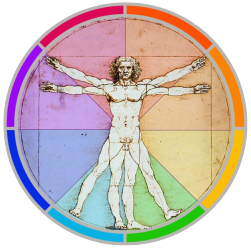
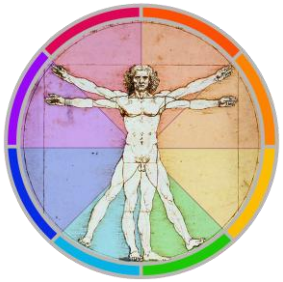
HUBS191 Lecture Material

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
ŌTĀKOU WHAKAIHU WAKA



HUBS 191

Human Movement and Sensation

Theme 2: Integrating and coordinating roles of the nervous system

Lecture 22: Structure and layout of major brain areas;
Sensory and motor pathways

Dr. Rob Munn
Director of Neuroscience
Department of Anatomy

Lecture 21: Post-lecture quiz

1. Which of these is not a layer of meninges

(a) dura mater; (b) epineurium; (c) pia mater; (d) arachnoid

2. Cerebrospinal fluid (CSF) circulates around the brain in which layer of the meninges?

(a) arachnoid; (b) dura mater; (c) perineurium; (d) choroid plexus

3. Old/used CSF is transported into the venous circulation through which structure?

(a) choroid plexus; (b) arachnoid granulations; (c) dural reflections; (d) pia mater

4. The third ventricle is located with which brain region?

(a) cerebrum; (b) cerebellum; (c) diencephalon; (d) midbrain

Lecture 22: Learning objectives

After you have reviewed and studied this lecture, you should understand and be able to describe the:

1. External anatomy of the brain, from lateral (surface) and medial views, including
   (a) the names of the lobes of the cerebral cortex (cerebrum),
   (b) major sulci and gyri that divide them,
   (c) their basic functions

2. Names of the regions of the brainstem (from medial, ventral and dorsolateral views)

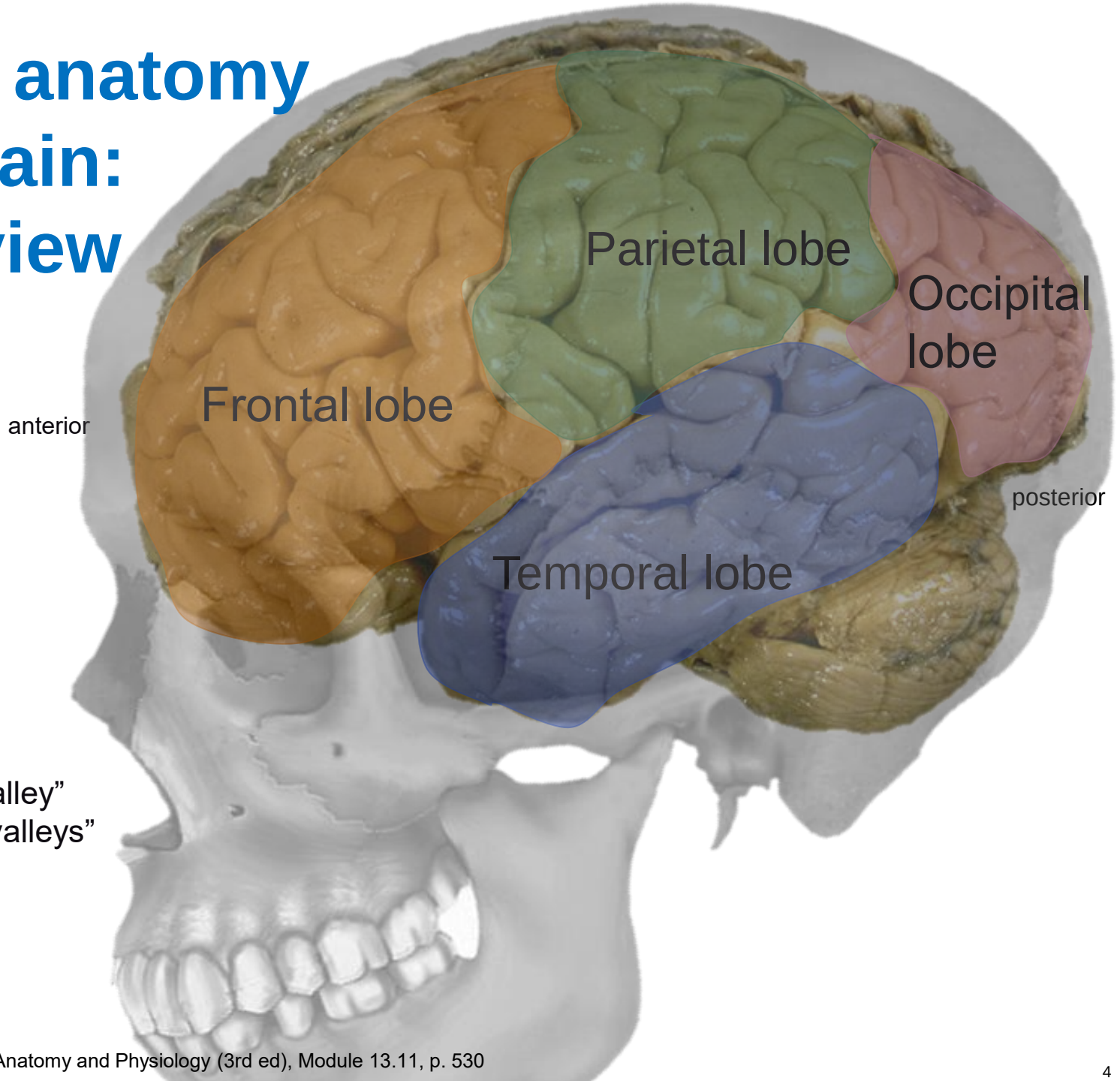
3. Selected internal structures of the brain (from coronal view)

4. Different types of white matter tracts in the brain

5. Anatomy of the main motor pathway for voluntary movement (corticospinal tract)

6. Anatomy of a *representative* somatosensory pathway (dorsal/posterior column pathway)

External anatomy of the brain: Lateral view

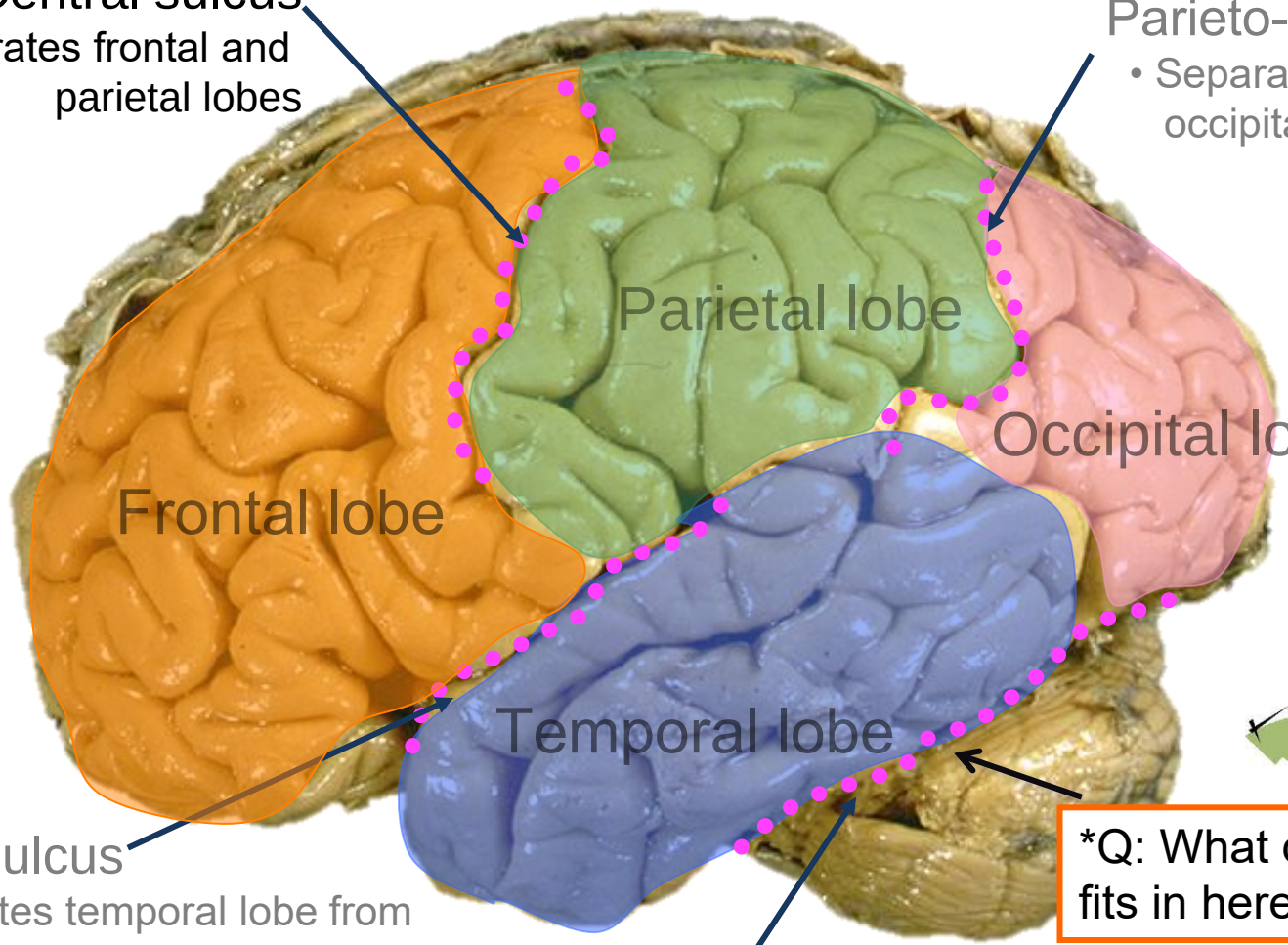


SULCUS = “furrow/valley”
pl SULCI = “furrows/valleys”

GYRUS = “hill”
pl GYRI = “hills”

Photo: Anatomy Museum.
Equivalent to Martini et al. Visual Anatomy and Physiology (3rd ed), Module 13.11, p. 530

External anatomy of the brain: Major sulci, gyri and fissures



*Q: What dural fold fits in here?

Functions associated with lobes of the cerebrum (cerebral cortex)

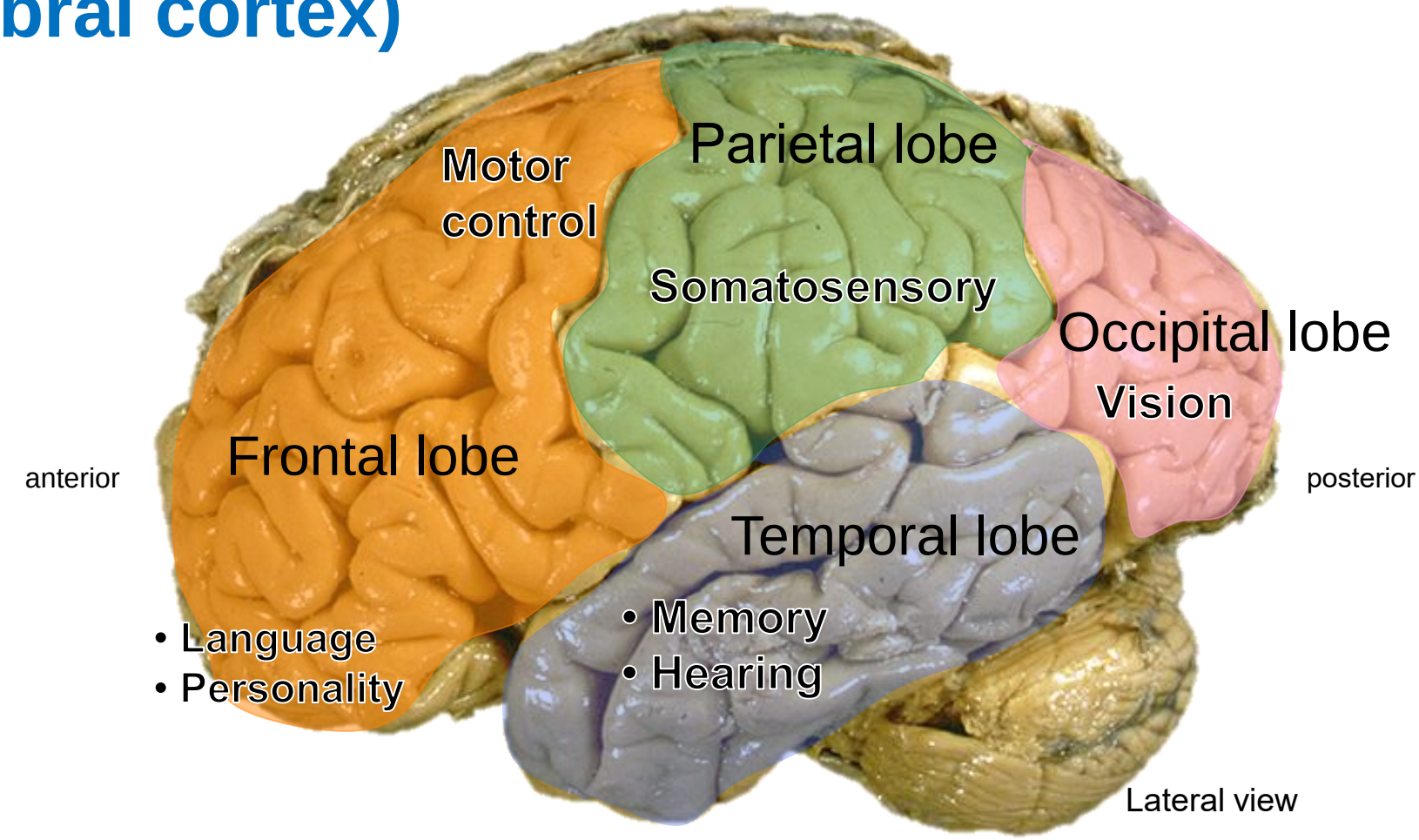


Photo: Anatomy Museum.
See also Martini et al.

Major divisions of the brain: medial view

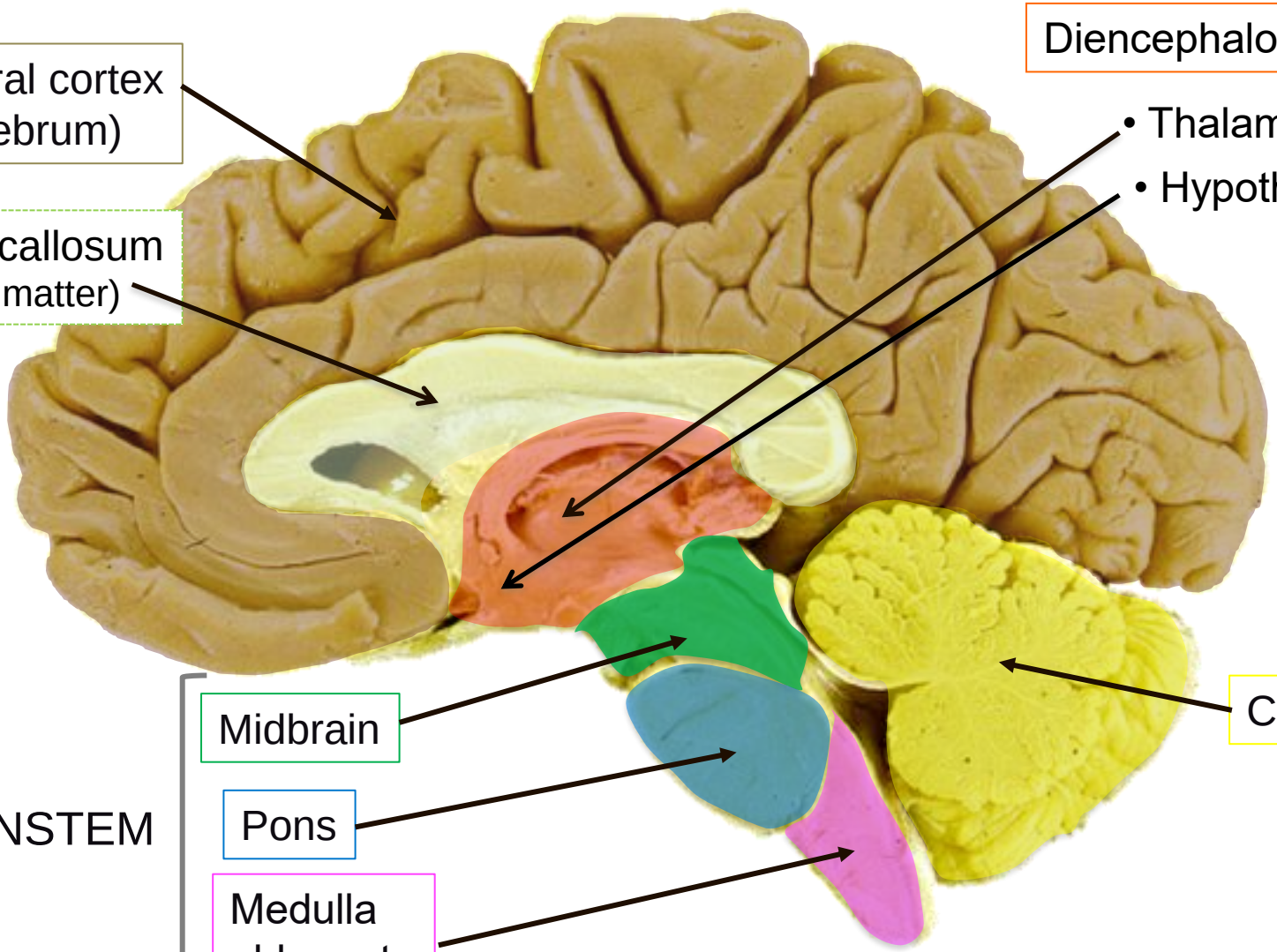
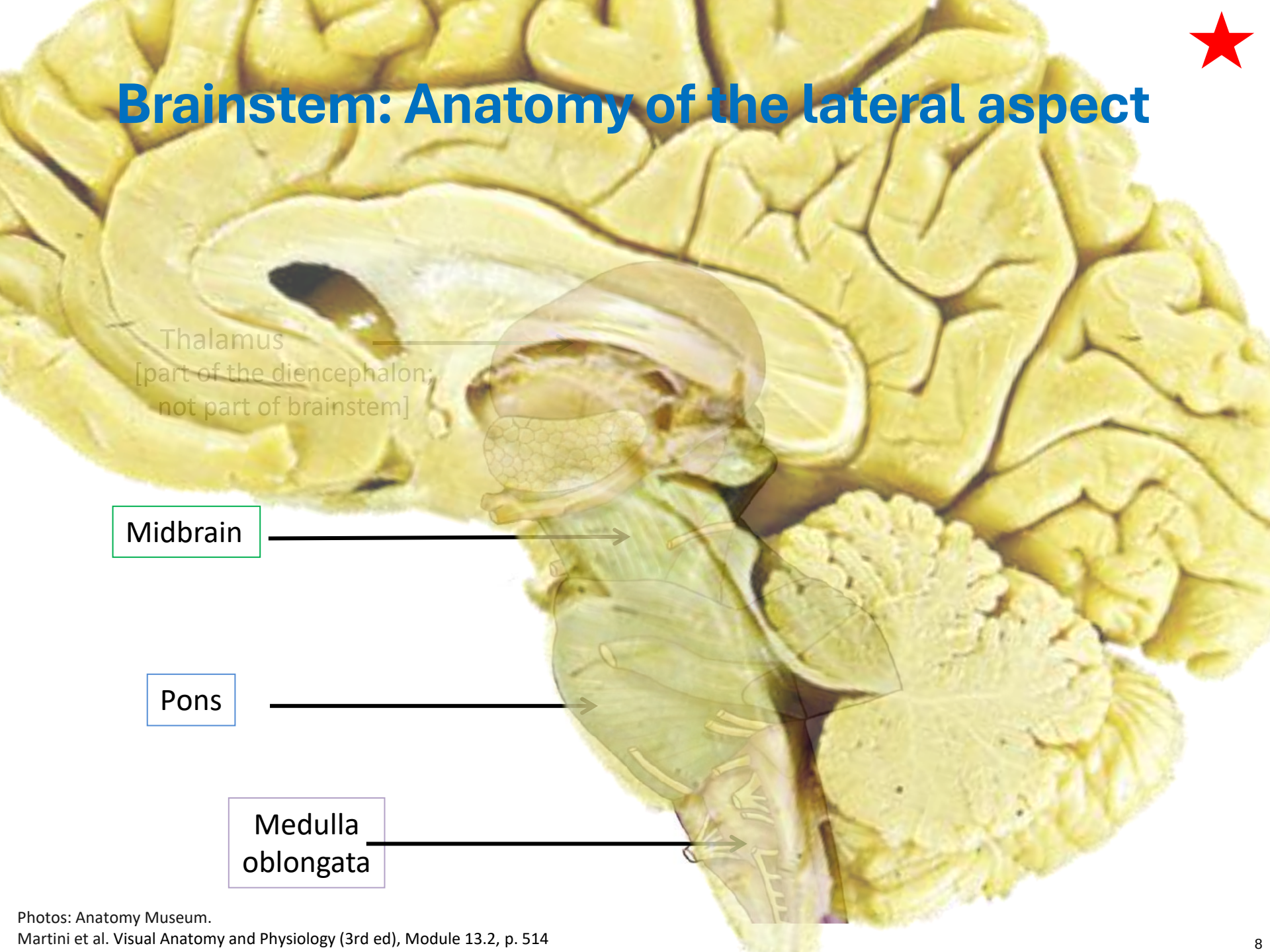


Photo: Anatomy Museum.
Equivalent to Martini et al. Visual Anatomy and Physiology (3rd ed), Module 13.11, p. 531

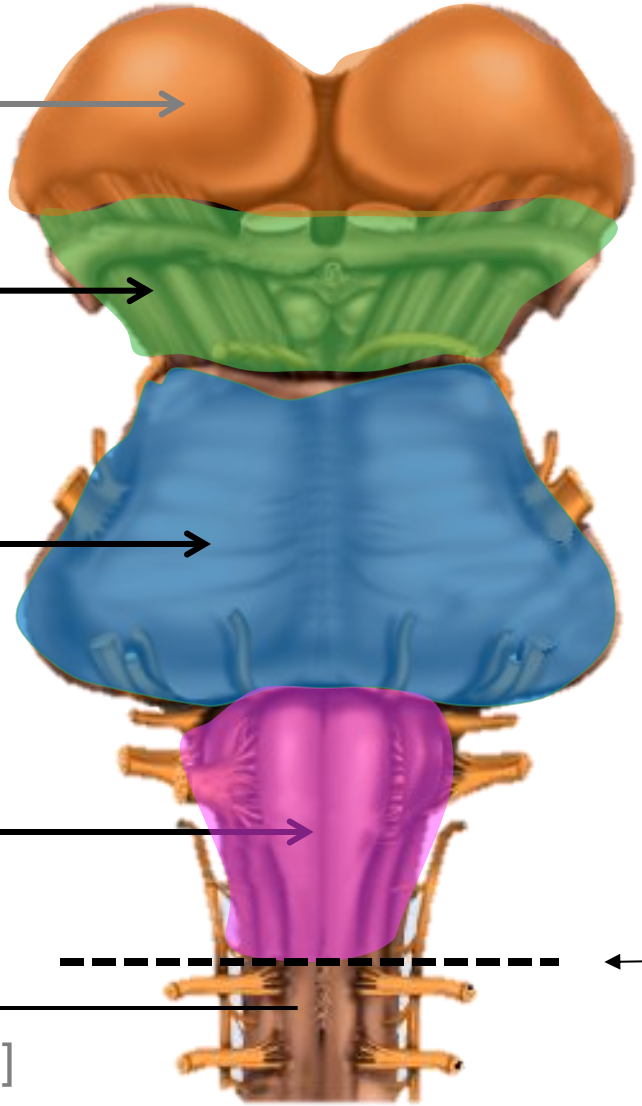
Brainstem: Anatomy of the lateral aspect



Photos: Anatomy Museum.
Martini et al. Visual Anatomy and Physiology (3rd ed), Module 13.2, p. 514

Brainstem: Anatomy of the ventral aspect

("facing" you)



Thalamus
[part of diencephalon; not part of brainstem]

Midbrain

Pons

Medulla oblongata

Spinal cord
[not part of brainstem]

Level of foramen magnum

Saladin, Fig. 14.8 (P. 525).
Equivalent to Martini et al. Visual Anatomy and Physiology (3rd ed), Module 13.2, p. 514

Internal structures of the brain: Coronal view

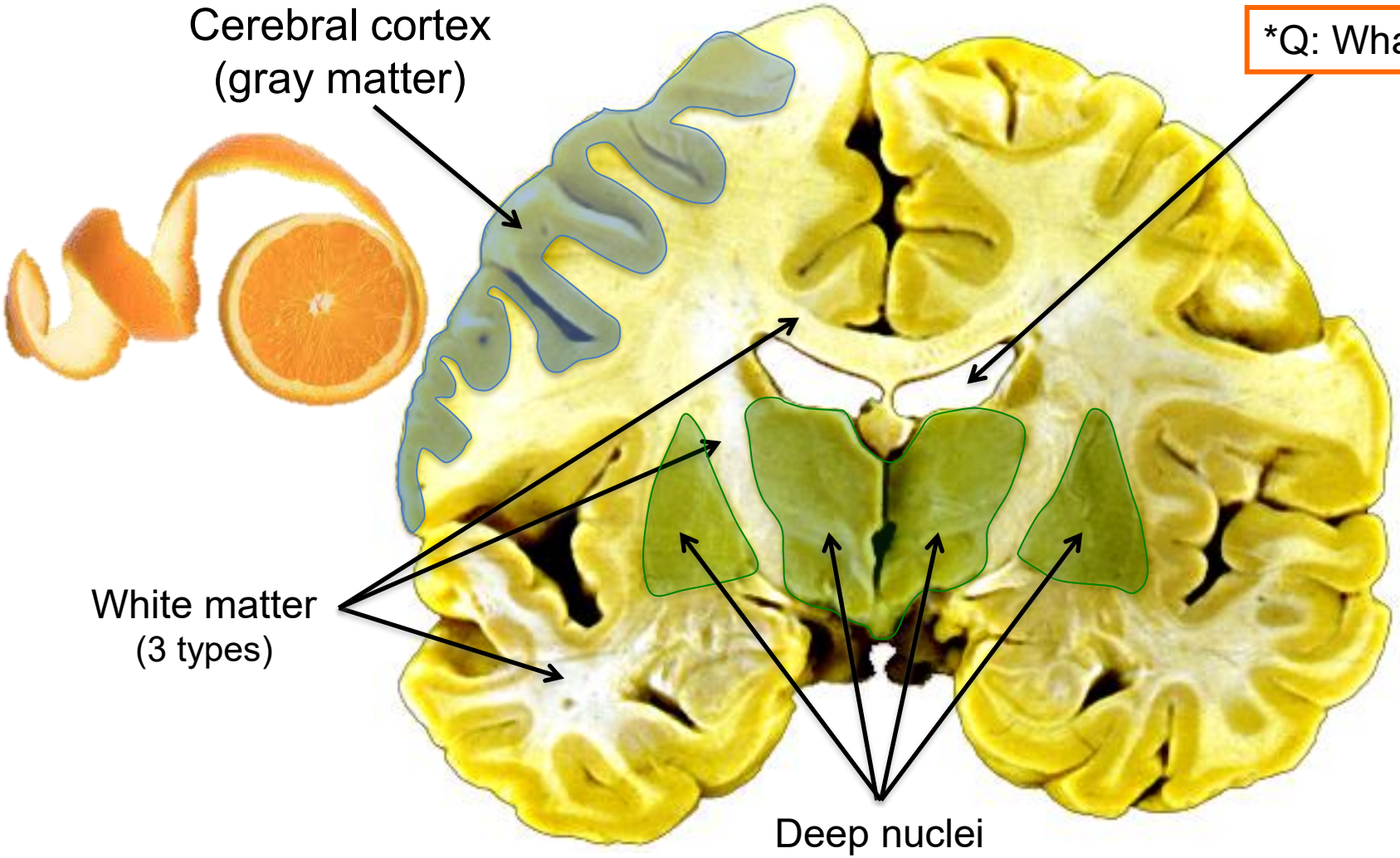


Photo: Anatomy Museum.
See similar: Martini et al. Visual Anatomy and Physiology (3rd ed), Module 13.10, p. 528 (bottom)

3 types of White Matter: #1 Commissural tracts

- Axons cross from side to side;
  - Both directions

- *Example*: Corpus callosum

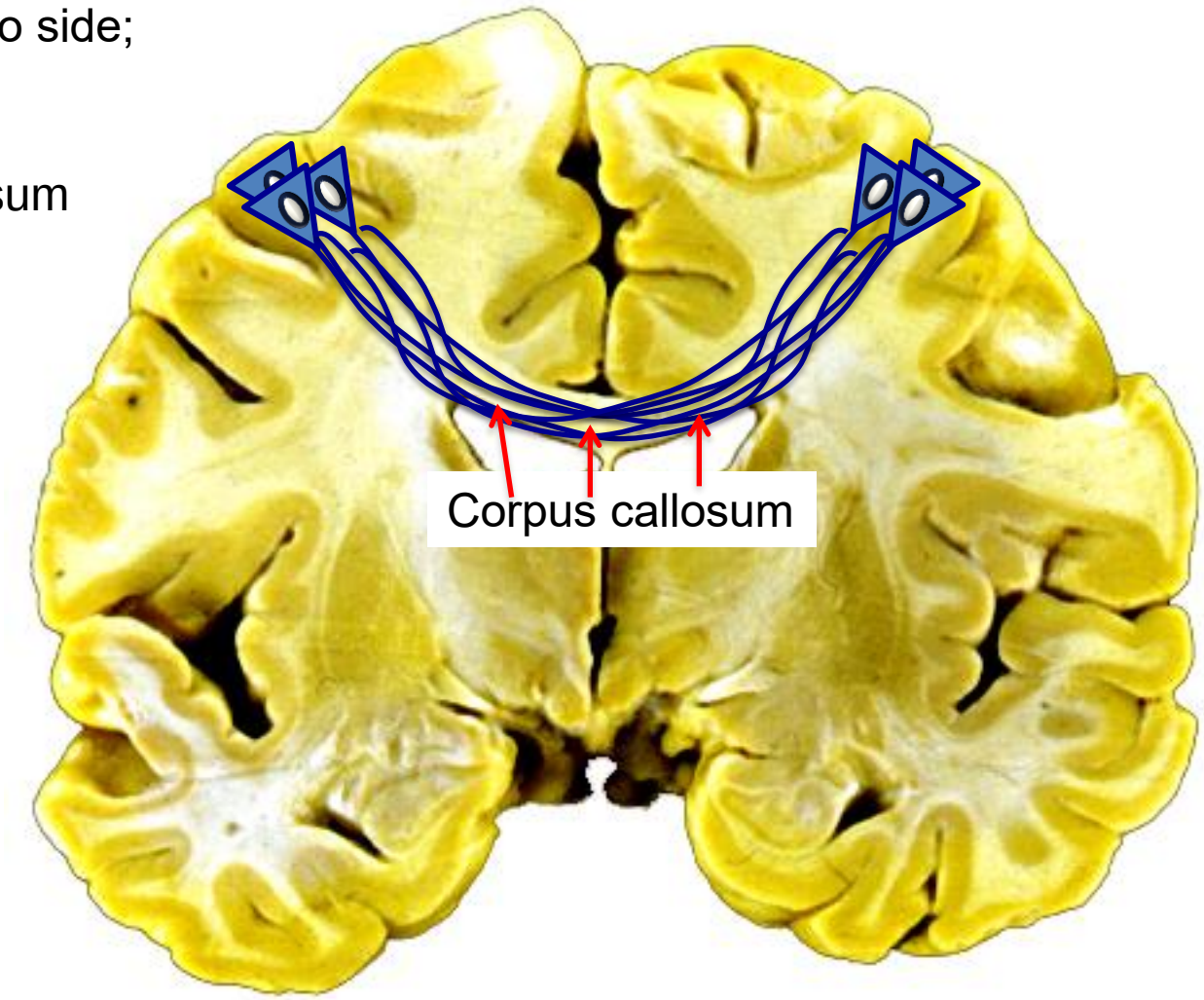


Photo: Anatomy Museum.
See also 13.13.2

3 types of White Matter: #2 Projection tracts

- Axons extend between cortex and other CNS areas outside cerebrum

- *Example*: **Corticospinal tract** (somatic motor pathway) [in a few slides!]

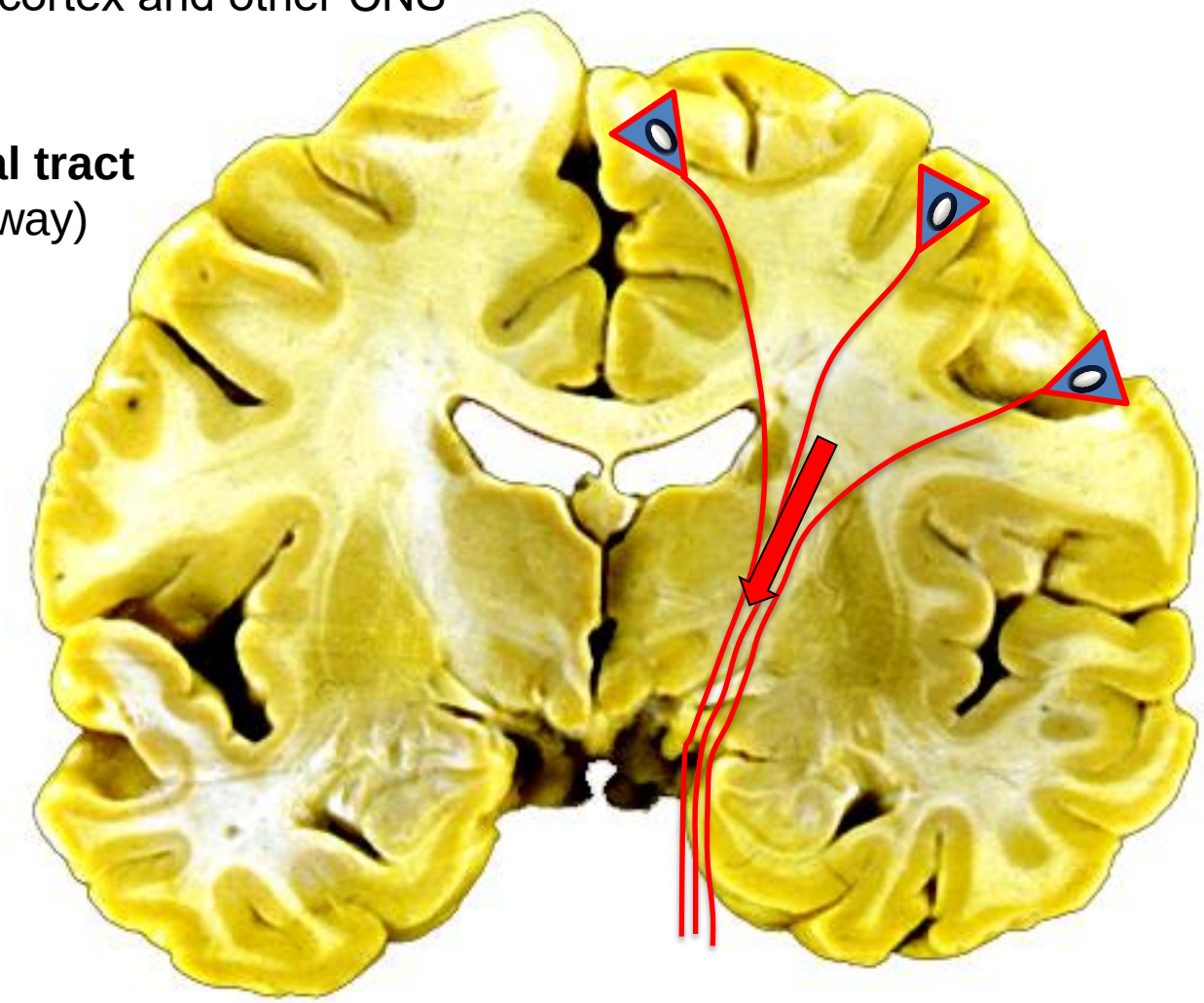
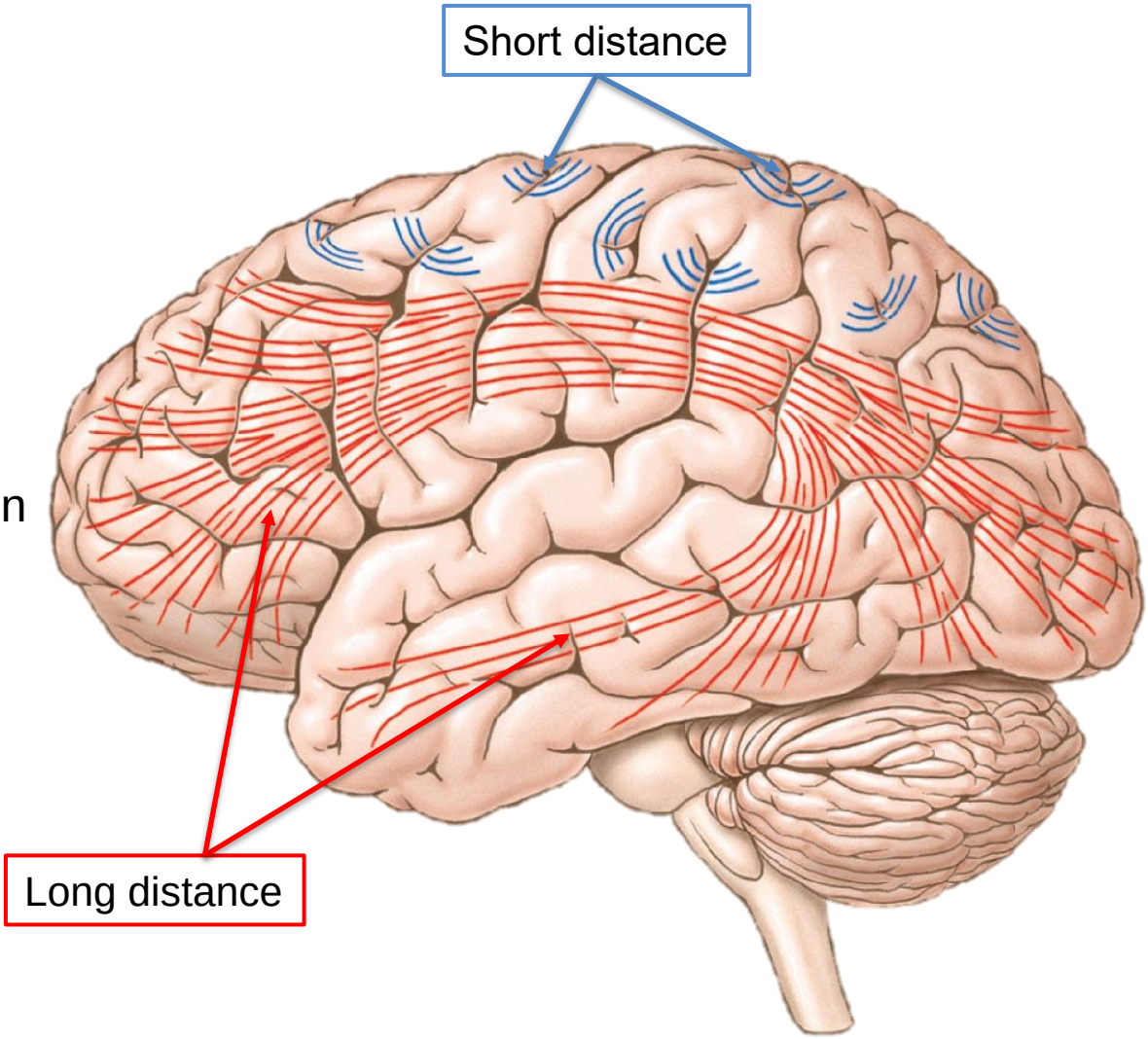


Photo: Anatomy Museum.
See also 13.13.2

3 types of White Matter: #3 Association tracts

1. Axons on <u>same</u> side within cerebral cortex

2. Communication between brain areas
    - Short or long distance



Martini et al. 13.13.1

Major cortical areas for motor control and somatosensory perception

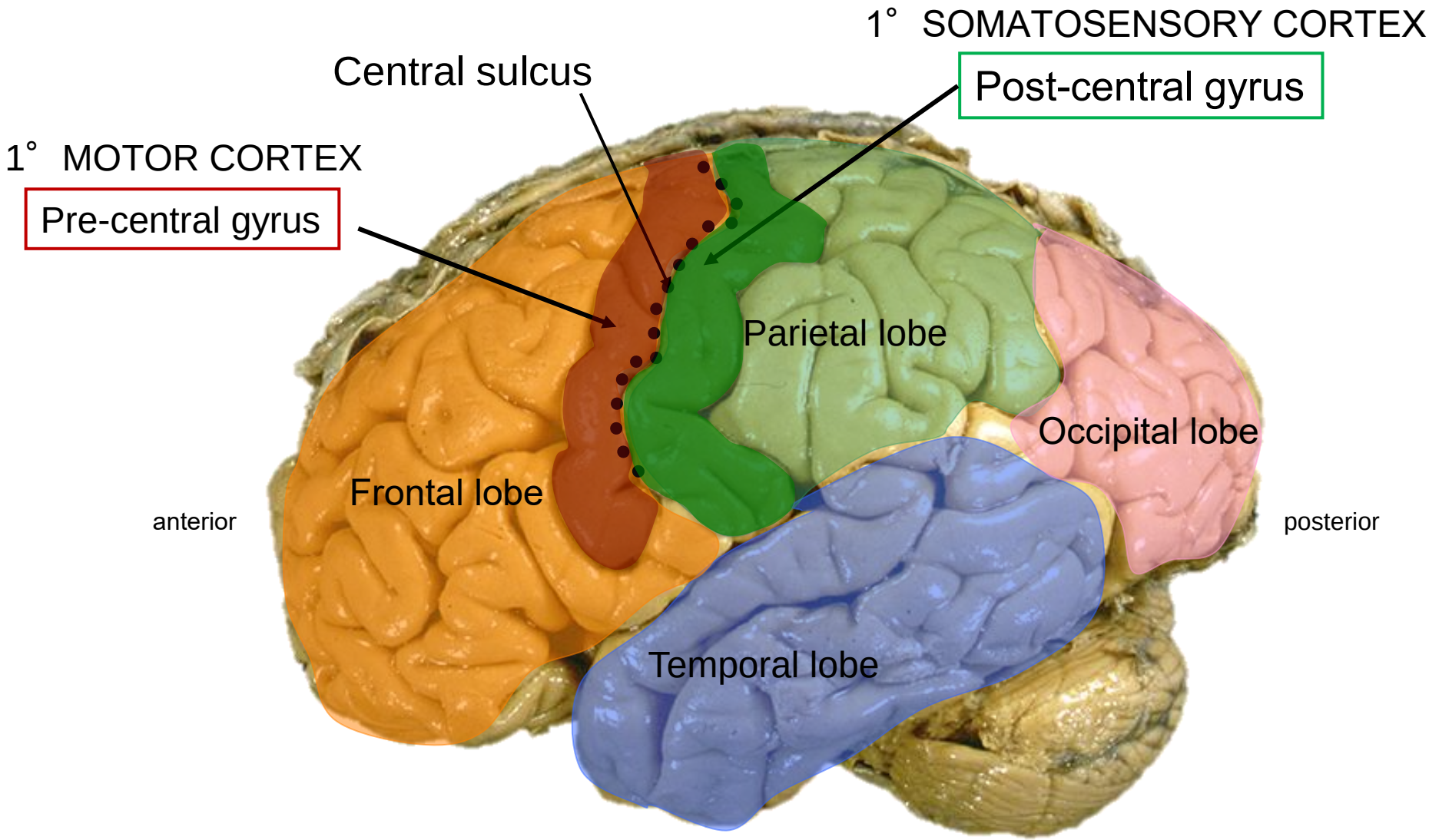


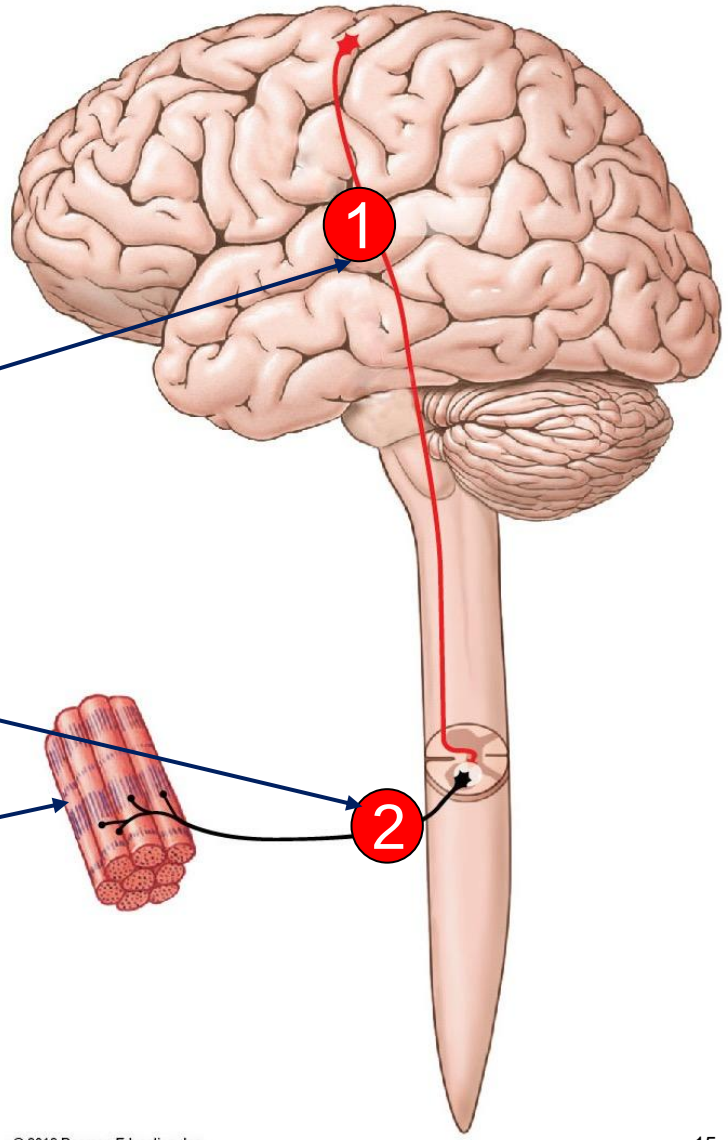
Photo: Anatomy Museum.
Equivalent to Martini Fig. 13.11, pp530,531

Summary: Somatic Efferent (motor) division

[Review: Lecture 17, slide 11]

Upper motor neuron cell body is in primary motor cortex = precentral gyrus

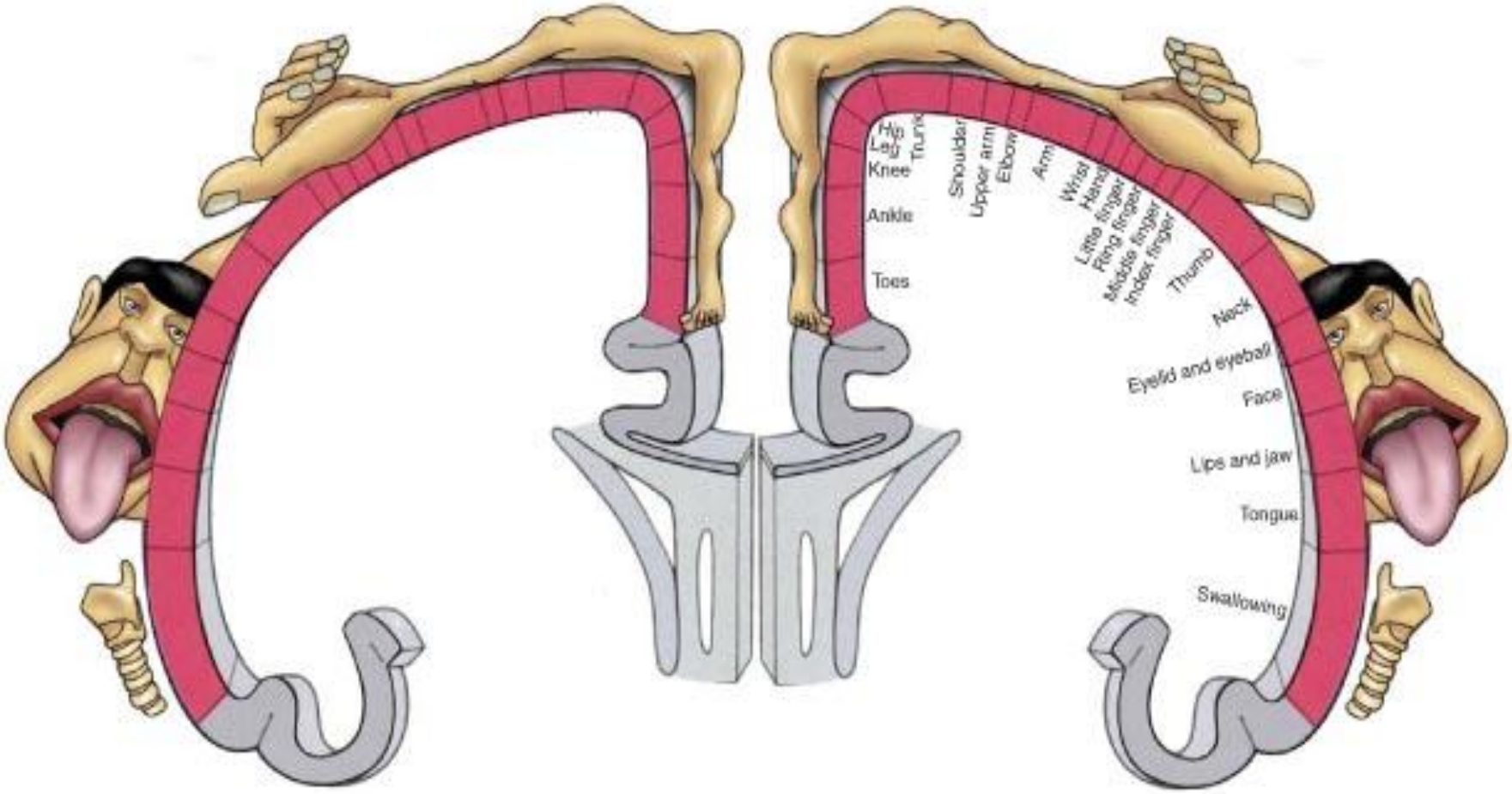
- Voluntary movement
- Efferent - information flow *AWAY* from CNS
- Two neurons between brain & effector
  1. UPPER motor neuron
  2. LOWER motor neuron
- Axons are myelinated
- Neurotransmitter = Acetylcholine (ACh)
- Effector = skeletal muscle



Modified from Martini, Fig. 14.1, p559

Primary motor cortex organisation

- The precentral gyrus functions as the primary motor cortex
- Specific regions of the motor cortex control specific regions of the body



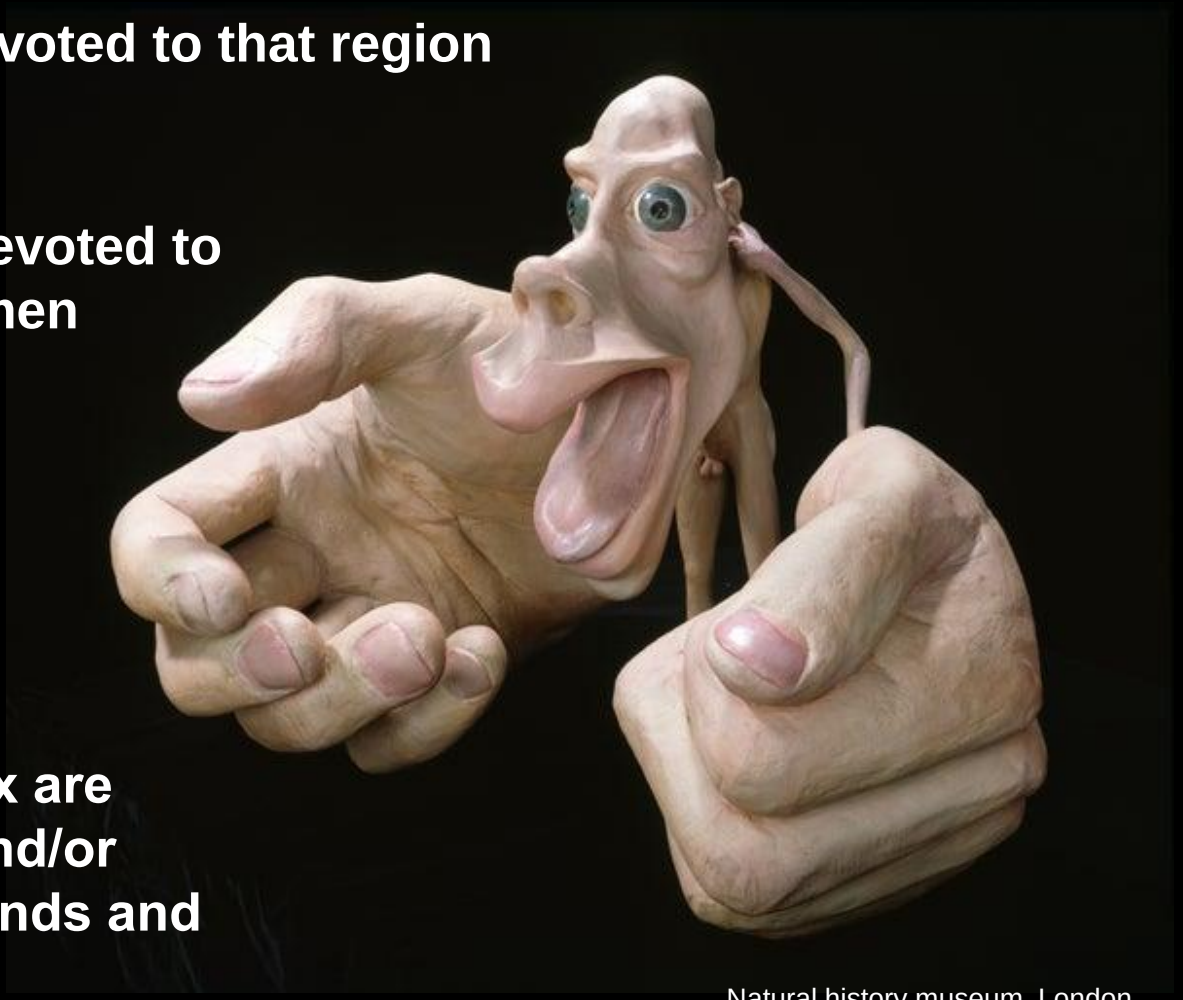
Photos: Anatomy Museum.
Equivalent to Martini Fig. 13.11, pp530,531, 546

The homunculus

Body scaled to the area of cortex devoted to that region

Relatively little area is devoted to regions like trunk/abdomen

Large regions of cortex are devoted to sensitive and/or precision areas like hands and mouth/tongue



Natural history museum, London

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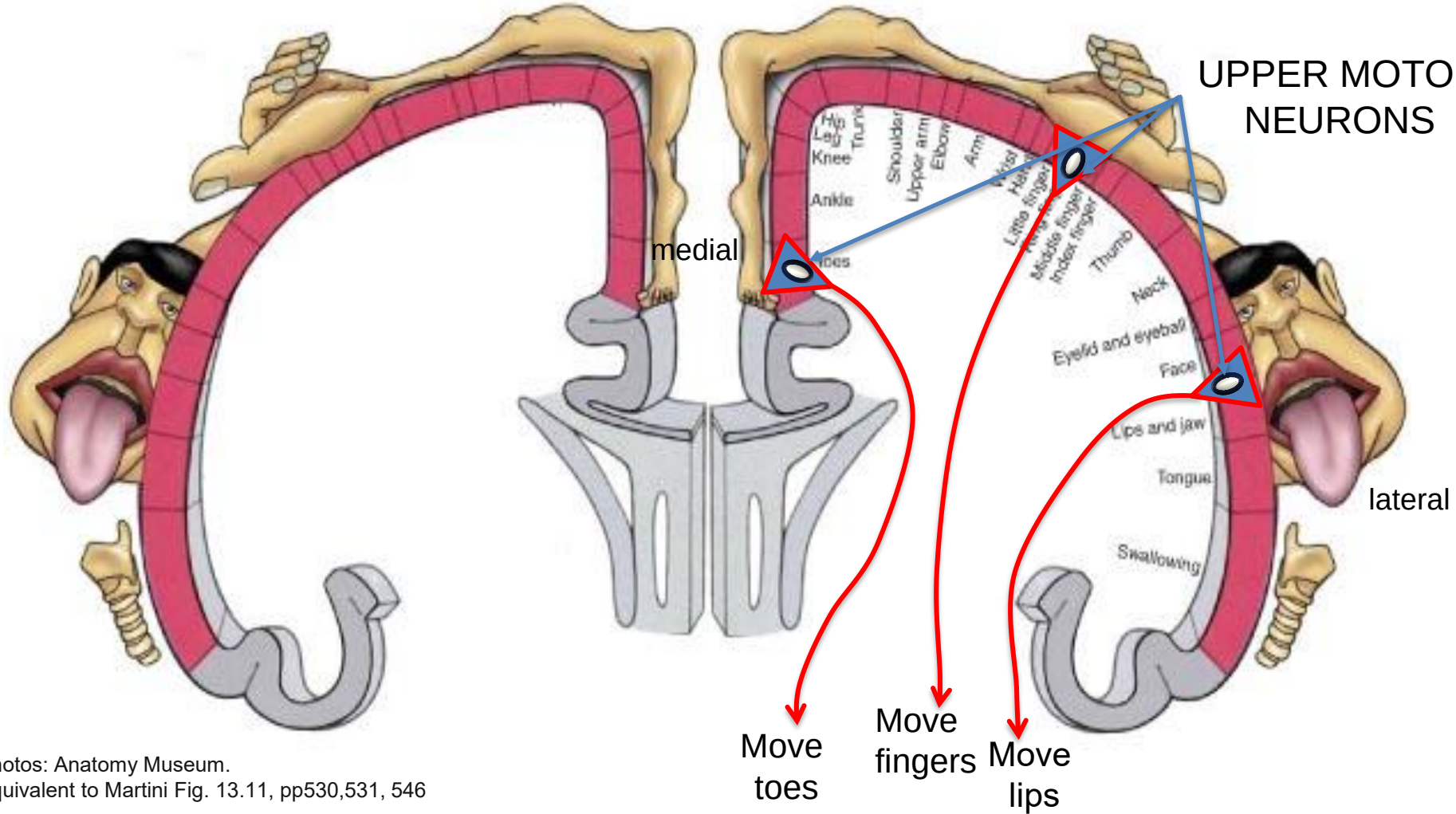


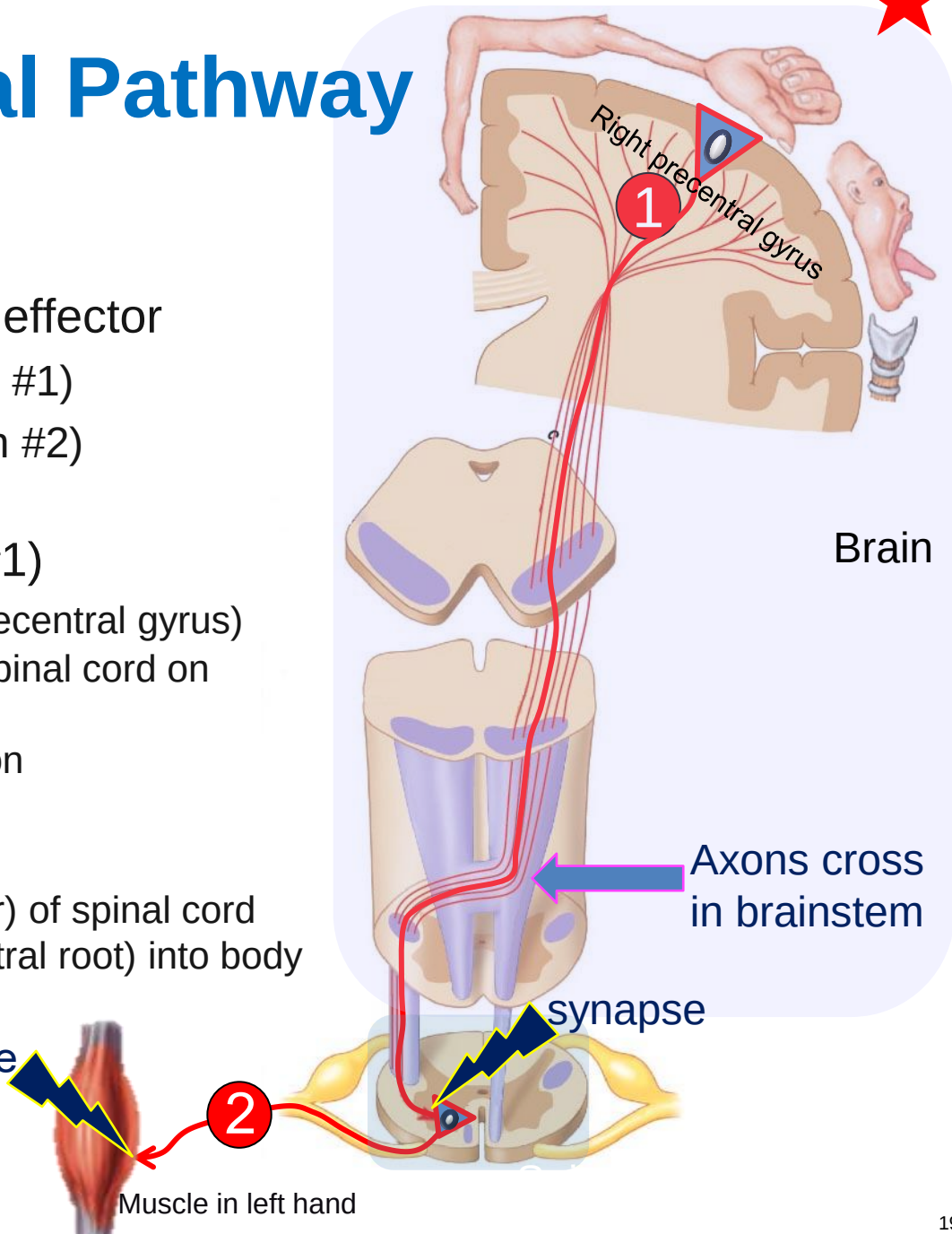
Photos: Anatomy Museum.
Equivalent to Martini Fig. 13.11, pp530,531, 546

The Corticospinal Pathway

- Somatic efferent
- Two neurons between brain & effector
  1. UPPER motor neuron (neuron #1)
  2. LOWER motor neuron (neuron #2)

- UPPER motor neuron (neuron #1)
  1. Cell body in primary motor cortex (precentral gyrus)
  2. Axon extends from motor cortex to spinal cord on ***opposite*** side
  3. Makes synapse on lower motor neuron

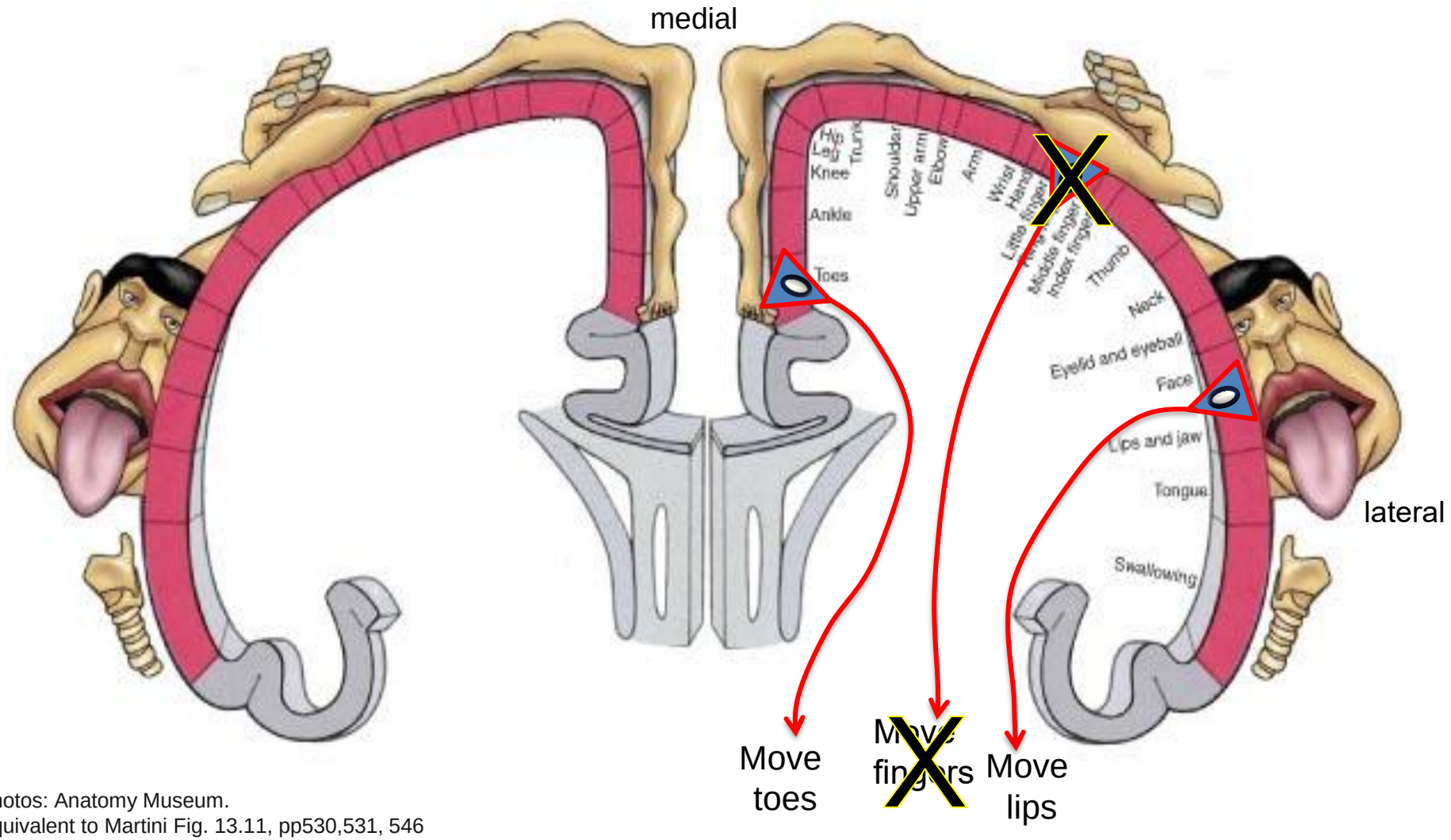
- LOWER motor neuron (neuron #2)
  1. Cell body in ventral horn (grey matter) of spinal cord
  2. Axon extends out of spinal cord (ventral root) into body
  3. Makes synapse on skeletal muscle



Modified from Martini Fig. 13.20, p546

Primary motor cortex damage

- Damage to the motor cortex → Muscle weakness and paralysis in region of body corresponding to the location of damage, opposite side



Photos: Anatomy Museum.
Equivalent to Martini Fig. 13.11, pp530,531, 546

Major cortical areas for motor control and somatosensory perception

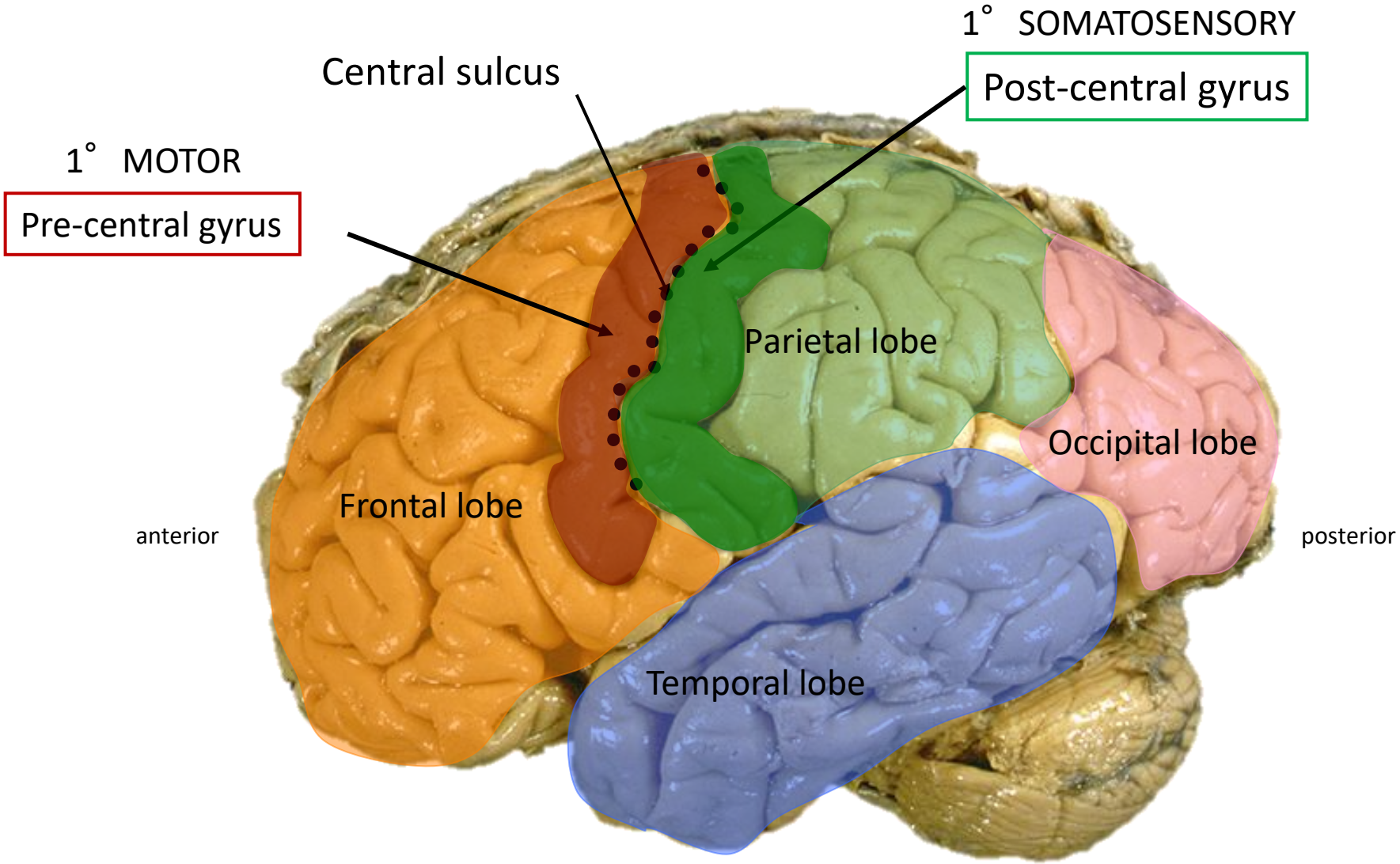
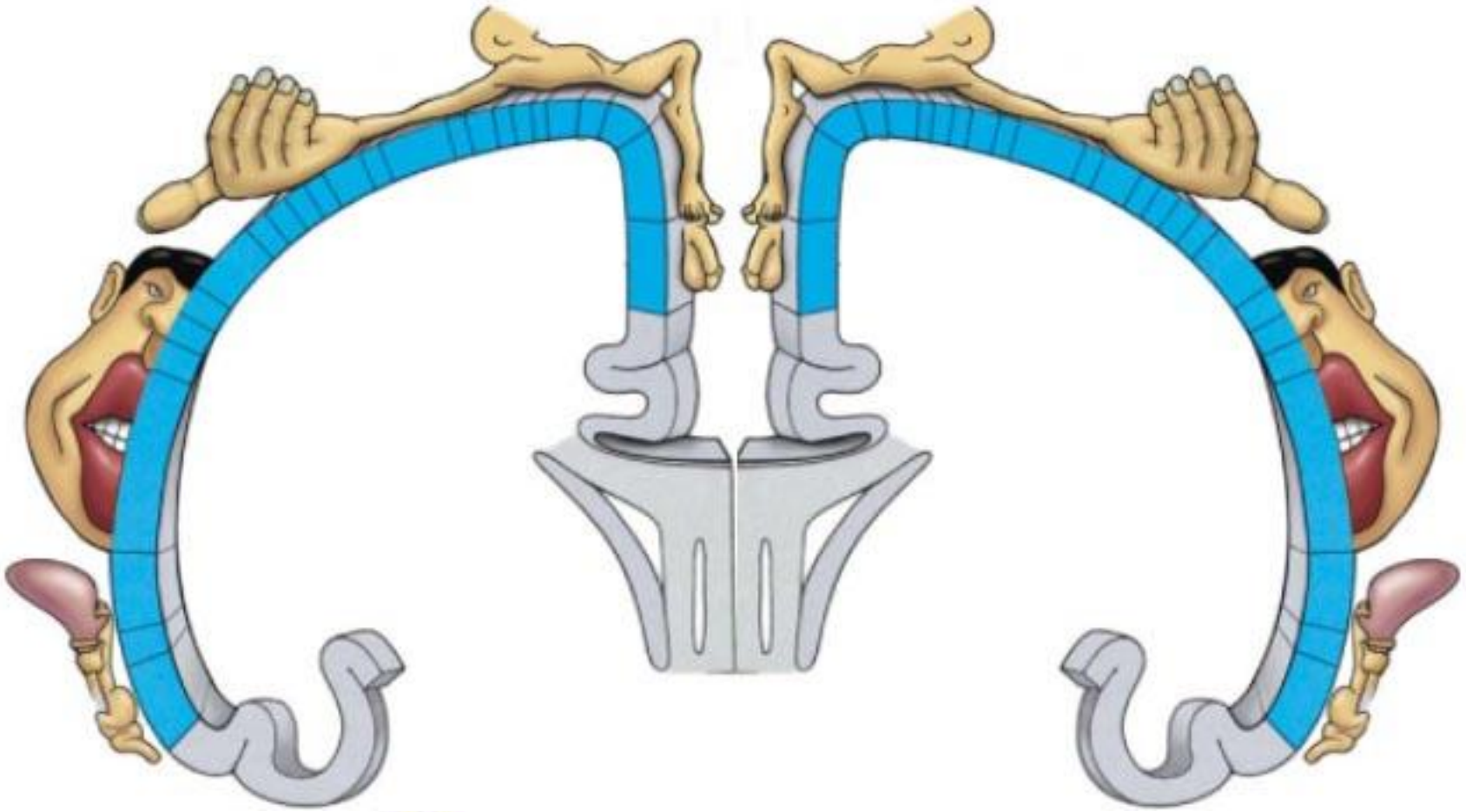


Photo: Anatomy Museum.
Equivalent to Martini Fig. 13.11, pp530,531

Primary somatosensory cortex organisation

- The postcentral gyrus functions as the primary somatosensory cortex
- Specific regions of the somatosensory cortex receive sensory information from specific regions of the body



Photos: Anatomy Museum.
Equivalent to Martini Fig. 13.19, p545

Primary somatosensory cortex organisation

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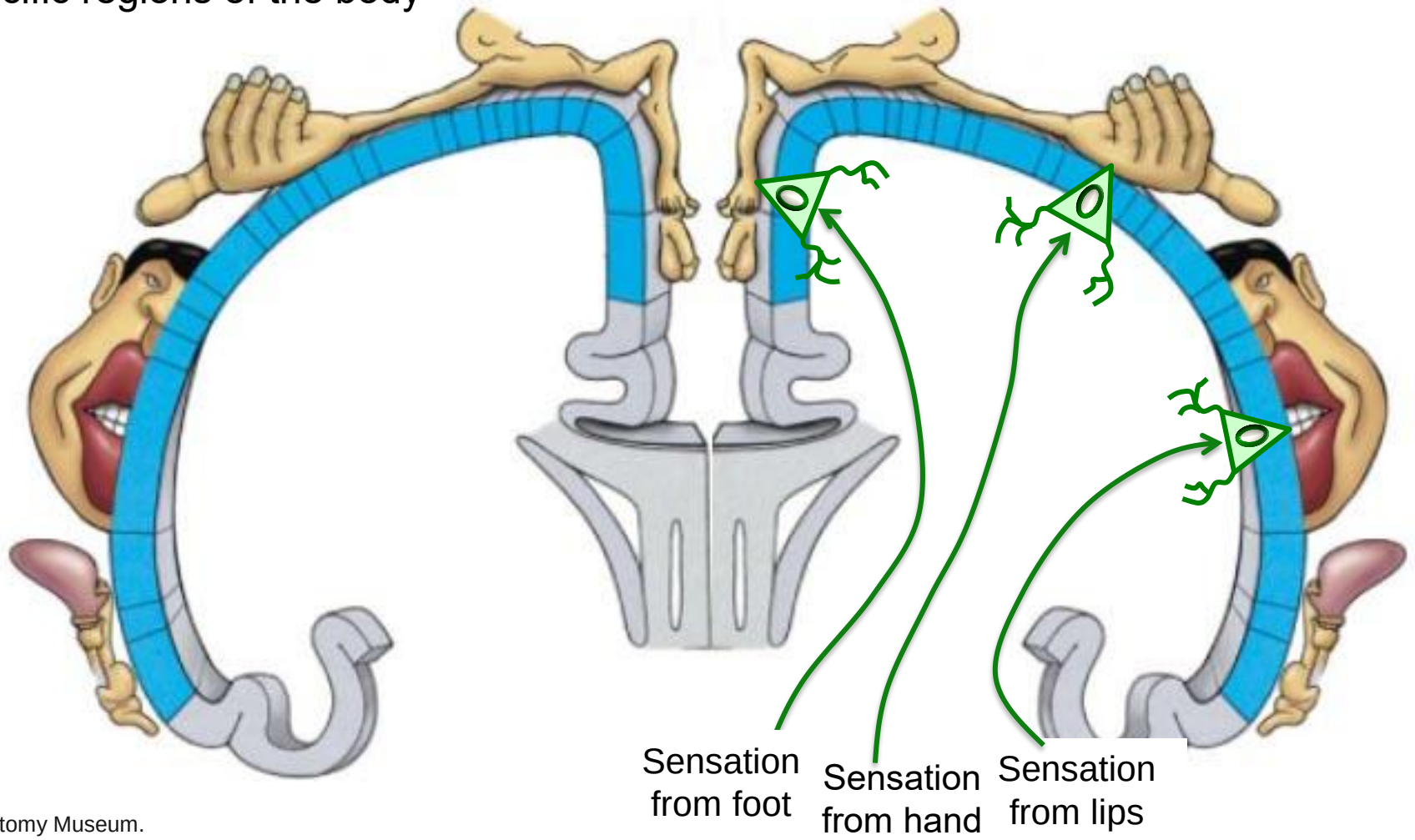


Photos: Anatomy Museum.
Equivalent to Martini Fig. 13.19, p545

The Dorsal/Posterior Column Pathway

Fine touch, vibration, pressure, proprioception

- *Three* neurons between sensory receptor (in body) and somatosensory neuron in postcentral gyrus

Neuron #1

a. Cell body in dorsal root ganglion (unipolar neuron, lecture 16,17)
b. Peripheral fibre (input zone, lecture 16,17) from sensory receptor in skin
c. Central fibre (output zone, lecture 16,17) ascends toward brain in dorsal columns (spinal cord white matter, lecture 20).
d. Makes synapse on neuron #2 in medulla oblongata

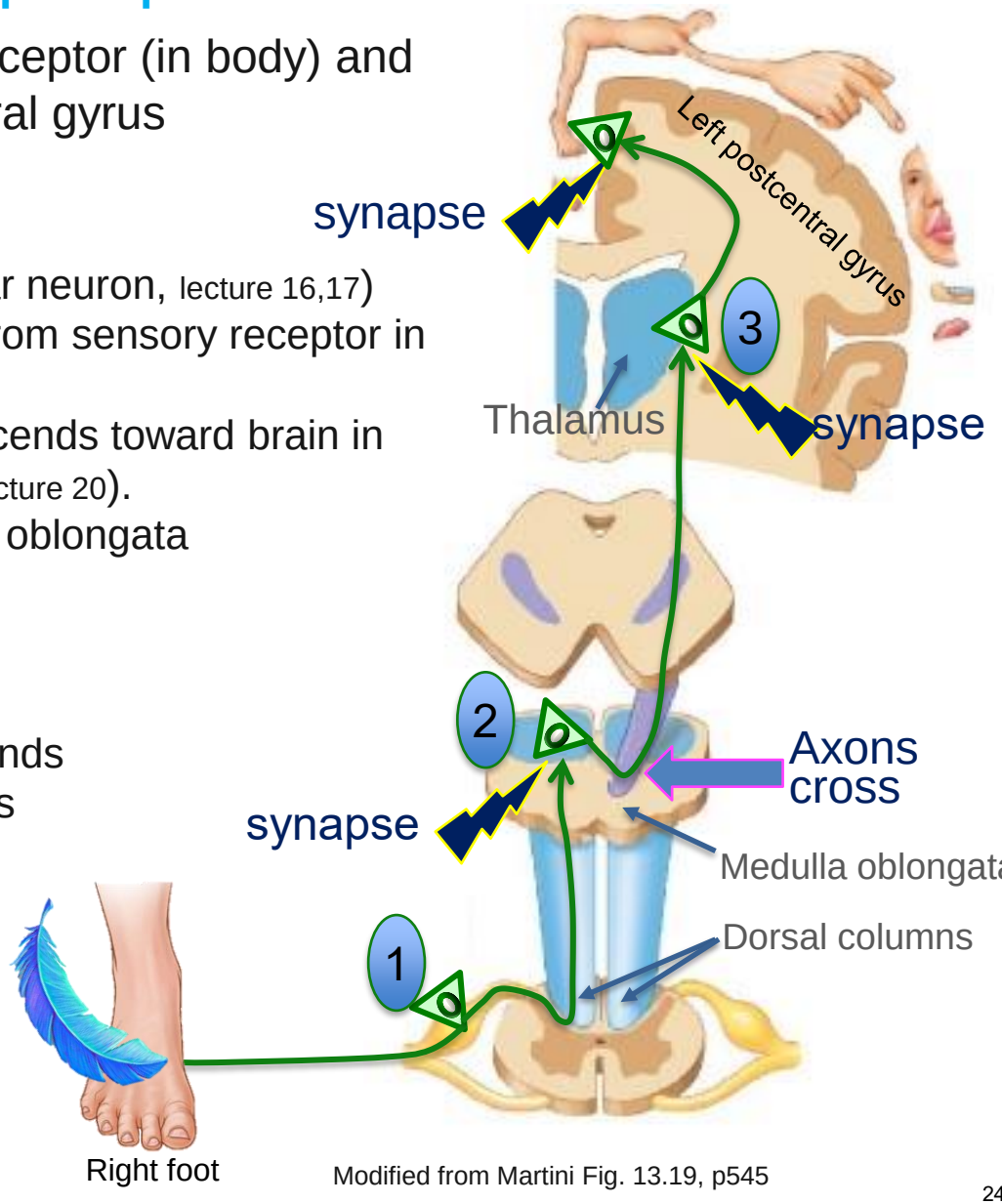
Neuron #2

a. Cell body in medulla oblongata
b. Axon crosses to **opposite** side and ascends
c. Makes synapse on neuron #3 in thalamus

Neuron #3

a. Cell body in thalamus
b. Axon ascends to somatosensory cortex
c. Makes a synapse on the cell body of a somatosensory cortex neuron

→ Perception of light touch on foot



Modified from Martini Fig. 13.19, p545

The Spinothalamic Tract

Pain, Temperature

- *Three* neurons between sensory receptor (in body) and somatosensory neuron in postcentral gyrus

Neuron #1

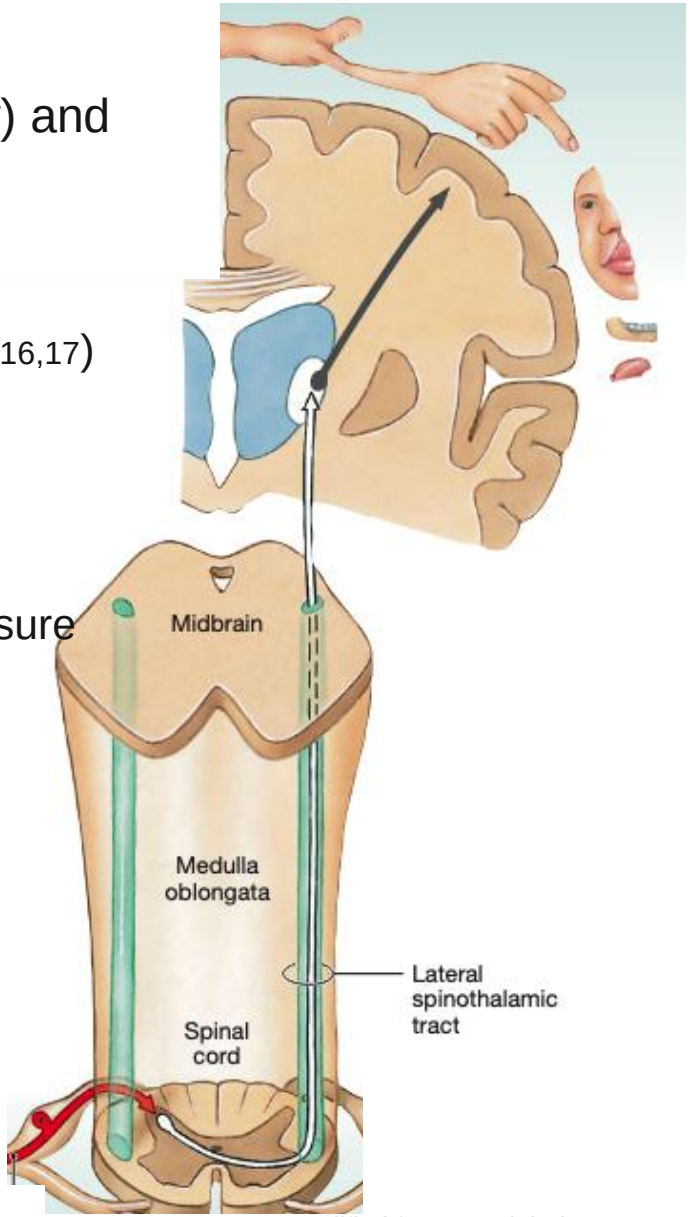
a. Cell body in dorsal root ganglion (unipolar neuron, lecture 16,17)
b. Makes synapse on neuron #2 in spinal cord

Neuron #2

a. Cell body in **spinal cord**
b. Axon crosses to **opposite** side via anterior white commissure
c. Cells are called *tract cells*
c. Makes synapse on neuron #3 in thalamus

Neuron #3

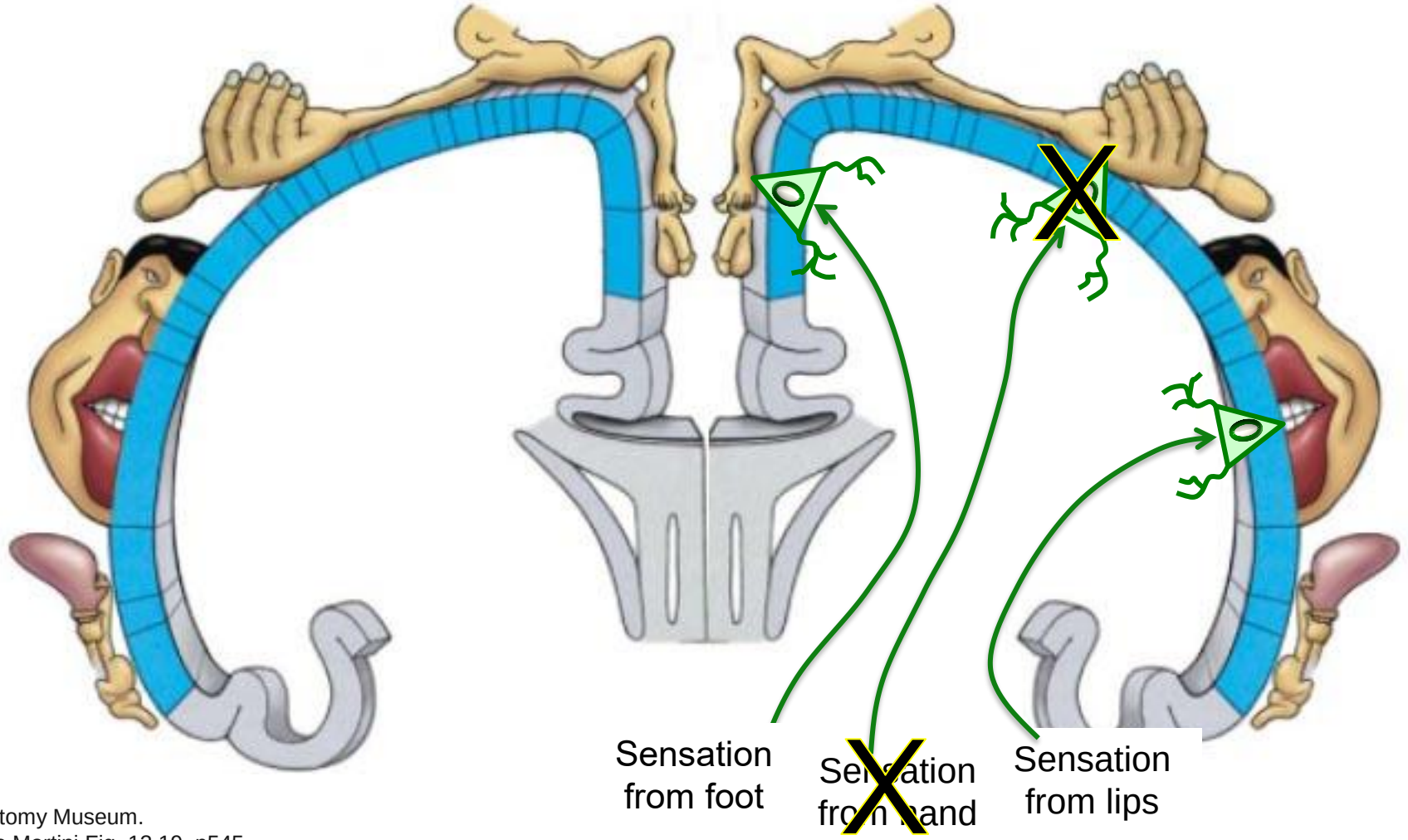
a. Cell body in thalamus
b. Axon ascends to somatosensory cortex
c. Makes a synapse on the cell body of a somatosensory cortex neuron



Modified from Martini Fig. 13.19, p545

Primary somatosensory cortex damage

Cell in somatosensory cortex that receives information from dorsal column pathway dies
→ Ascending information has no place to go
→ No perception of touch in that area of body on opposite side



Photos: Anatomy Museum.
Equivalent to Martini Fig. 13.19, p545

Cortex damage: Agnosias and Aphasias

Agnosia: Damage to a region involved with sensory perception

Causes changes in perception

Aphasia: Damage to regions governing language

Changes in speech perception or production

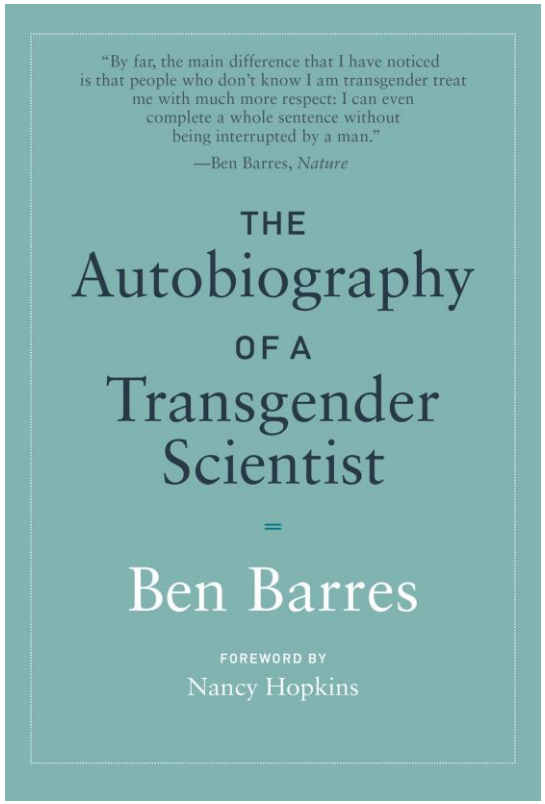
Example Agnosias:

Prosopagnosia: "Face blindness". Two kinds:

1. Apperceptive: cannot recognize facial expressions/cues

2. Associative: Cannot recognize an individual from their facial features

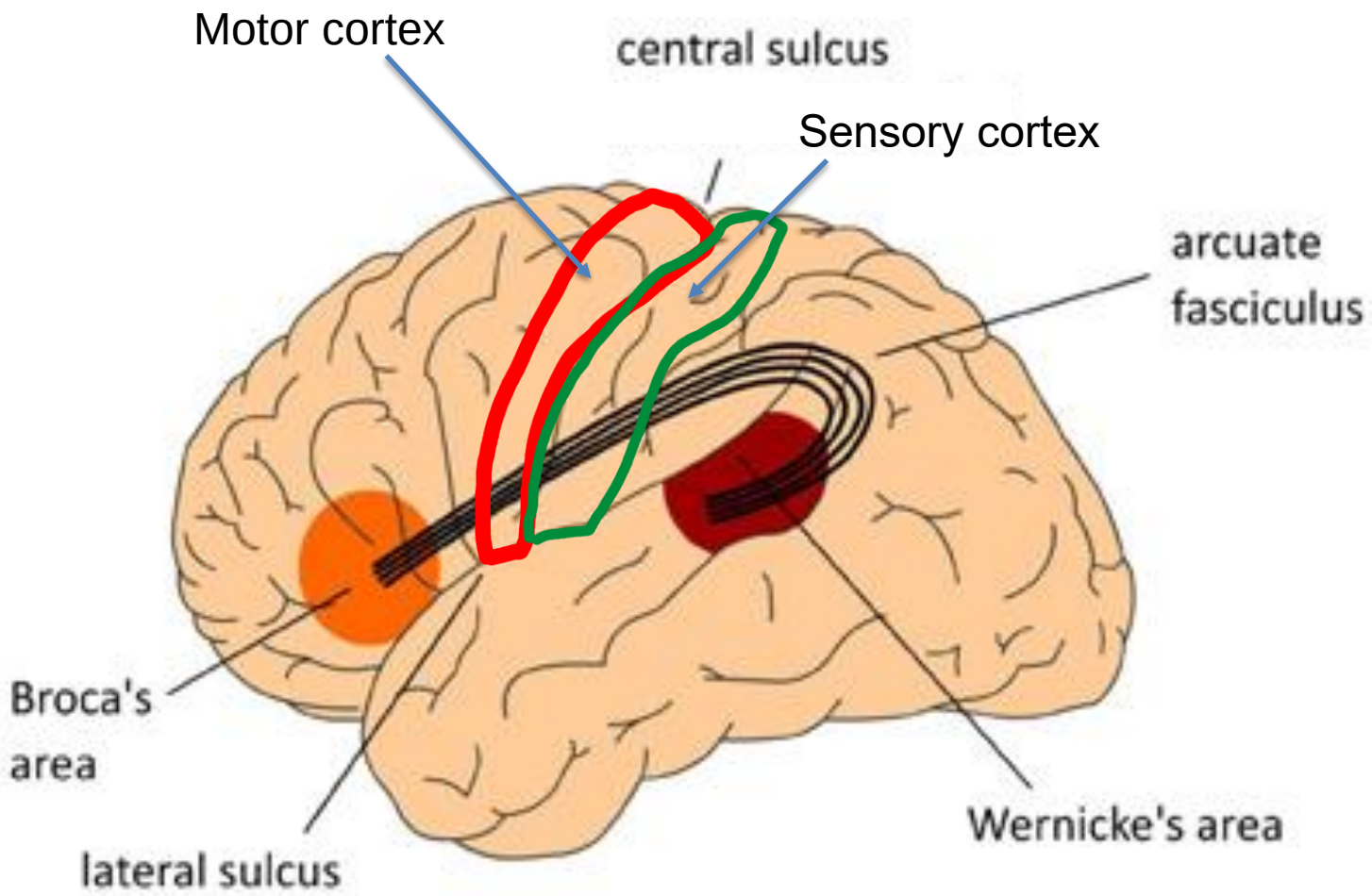
Ben Barres: Brilliant Neuroscientist, Champion for women in science



Example Aphasias:

Wernicke's: Individuals can produce words and even whole sentences, but the meaning is lost – create "word salad"

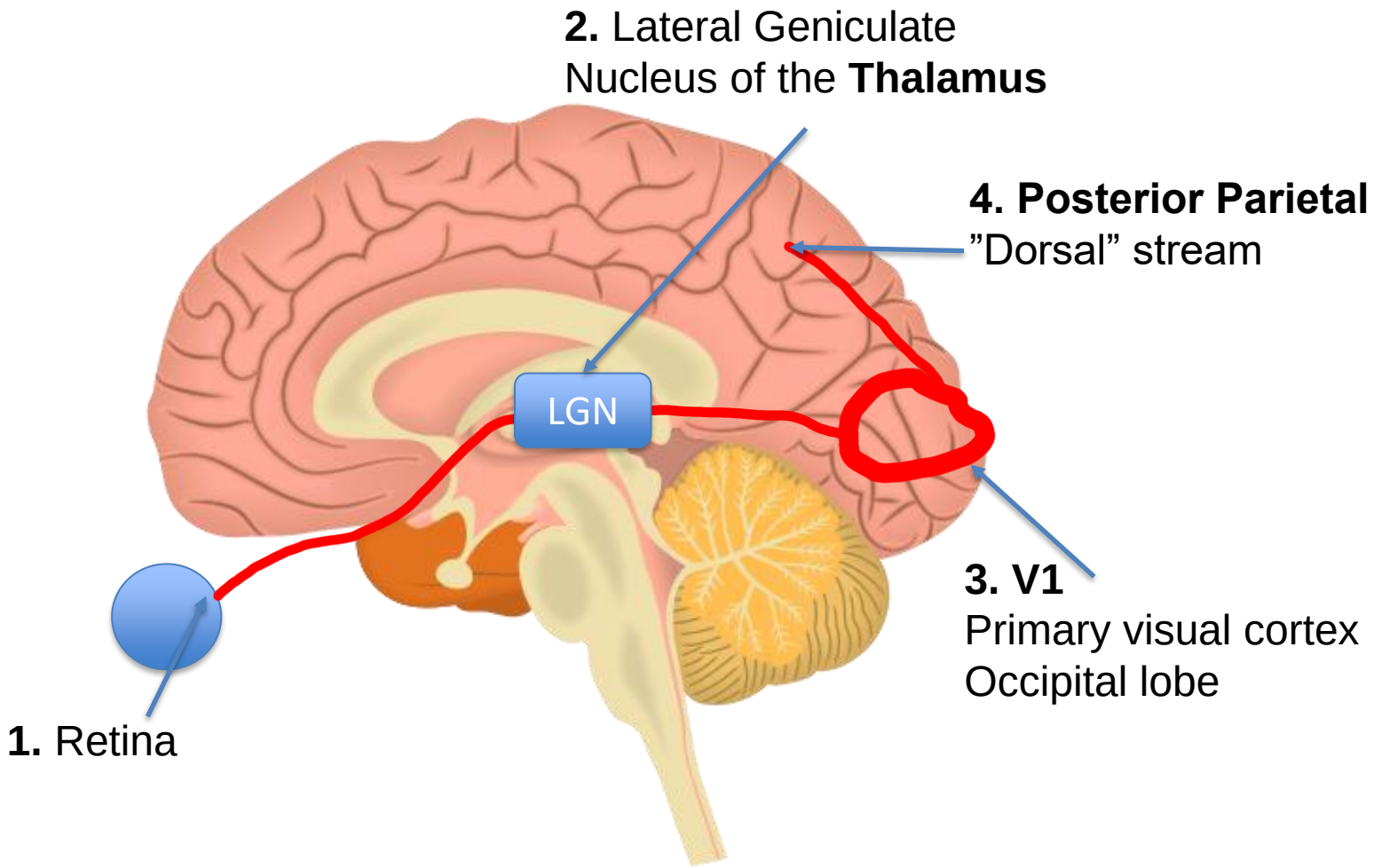
Broca's: Individuals can understand words, but cannot form the motor patterns to produce whole speech


Motor cortex
central sulcus
Sensory cortex
arcuate
fasciculus
Broca's
area
lateral sulcus
Wernicke's area

Blindsight

Primary visual pathway

Retina ➡ LGN ➡ V1 ➡ Posterior Parietal

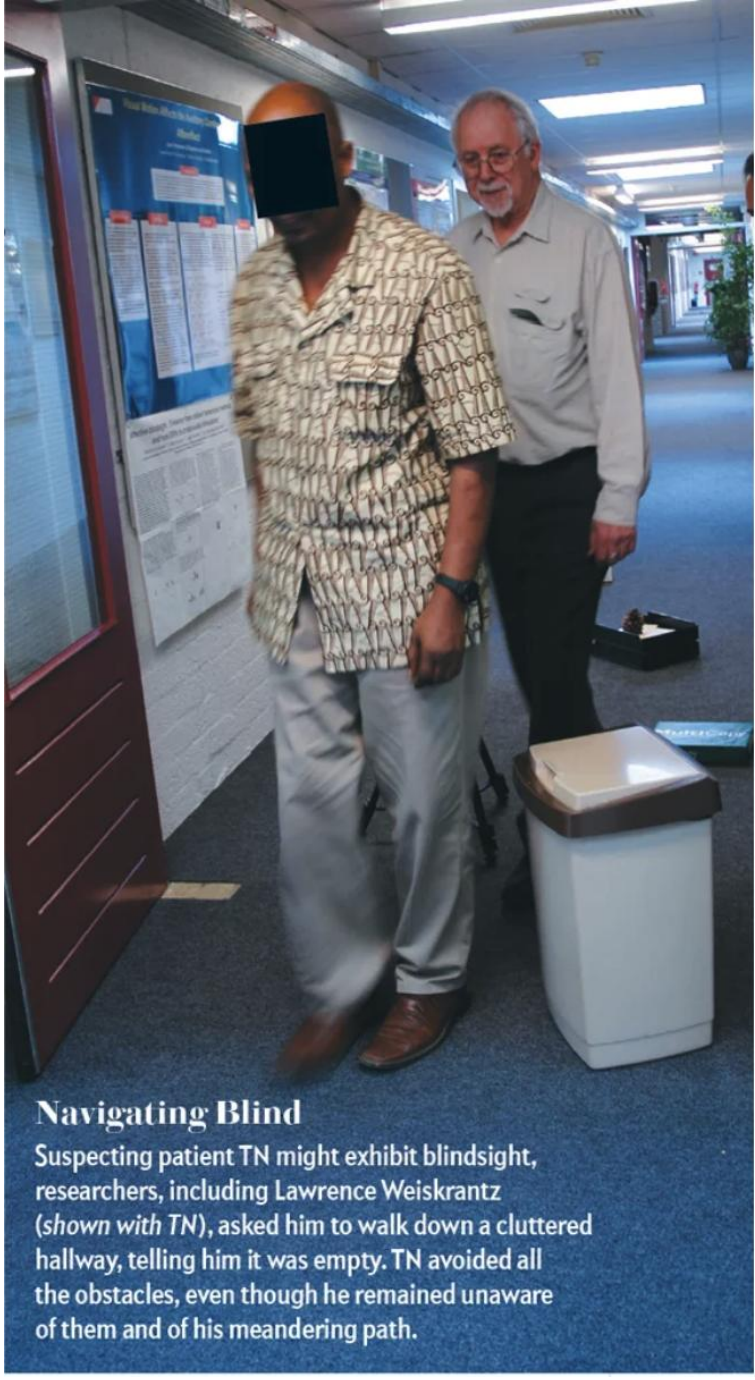


Blindsight

Damage to V1

Individuals report **no conscious perception** of “sight” – they experience blindness

Individuals ***still react to visual stimuli***



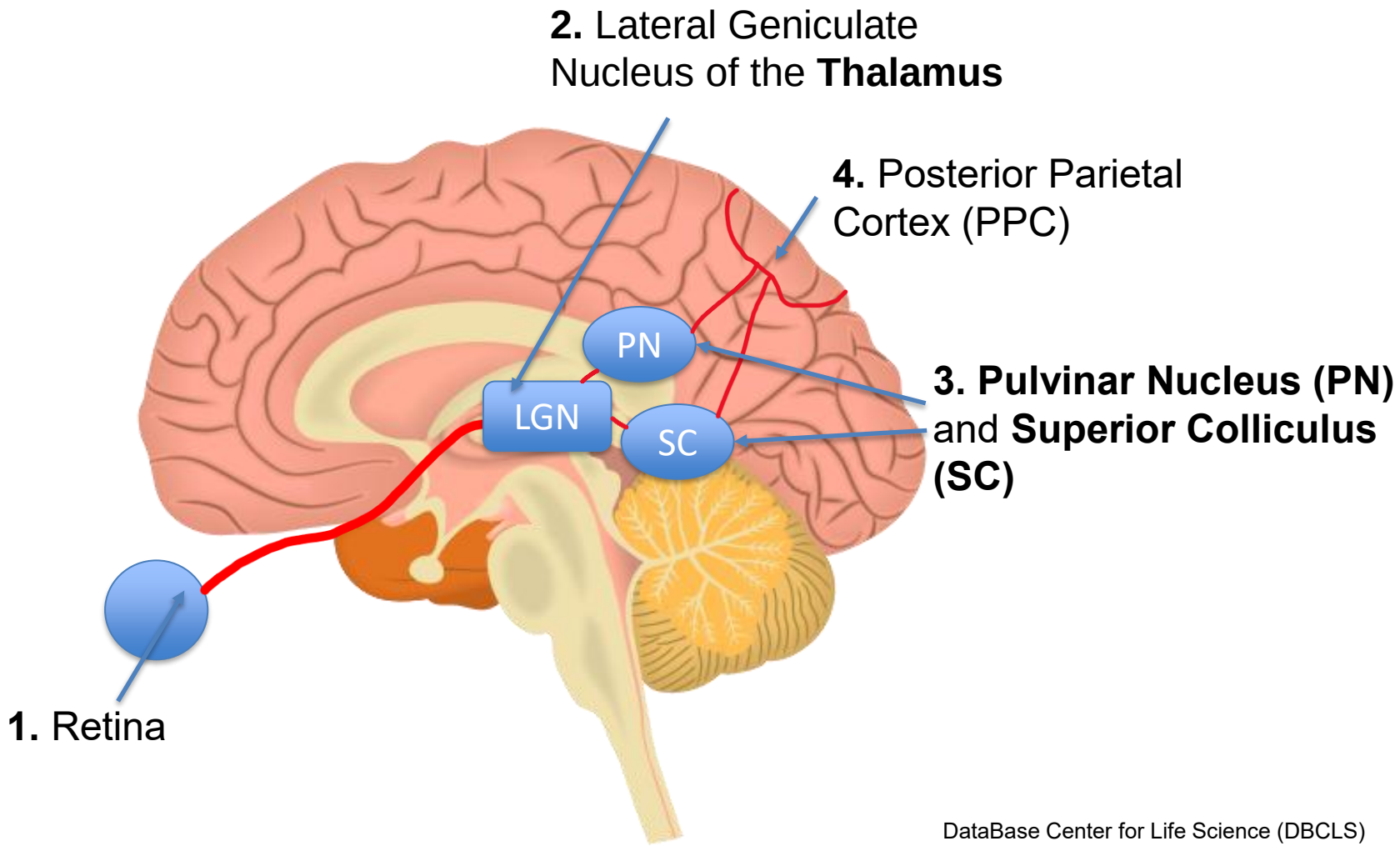
Navigating Blind
Suspecting patient TN might exhibit blindsight, researchers, including Lawrence Weiskrantz (*shown with TN*), asked him to walk down a cluttered hallway, telling him it was empty. TN avoided all the obstacles, even though he remained unaware of them and of his meandering path.

Scientific American

HOW!?

Secondary visual pathway

Retina ➡ LGN ➡ PN/SC ➡ Posterior Parietal



Thanks, HUBS191!

Good luck in HSFY or your major!

HUBS191