration)
Meissner's corpuscle

Touch
(deep pressure/high frequency vibration)
Pacini's corpuscle

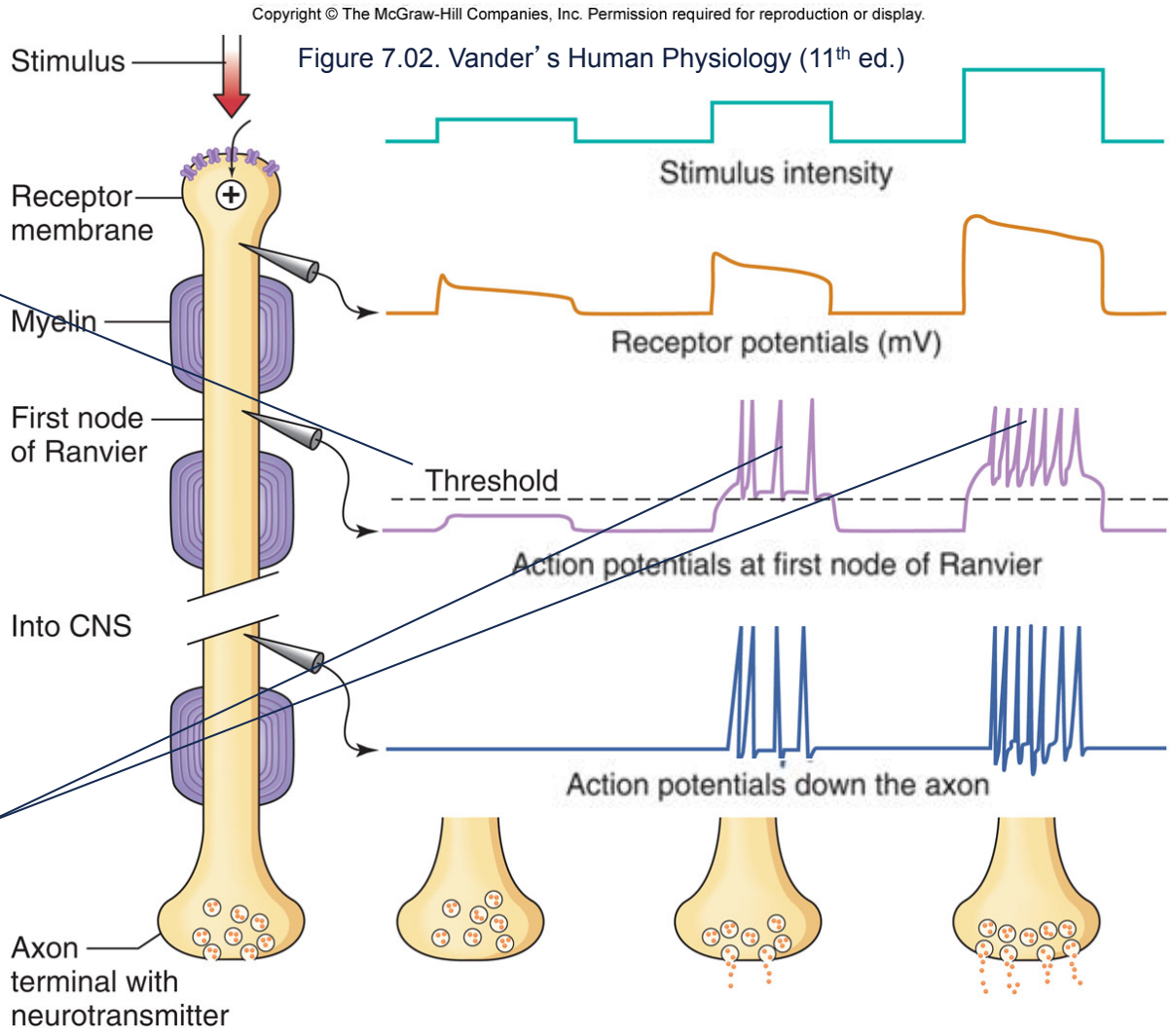
Touch
(crude, persistent)
Ruffini's corpuscle
(Ruffini ending)

Similar to: Figure 17-5A. Patton & Thibodeau. Anatomy & Physiology (8th ed) Elsevier, 2013

Stimulus intensity: frequency in afferent neuron

Below threshold: no response in afferent neuron

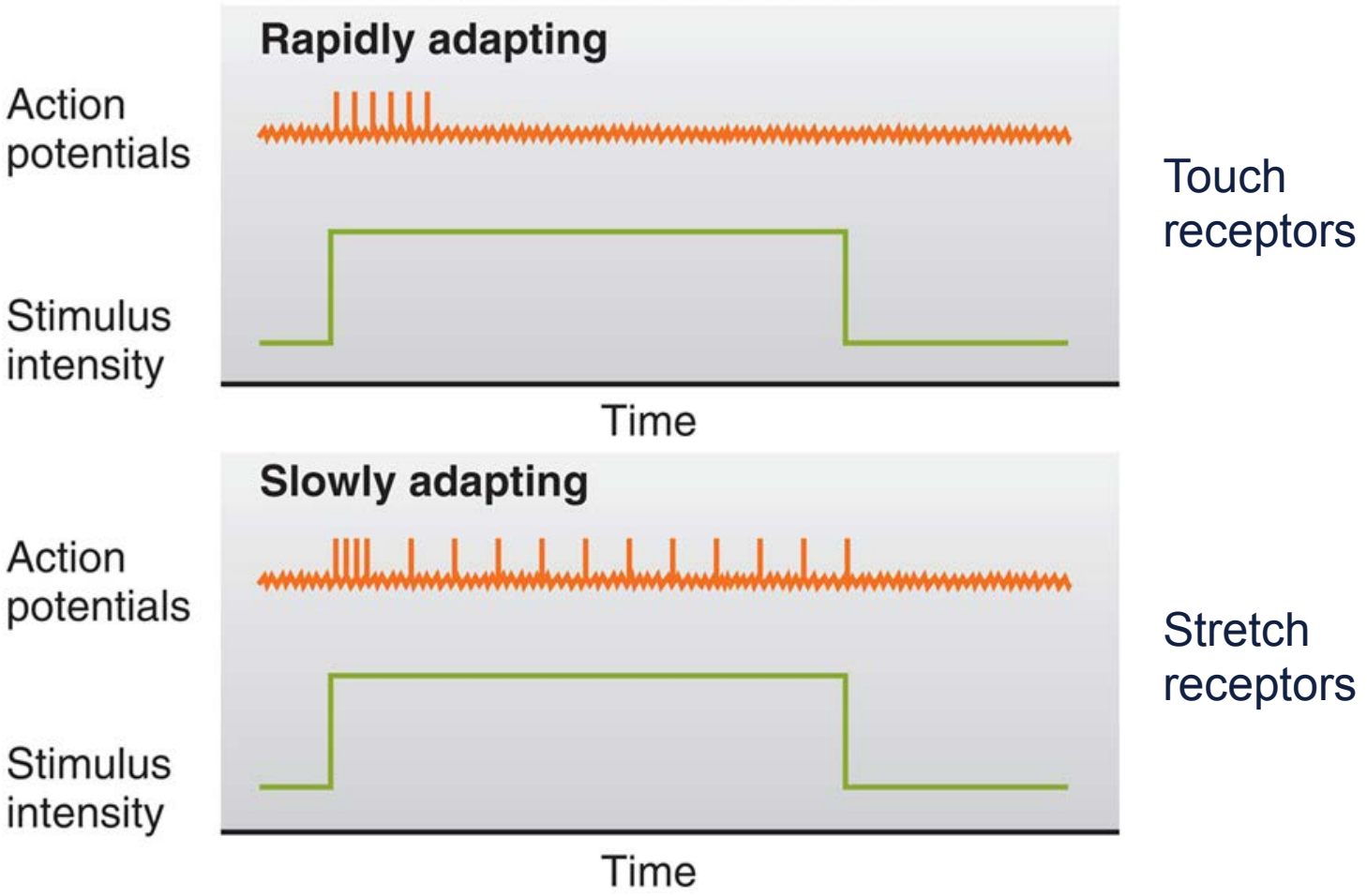
Increasing stimulus increases action potential frequency



Stimulus duration

- Sensory receptors are most sensitive to change
- Often show adaptation: decreased receptor potential over time in response to continuous stimulation

Figure 7.11. Vander's Human Physiology (11th ed.)



Stimulus location: receptive field

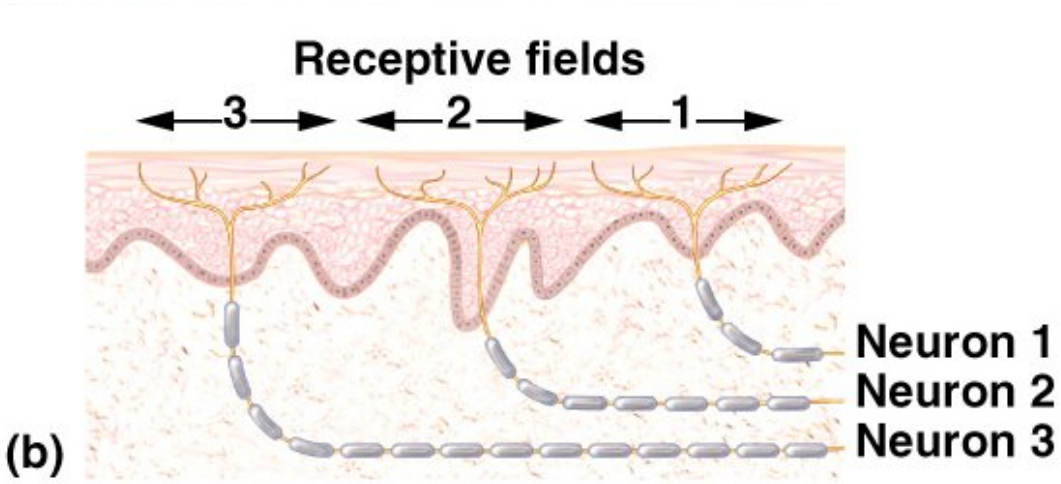


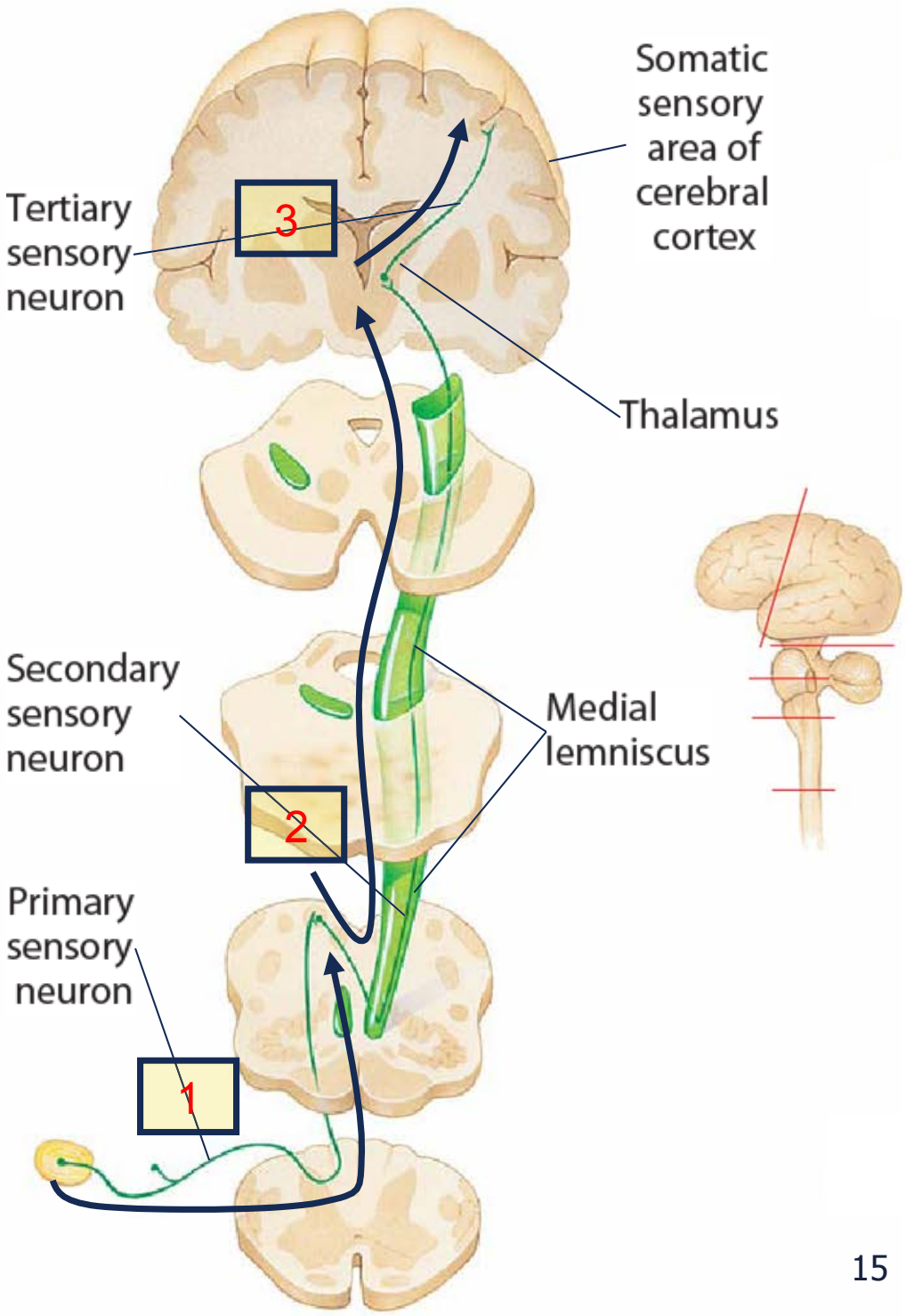
Fig 16-01, Saladin, 3rd edn., 2004, p. 587.

- **Receptive field:-**
  - Region of space in which a stimulus can lead to activity in a particular afferent neuron
  - Small fields & dense innervation gives good discrimination
- Ex: two- point discrimination test

Afferent pathway for touch and posture

Medial lemniscal (dorsal column) **pathway:**

- Three neurons in relay
- ‘Up and across’
- Ia sensory neurons from muscle spindles - Fastest neurons in body



Similar to: Figure 14-23. Patton & Thibodeau. Anatomy & Physiology (8th ed) Elsevier, 2013

Somatosensory cortex

- Sensation
  - Conscious identification of ‘what and where’
  - Primary region of cortex
- Perception
  - Meaningful interpretation
  - Association (secondary) region of the cortex

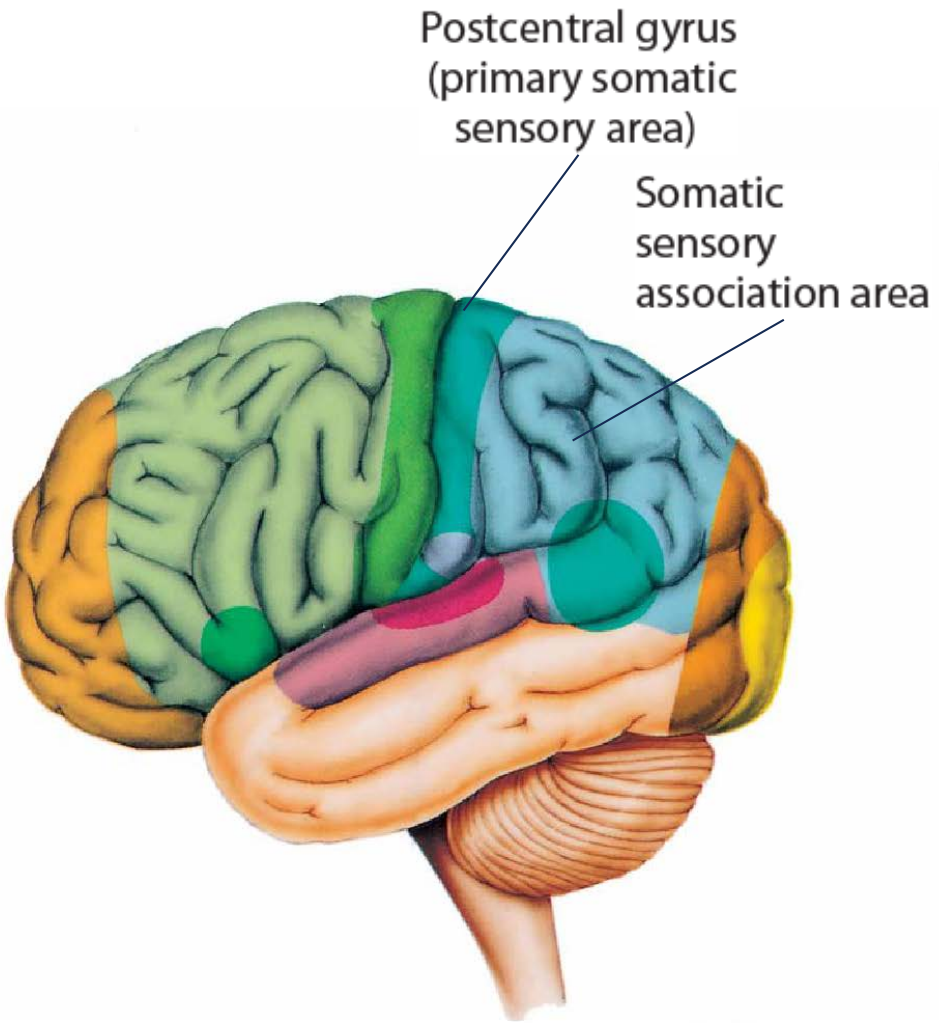
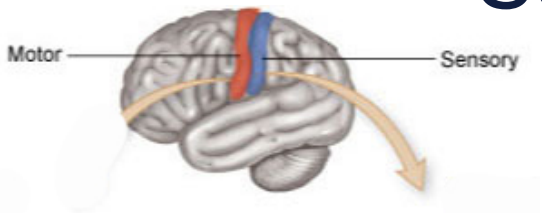
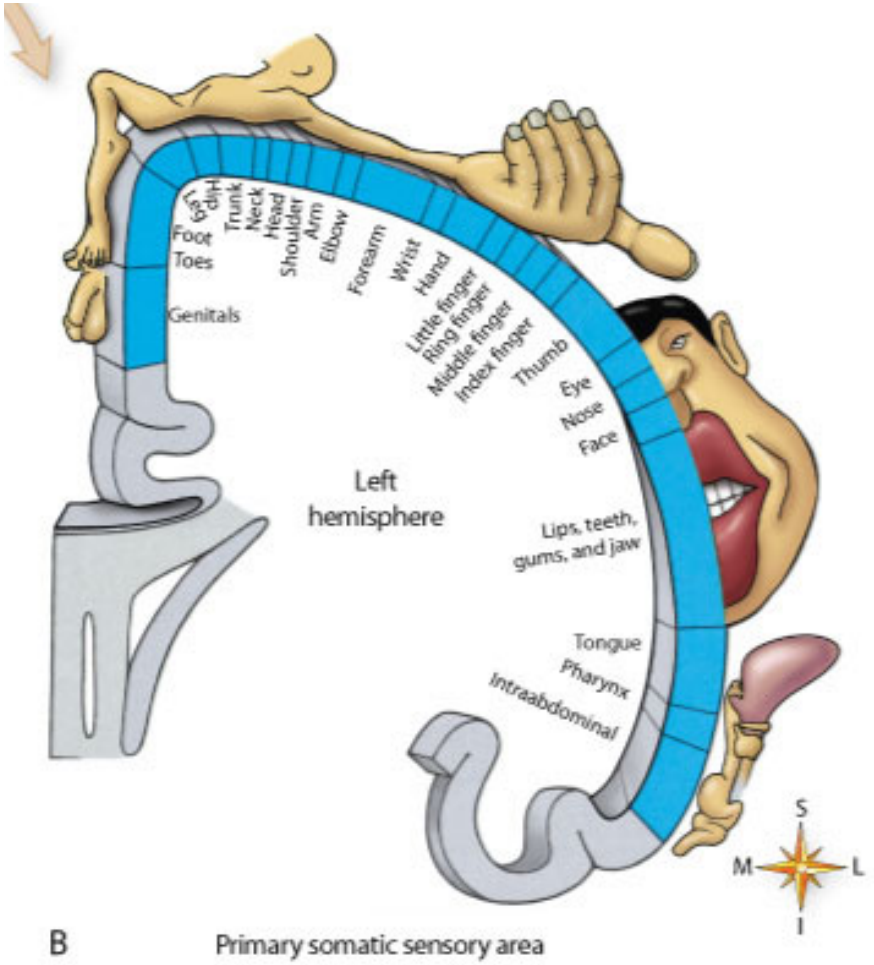


Figure 13-19. Thibodeau & Patton. Anatomy & Physiology (6th ed.)

Similar to: Figure 14-19. Patton & Thibodeau. Anatomy & Physiology (8th ed) Elsevier, 2013

Somatotopic organization





- Areas of cortex correspond to areas of the body
- Densely innervated areas of body occupy large regions of cortex
- Left cortex represents right body and *vice versa*

Figure 13-20. Patton & Thibodeau. Anatomy & Physiology (8th ed) Elsevier, 2013

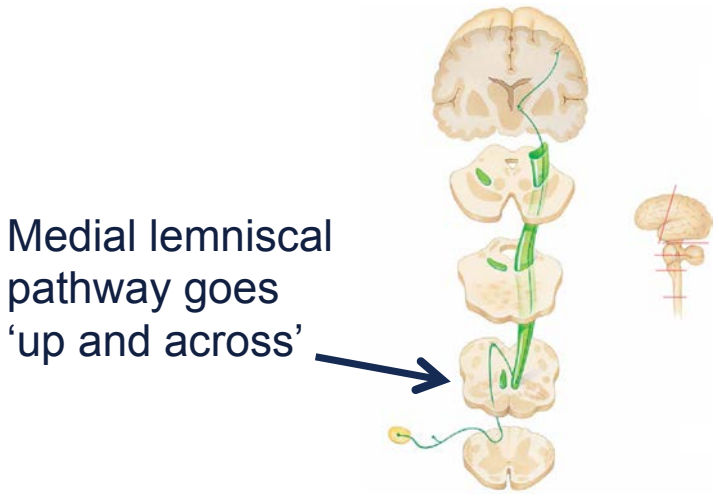
Stimulus modality: pain

- Sensed by free nerve endings (nociceptors)
- Fast (acute) pain
  - Small receptive field
  - Largish, myelinated afferent axons (A fibers)
  - Somatic pain
- Slow (chronic) pain
  - Large receptive field
  - Small, unmyelinated axons (B fibres) (~1 m/s)
  - Visceral pain

Afferent pathway for pain

Lateral spinothalamic (antero-lateral) **Pathway:**

- Minimum of 3 neurons in a relay (can have interneurons)
- Neurons go ‘across and up’



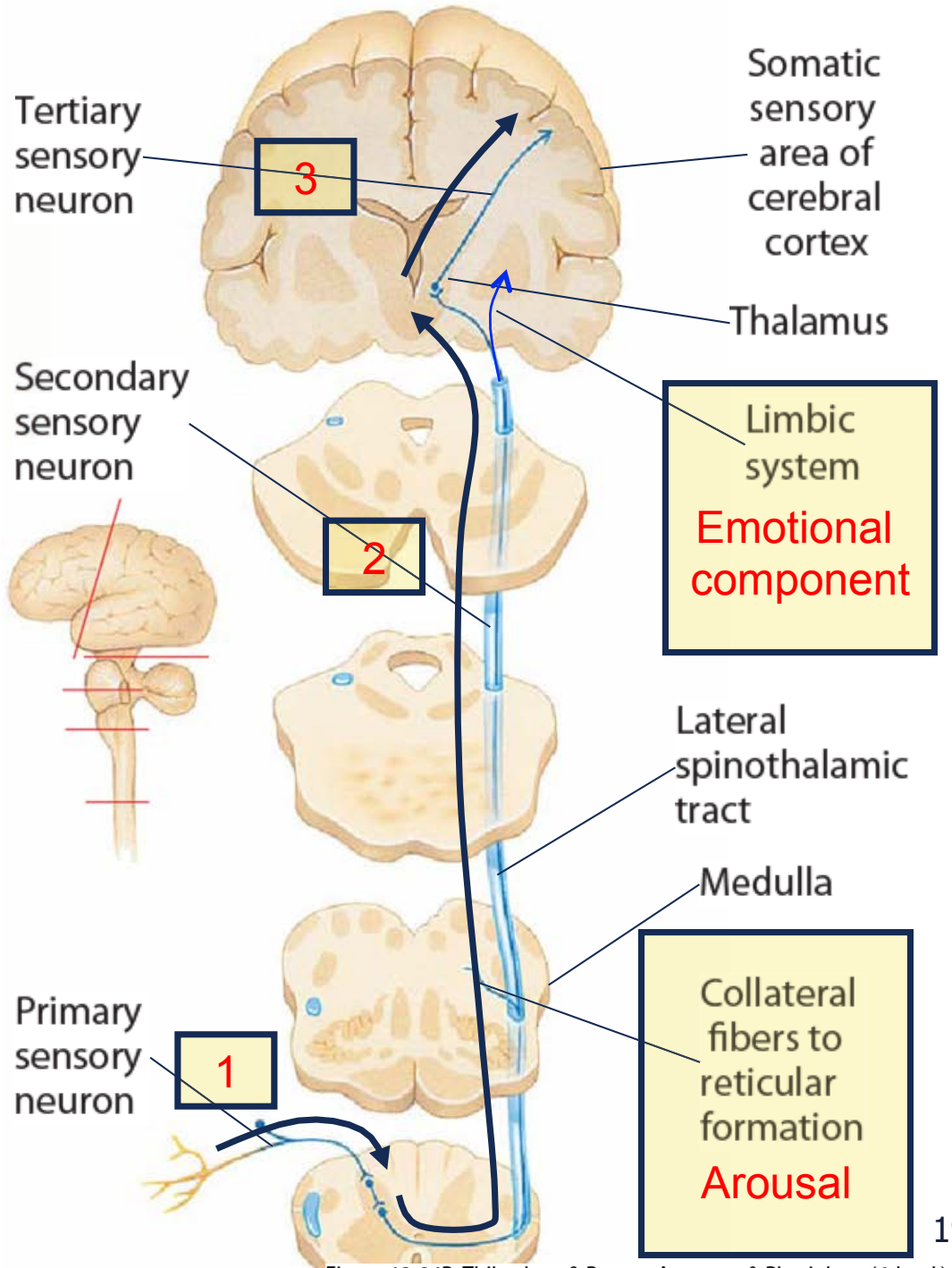


Figure 13-24B. Thibodeau & Patton. Anatomy & Physiology (6th ed.)

‘Systems neurophysiology’ lectures

Three lectures:-

Lecture 28: Sensory Functions: Sensory Receptors and the Somatosensory Cortex

Lecture 29: Somatic Control: Voluntary and Reflex Control of Movement

Lecture 30: Autonomic Control: Sympathetic and Parasympathetic Nervous Systems

HUBS191