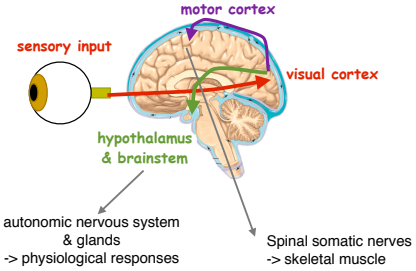
Vert Phys PCB3743

Central Nervous System
Fox Chapter 8

General Scheme of CNS

receive sensory inputs, coordinate response of the organs & functions of the body

inputs:
see bear -> retina -> cranial nerve II (optic nerve) -> visual cortex
outputs:
-> motor cortex -> run away
-> hypothalamus -> stress hormone release -> mobilize glucose
-> brainstem -> increase heart rate, blood pressure, breathing



Structure of CNS

Central Nervous System: spinal cord & brainstem, cerebellum, cerebrum

Afferents and Efferents: spinal nerves & cranial nerves

Features of CNS:

Ventricles and Central Canal: filled with cerebral spinal fluid

cerebral cortex: "bark" of the brain -- where cerebral neurons are located.

gray matter: cell bodies of neurons

white matter: axon fibers of neurons (the wires)
corpus callosum: the giant fiber bridge that connects the two hemispheres of the cerebrum

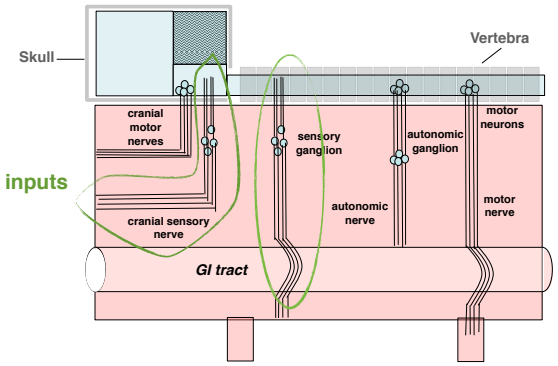
gyrus: the bulging part of a wrinkle on the cortex

sulcus: the valley of the fold (in between the wrinkles)

The more connections between parts of the cortex, the greater the surface area but also the more wrinkly the brain: the axons try to minimize distance between connected neurons.

Sensory Afferents and Motor Efferents

inputs to and outputs from the CNS



Sensory Afferents and Motor Efferents

inputs to and outputs from the CNS

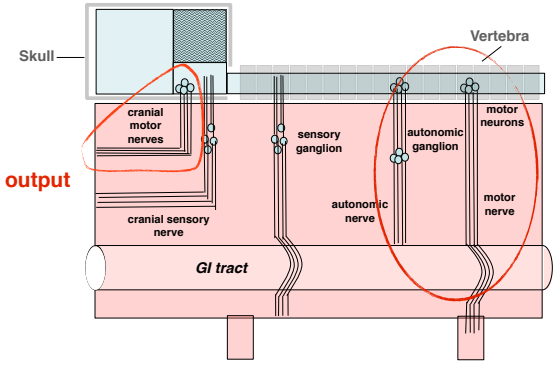
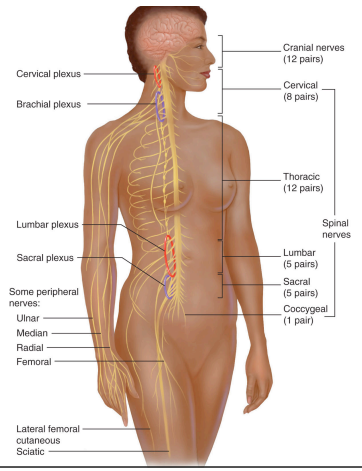
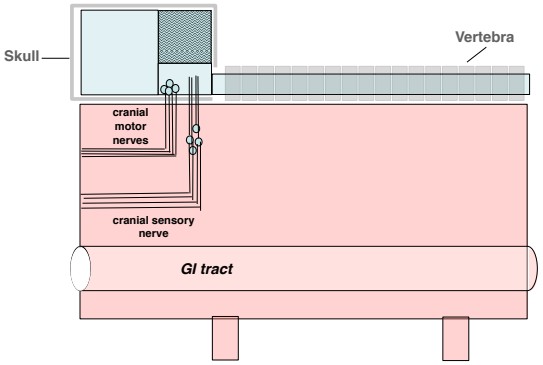


Figure 8.27



Cranial Nerves

inputs to and outputs from the CNS



Cranial Nerves

Sensory and motor nerves that come straight to and from the brain

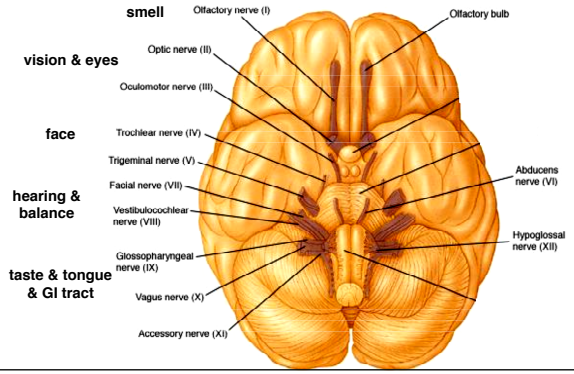


Table 8.6

Table 8.6 | Summary of Cranial Nerves

Number and Name	Composition	Function
I Olfactory	Sensory	Olfaction
II Optic	Sensory	Vision
III Oculomotor	Motor	Motor impulses to levator palpebrae superioris and extrinsic eye muscles, except superior oblique and lateral rectus; innervation to muscles that regulate amount of light entering eye and that focus the lens
	Sensory: proprioception	Proprioception from muscles innervated with motor fibers
IV Trochlear	Motor	Motor impulses to superior oblique muscle of eyeball
	Sensory: proprioception	Proprioception from superior oblique muscle of eyeball
V Trigeminal		
Ophthalmic division	Sensory	Sensory impulses from cornea, skin of nose, forehead, and scalp
Maxillary division	Sensory	Sensory impulses from nasal mucosa, upper teeth and gums, palate, upper lip, and skin of cheek
Mandibular division	Sensory	Sensory impulses from tongue, lower teeth and gums, and skin of chin and lower jaw
	Sensory: proprioception	Proprioception from muscles of mastication
	Motor	Motor impulses to muscles of mastication and muscle that tenses the tympanum
VI Abducens	Motor	Motor impulses to lateral rectus muscle of eyeball
	Sensory: proprioception	Proprioception from lateral rectus muscle of eyeball
VII Facial	Motor	Motor impulses to muscles of facial expression and muscle that tenses the stapes
	Motor: parasympathetic	Secretion of tears, nasal, and palatal gland and salivation from sublingual and submandibular salivary glands
	Sensory	Sensory impulses from taste buds on anterior two-thirds of tongue; nasal and palatal sensation.
	Sensory: proprioception	Proprioception from muscles of facial expression
VIII Vestibulocochlear	Sensory	Sensory impulses associated with equilibrium
		Sensory impulses associated with hearing
IX Glossopharyngeal	Motor	Motor impulses to muscles of pharynx used in swallowing
	Sensory: proprioception	Proprioception from muscles of pharynx
	Sensory	Sensory impulses from pharynx, middle-ear cavity, carotid sinus, and taste buds on posterior one-third of tongue
	Parasympathetic	Salivation from parotid salivary gland
X Vagus	Motor	Contraction of muscles of pharynx (swallowing) and larynx (phonation)
	Sensory: proprioception	Proprioception from visceral muscles
	Sensory	Sensory impulses from taste buds on rear of tongue; sensations from auricle of ear; general visceral sensations
	Motor: parasympathetic	Regulation of many visceral functions
XI Accessory	Motor	Laryngeal movement; soft palate
		Motor impulses to trapezius and sternocleidomastoid muscles for movement of head, neck, and shoulders
	Sensory: proprioception	Proprioception from muscles that move head, neck, and shoulders
XII Hypoglossal	Motor	Motor impulses to intrinsic and extrinsic muscles of tongue and infrahyoid muscles
	Sensory: proprioception	Proprioception from muscles of tongue

Vertebrate Central Nervous System

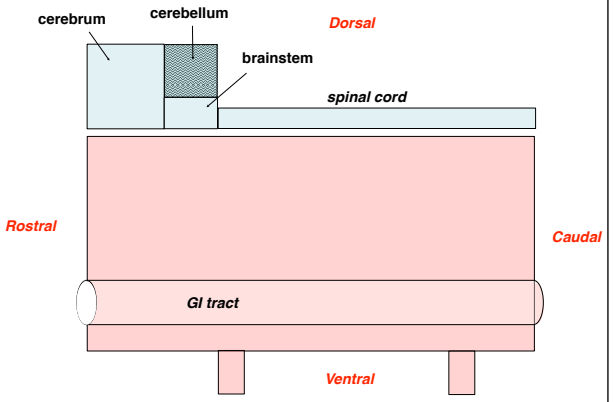
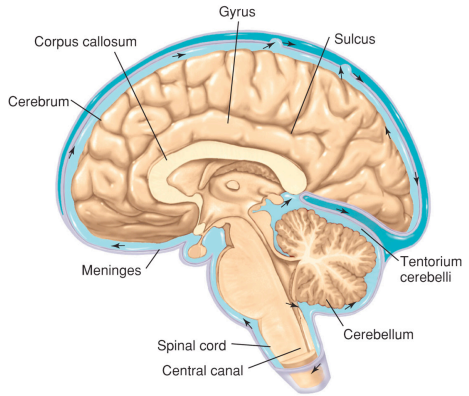


Figure 8.1



Cerebral Ventricles and Central Canal:

Spaces within the brain and spinal cord filled with cerebral spinal fluid (CSF)

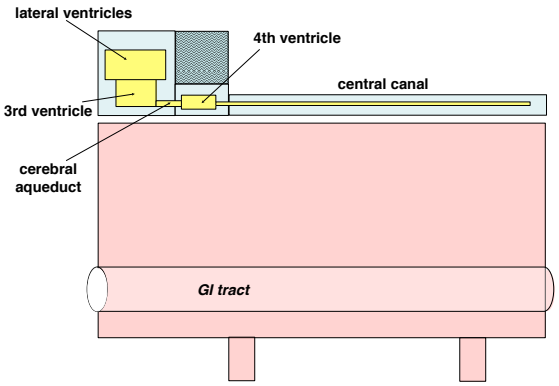
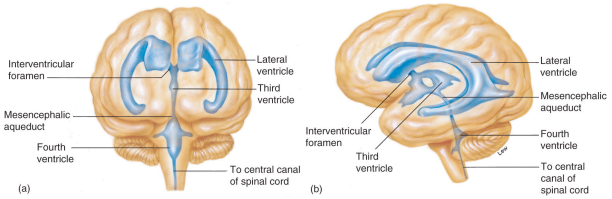


Figure 8.4

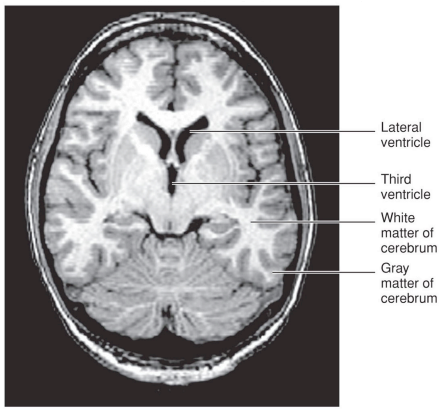


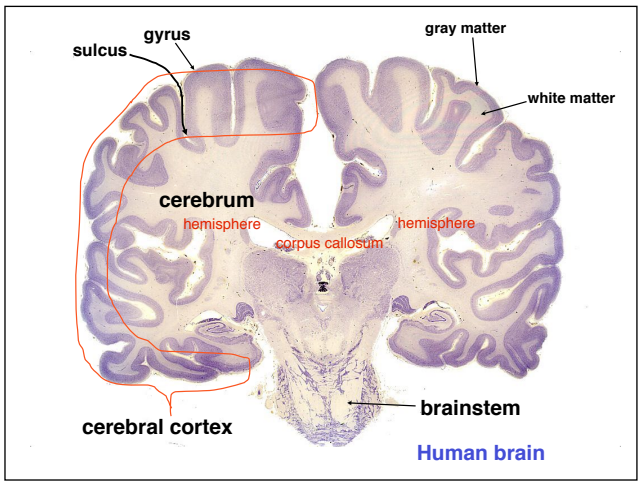
Intracranial contents by volume (1,700 ml; 100%):
brain tissue = 1,400 ml (80%)
blood = 150 ml (10%)
cerebrospinal fluid = 150 ml (10%)

(from Rengachary, S.S. and Ellenbogen, R.G., editors, *Principles of Neurosurgery*)

Figure 8.9

MRI
black = water
gray = cell bodies
white = fat, bone





without gyrus: local connections require long axons

within gyrus: local connections use short axons;
long-distance connections still require long axons

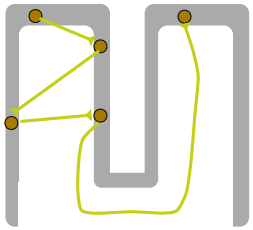
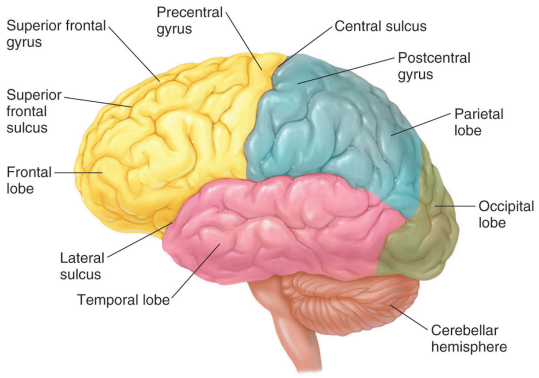


Table 8.1 | Functions of the Cerebral Lobes

Lobe	Functions	
Frontal	Voluntary motor control of skeletal muscles; personality; higher intellectual processes (e.g., concentration, planning, and decision making); verbal communication	
Parietal	Somatesthetic interpretation (e.g., cutaneous and muscular sensations); understanding speech and formulating words to express thoughts and emotions; interpretation of textures and shapes	*"the walls" of the skull*
Temporal	Interpretation of auditory sensations; storage (memory) of auditory and visual experiences	*near the temples*
Occipital	Integration of movements in focusing the eye; correlation of visual images with previous visual experiences and other sensory stimuli; conscious perception of vision	*ob-caput - back of the head*
Insula	Memory; sensory (principally pain) and visceral integration	

Used as landmarks for orientation on the brain

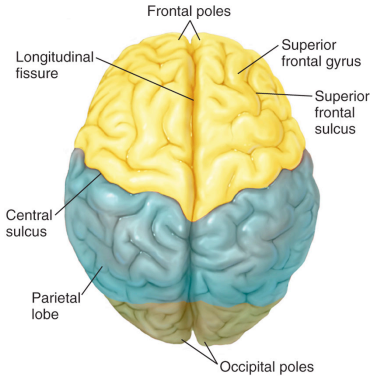
Cerebrum divided into lobes, separated by central sulcus and lateral sulcus



(a)

Figure 8.5a

Figure 8.5b



(b)

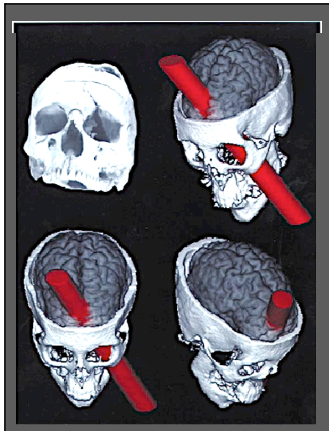
The most famous case of brain damage that causes a change in morality remains that of Phineas Gage, a railroad laborer in Vermont who, one day in the fall of 1848, suffered a horrific on-the-job injury. Gage, the foreman of a crew laying track outside the town of Cavendish, was tamping black powder into a hole drilled in rock when he apparently struck a spark. In a flash of explosion, the tamping iron, a three-and-a-half-foot-long bar an inch in diameter, blew through his left cheek and clean out the top of his head, landing some 30 yards behind him. "It essentially severed the front third of his brain," Eslinger says. "The surgeon who came to the scene described that he insert a could finger through either side of the wound and actually touch them. It was just this clean hole."

www.rps.psu.edu/ indepth/brainscans1.htm

Wikimedia: Phineas Gage GageMillerPhoto2010-02-17 Unretouched Color Cropped.jpg

Phineas Gage's skull and life mask

Credit Warren Anatomical Museum, Francis A. Countway Library of Medicine



Amazingly, Gage survived, and was in fact strong enough to resume work in less than a year. His basic mental faculties—motor skills, memory, speech—were essentially intact. What had changed, profoundly and irrevocably, was his personality. Where before the accident, Gage had been regarded as an excellent foreman, thoughtful, shrewd with money, and well-spoken, afterward he was described as "fitful, irreverent, and grossly profane," and acting with little regard for others. His friends said he was "no longer Gage."

Reconstruction of the lesion incurred by Phineas Gage, in which an iron bar was driven through his prefrontal cortex as a result of a blasting accident.

Somatosensory Cortex and Motor Cortex

Somatosensory cortex:
Located right behind central sulcus

Termination of sensory (touch) information coming from the skin

Motor cortex:
Located right in front of central sulcus

Cerebral neurons that initiate movement, sending axons directly and indirectly to spinal moto neurons

Homunculus *"little person"*
Topographic map of sensory input to the somatosensory cortex and motor output of motor cortex

Parts of the body with highest density of sensory receptors get a bigger share of the somatosensory cortex dedicated to processing.

Parts of the body with the finest motor control (most muscles) get a bigger share of the motor cortex.

Note that both somatosensory relays and motor relays **cross-over**: so left side of body -> right side of cortex, and vice versa.

Figure 8.6

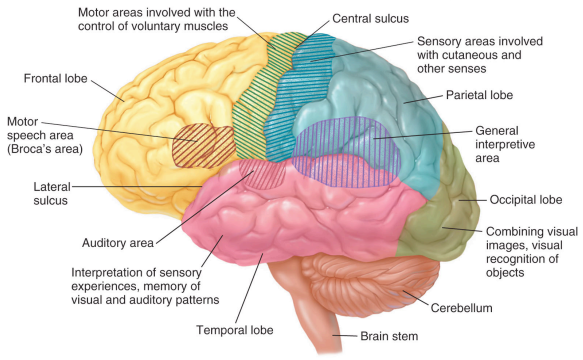
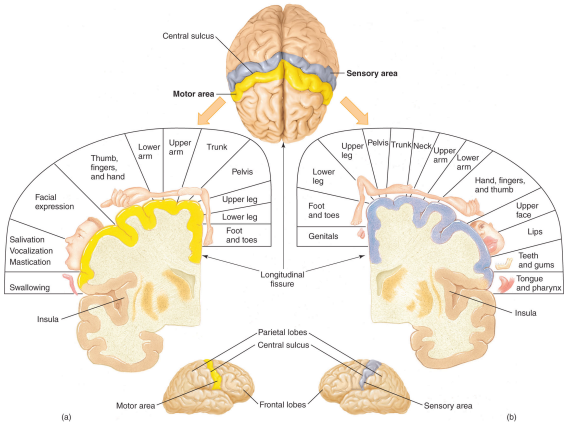


Figure 8.7



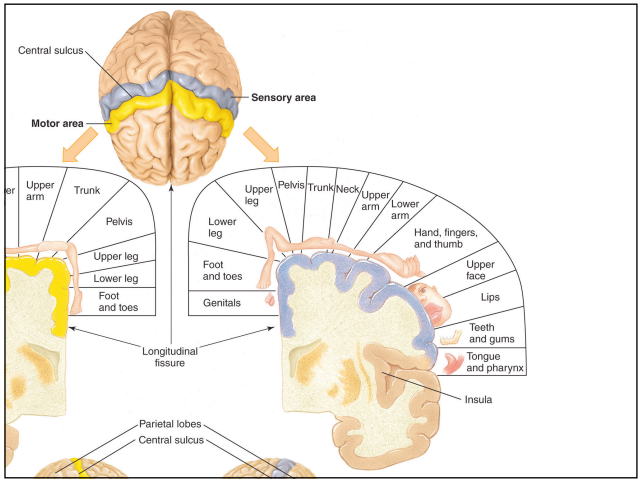


Figure 8.24

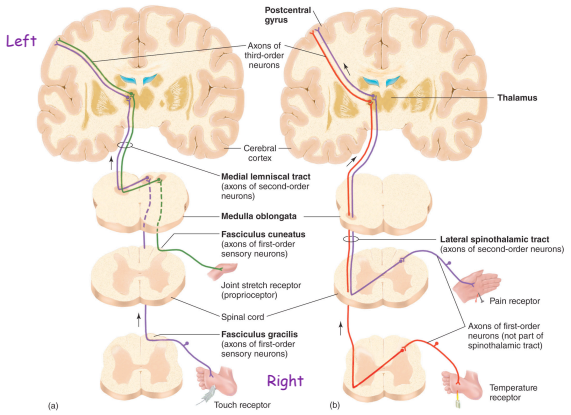


Figure 8.7

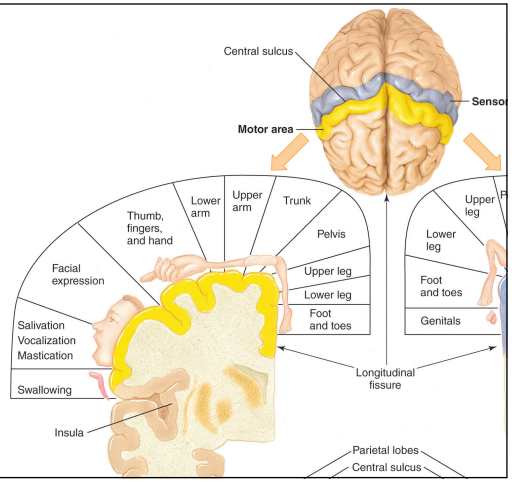
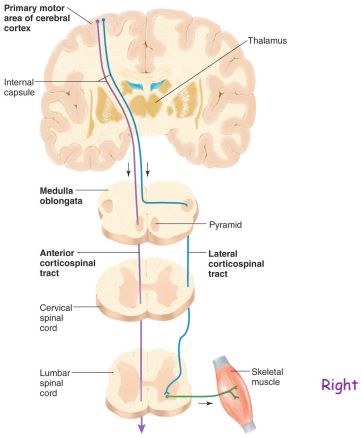


Figure 8.25



Brainstem and Hypothalamus

1. **Brainstem monitors internal chemical signals and controls autonomic function (e.g. breathing, heart rate, digestion)**

2. **Brainstem carries out reflexive functions to respond to acute (immediate) changes in bodily function (e.g. postural changes in blood pressure).**

3. **Hypothalamus also uses neural and endocrine signals to monitor peripheral variables**

4. **Hypothalamus controls long-term homeostasis by hormonal signals via the pituitary gland or by neural outputs through the brainstem**

Figure 8.19a

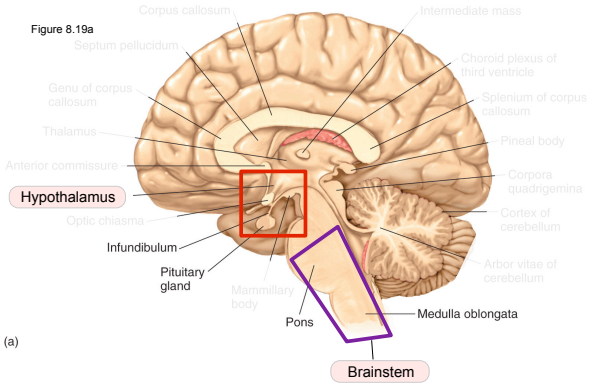


Figure 8.20

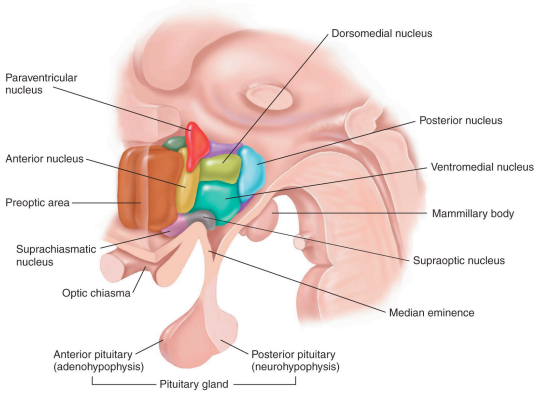


Figure 8.22