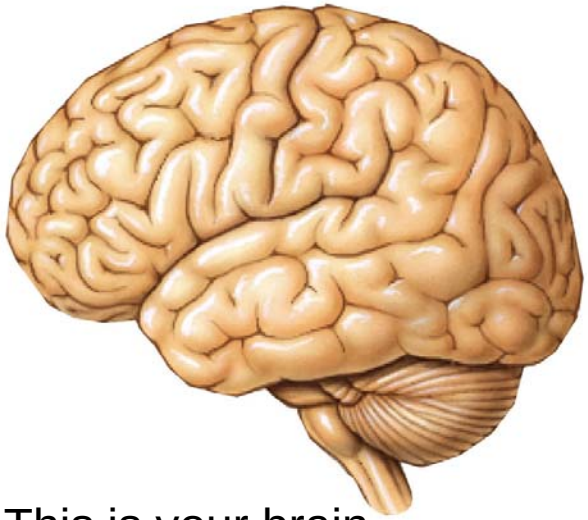
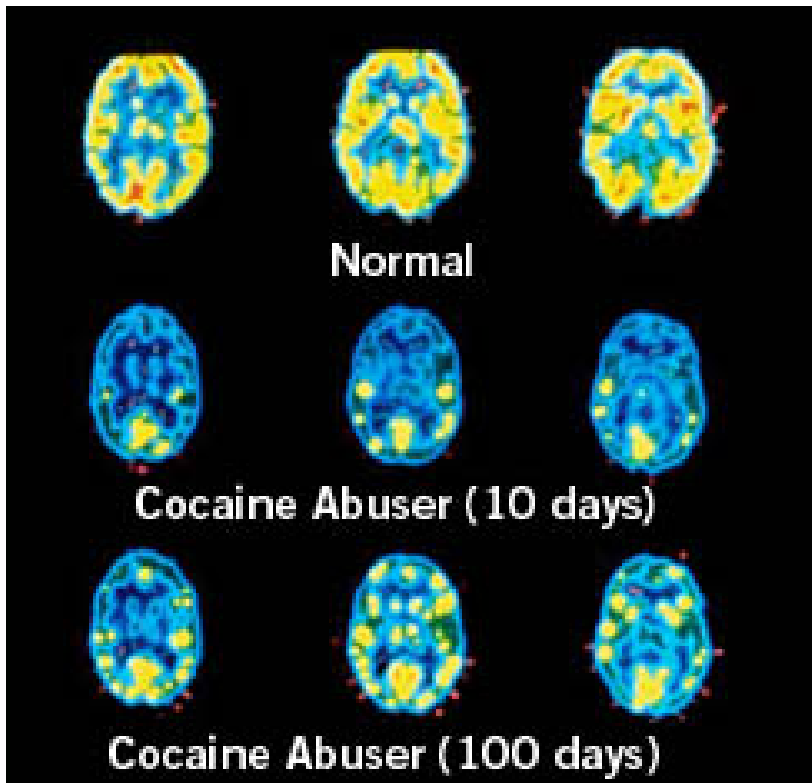


This is your brain

Nervous system I

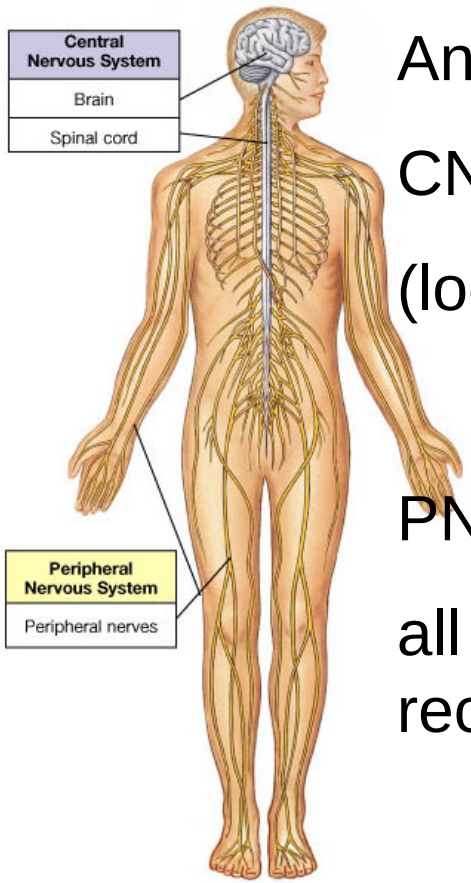


This is your brain on drugs

Functions of the nervous system

- Direct immediate response to stimuli
- Coordinates activities of other systems

Fig 13.1



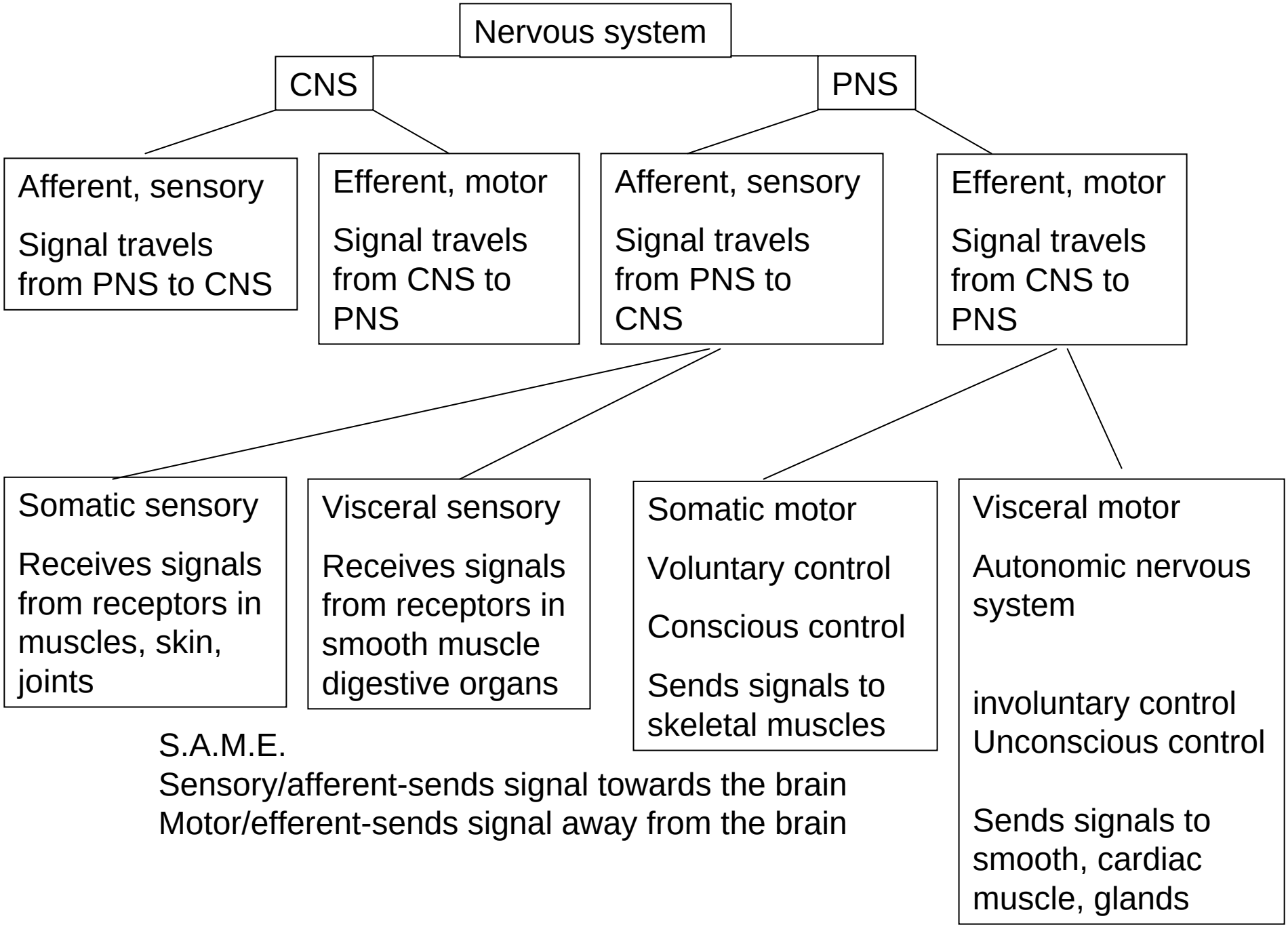
Anatomical divisions:

CNS, central nervous system

(located in the cranial & spinal cavities)

PNS, peripheral nervous system-

all other neural tissue, nerves, receptors, neuroglia



S.A.M.E.
Sensory/afferent-sends signal towards the brain
Motor/efferent-sends signal away from the brain

Autonomic nervous system

- Two functional divisions:
- Sympathetic
- Parasympathetic

Nervous System Terminology

Gray Matter – mostly nerve cell bodies.

White Matter – mostly myelinated axons.

Nerve fiber – a single axon of a neuron.

Nerve – a bundle of axons in the PNS.

Tract – a bundle of axons ins the CNS.

Ganglion – a cluster of nerve cell bodies in PNS.

Nucleus – gray matter in CNS with common function.

Cells of the nervous system

- Two types:
- Neuroglia-supporting cells 5:1 neuron
- Neurons-transfer and process information

neuron

- Cell that transmit electrical impulses from the dendrites to the synaptic terminals
- Organelles: mitochondria, ribosomes, ER
  - Lack centrioles no cell division, can't be replaced
- Surface covered by glial cells

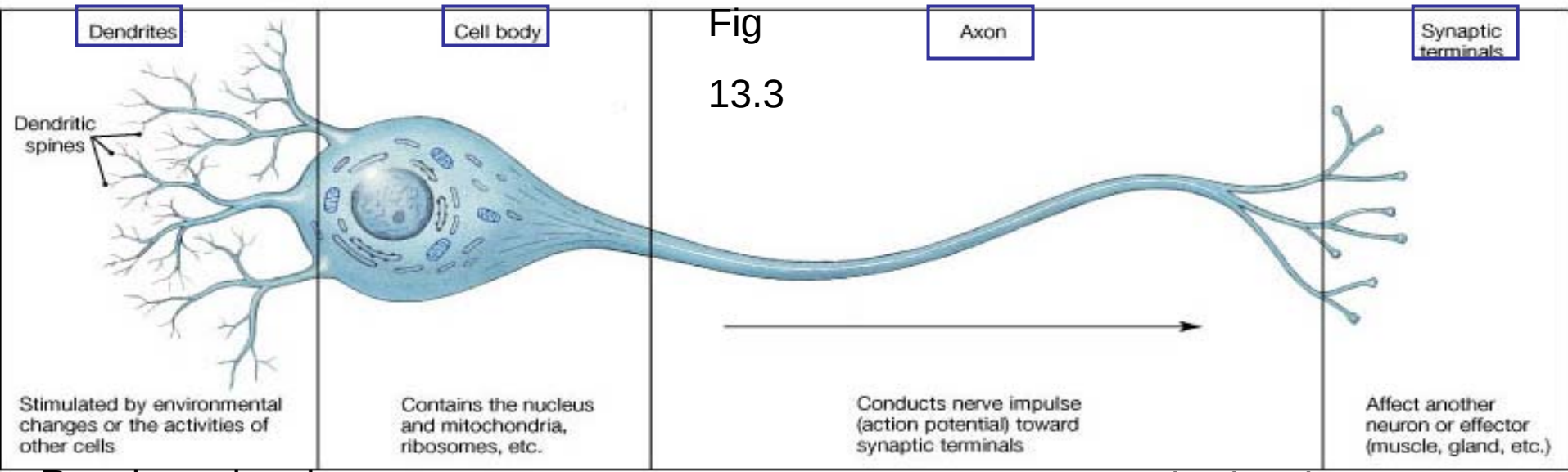


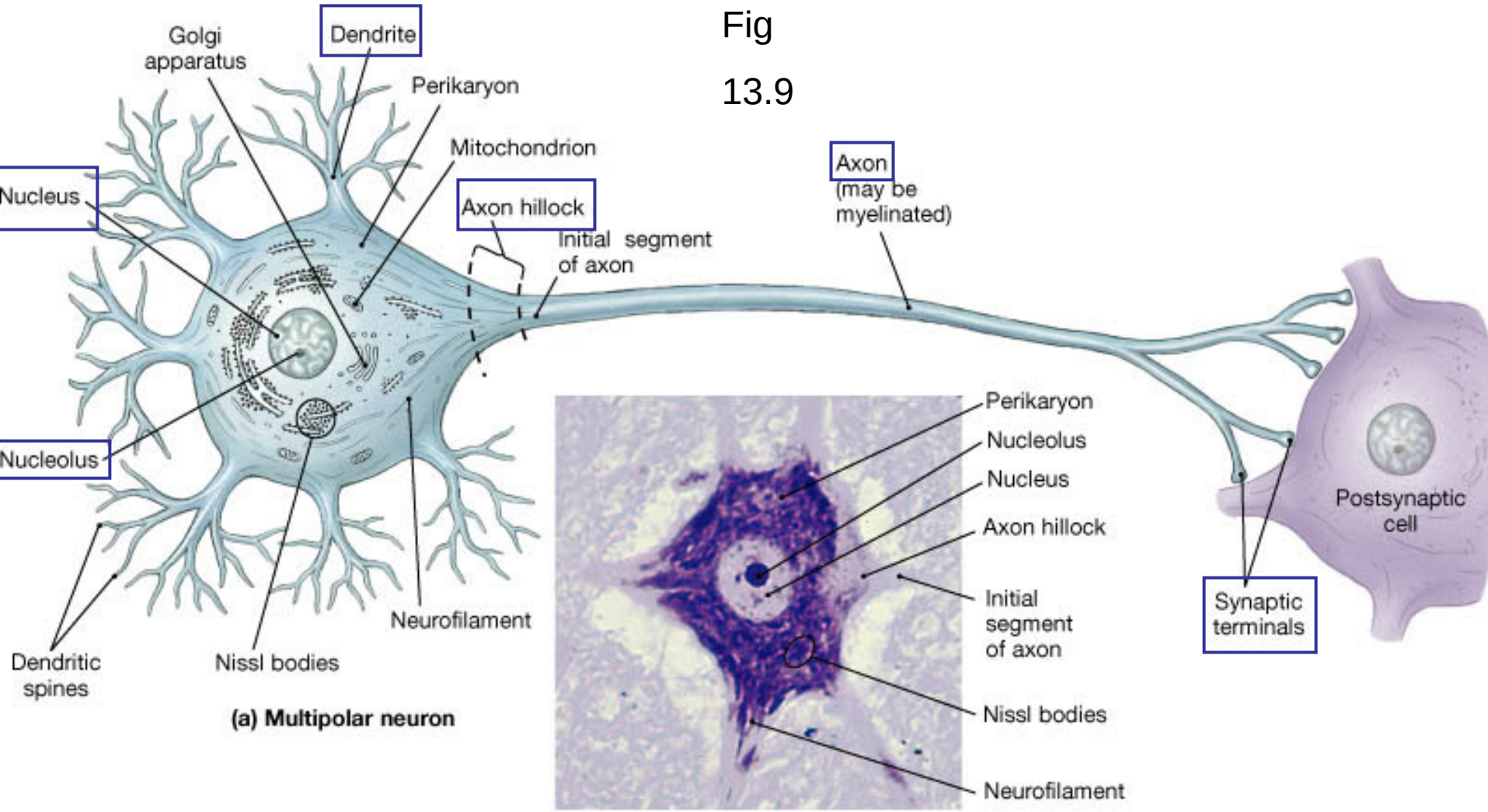
Fig 13.3

Receives signal

Sends signal

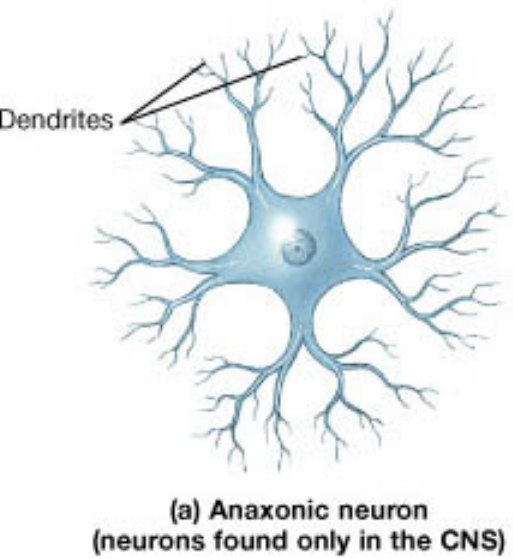
Fig

13.9

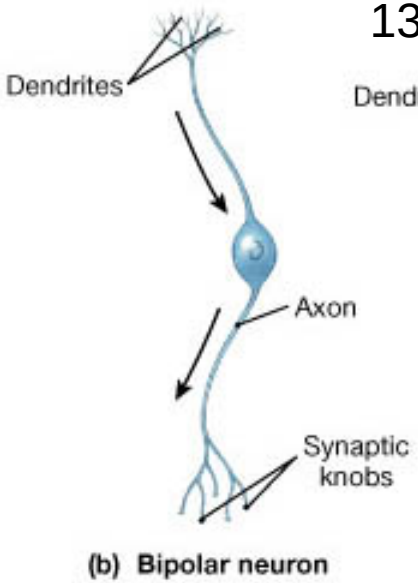

Golgi apparatus
Dendrite
Perikaryon
Mitochondrion
Nucleus
Axon hillock
Initial segment of axon
Axon (may be myelinated)
Nucleolus
Neurofilament
Dendritic spines
Nissl bodies
(a) Multipolar neuron
Perikaryon
Nucleolus
Nucleus
Axon hillock
Initial segment of axon
Nissl bodies
Neurofilament
Synaptic terminals
Postsynaptic cell

- Dendrites of neurons are stimulated
- Axon hillock summates this stimulation & creates a action potential
- Action potential travels on the axon to the synaptic terminals
- Synaptic terminals release chemicals called neurotransmitters

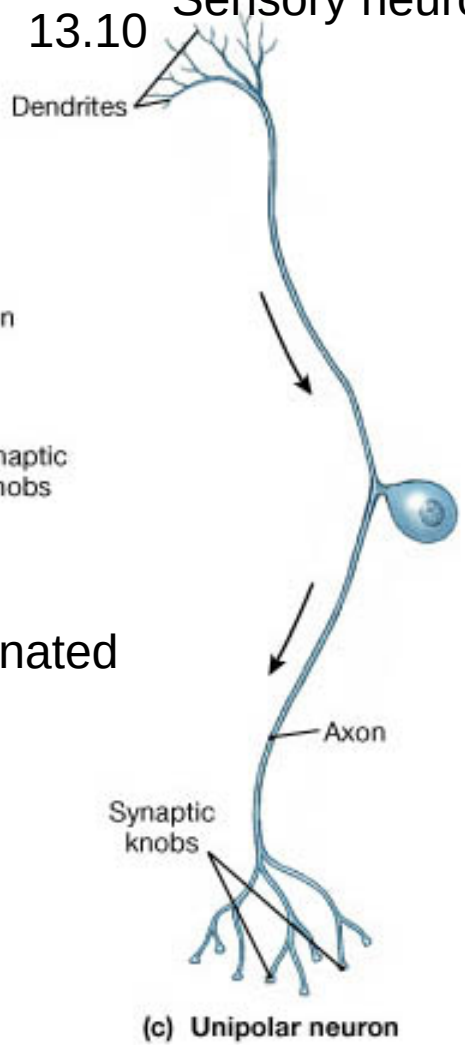
Fig 13.10



No axon

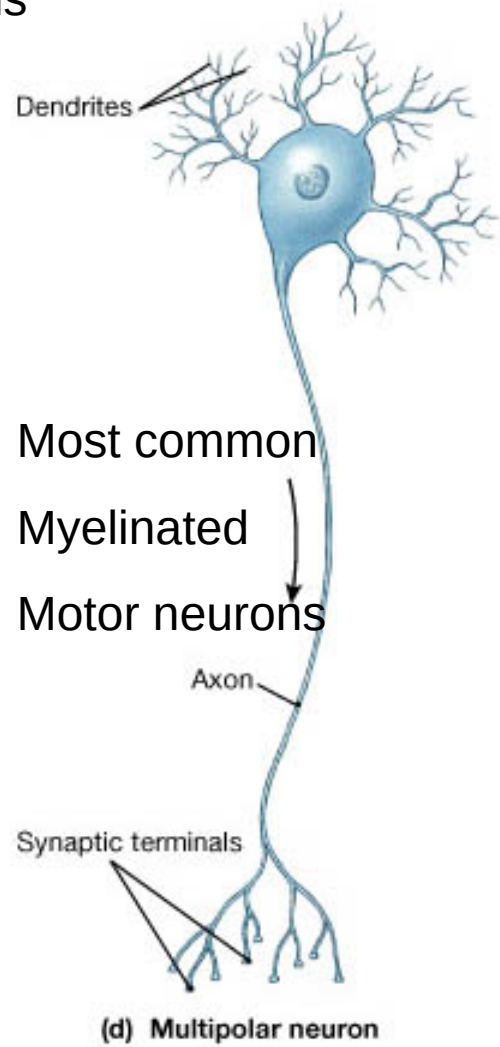


Rare, not myelinated



May be myelinated

Sensory neurons



Most common

Myelinated

Motor neurons

- Neurons release neurotransmitters to signal other cells

Signaling within a neuron is electric

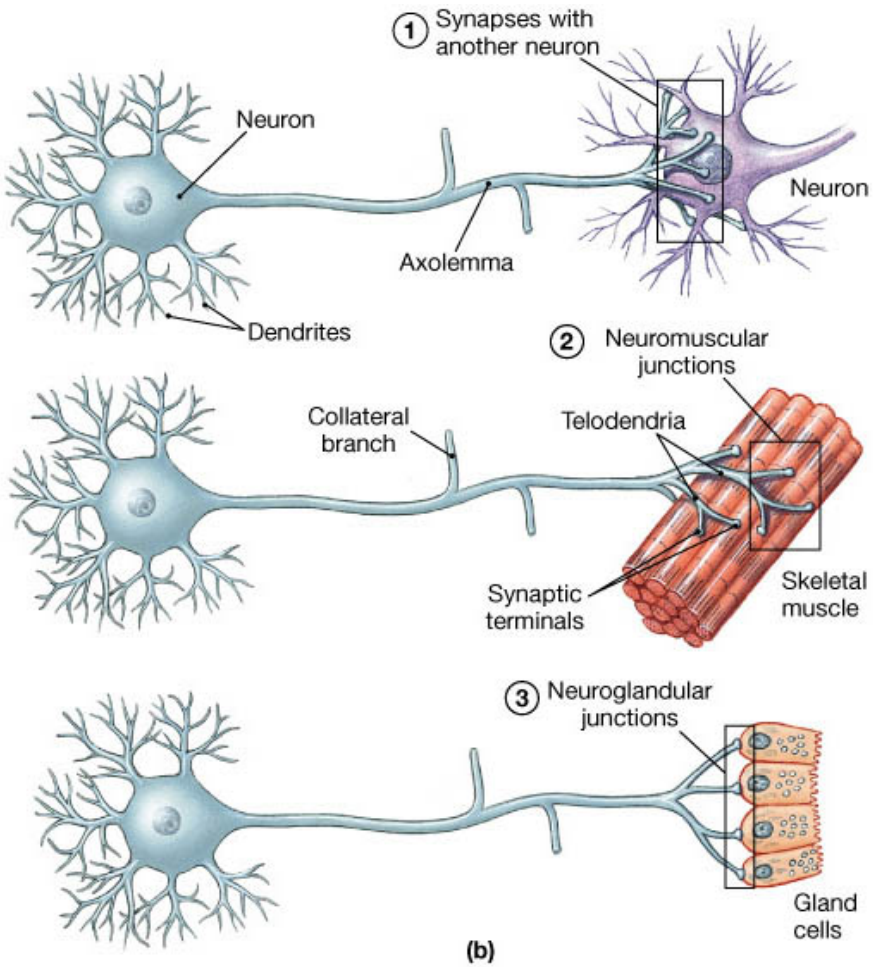
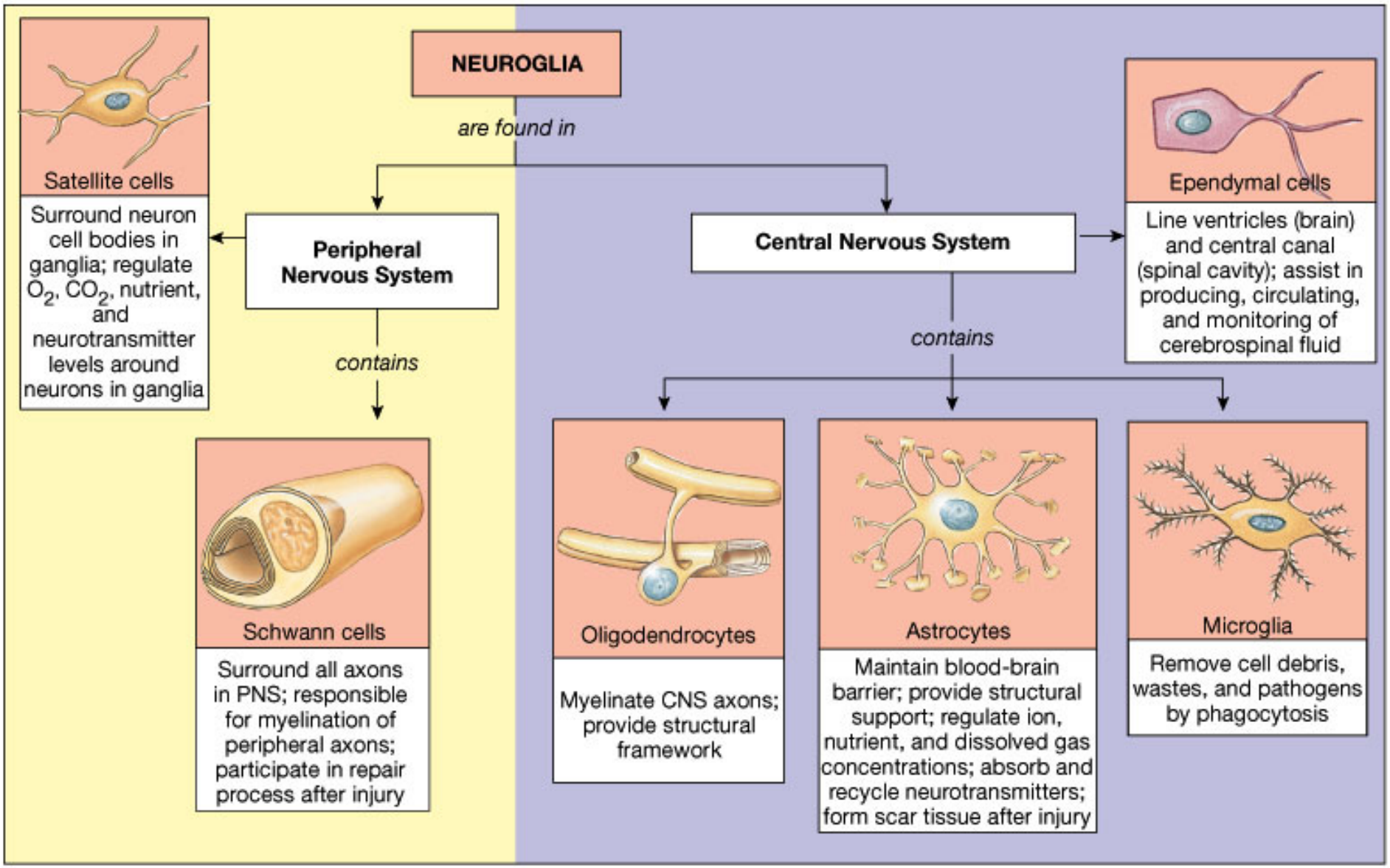


Fig 13.9

Signaling between a neuron & other cells is usually chemical

The neuroglia

Fig 13.4

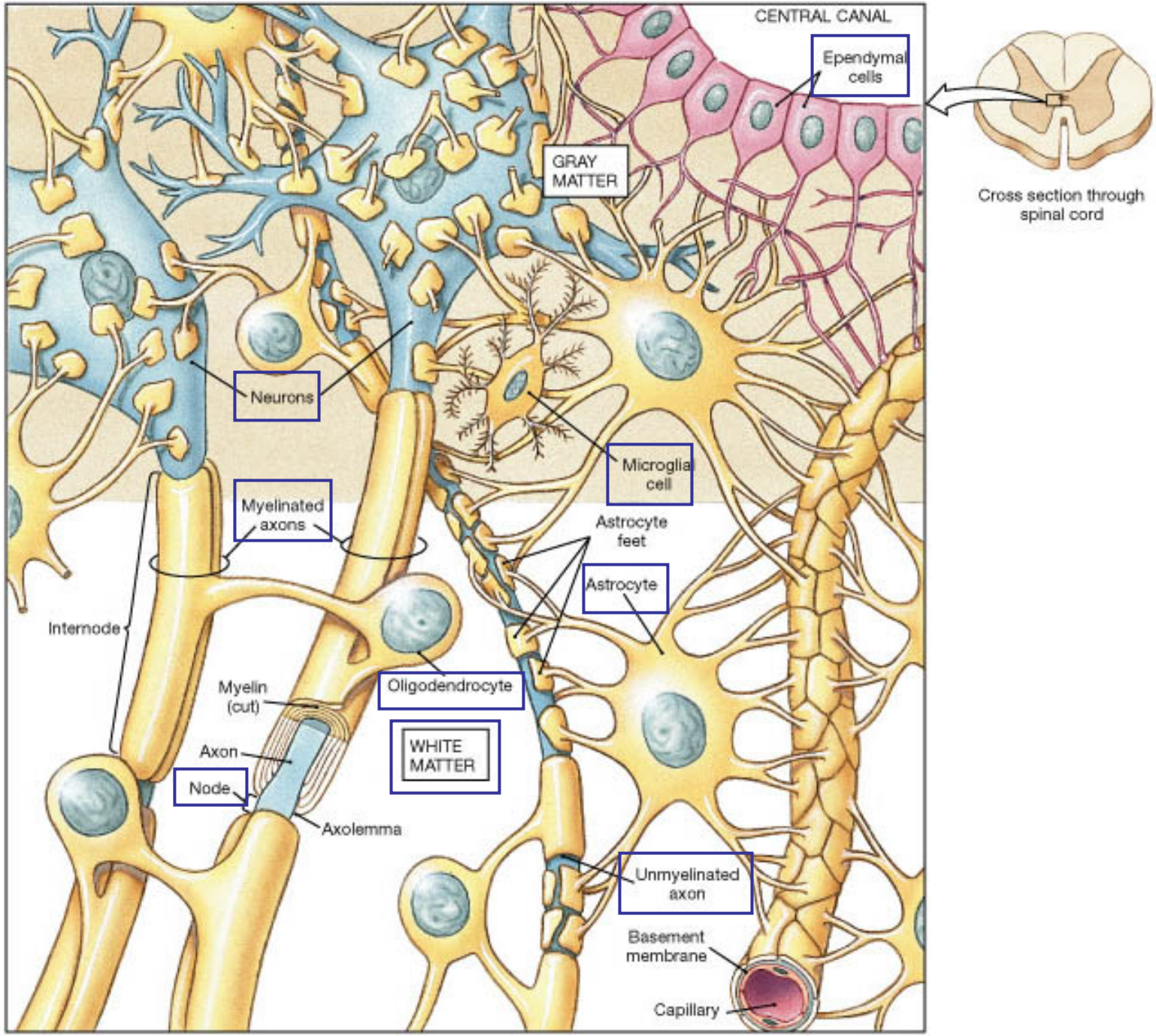


CNS neuroglia

- Astrocytes-most numerous
  - Repair damages neurons
  - Control interstitial environment
  - Blood brain barrier
    - surround capillaries to isolate the brain from chemicals in the plasma
- Ependymal cells-with capillaries produce cerebral spinal fluid in the brain

- Oligodendrocytes-myelinate axons in the CNS
  - Works like insulation making actions potentials travel down axons ~ 6 times faster
- Microglia-break down cellular waste and pathogens in the CNS

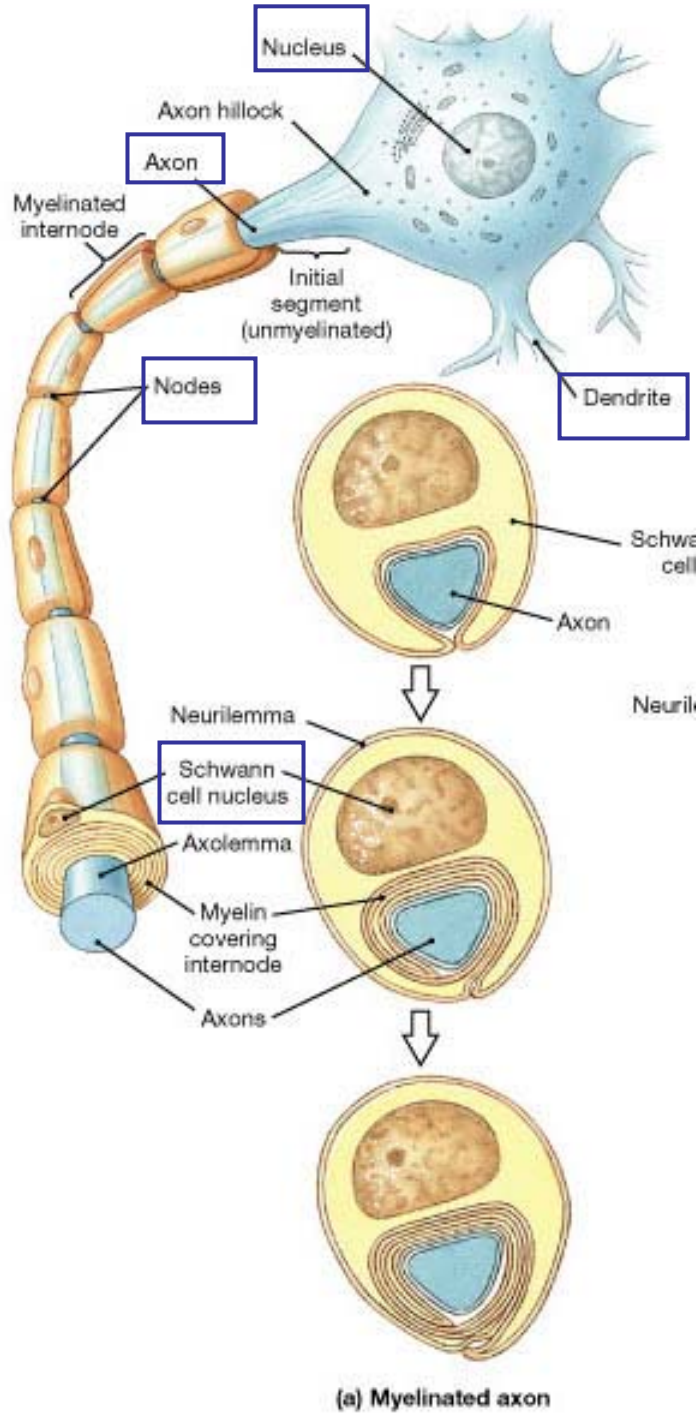
Fig 13.5


CENTRAL CANAL
Ependymal cells
GRAY MATTER
Cross section through spinal cord
Neurons
Microglial cell
Myelinated axons
Astrocyte feet
Astrocyte
Internode
Oligodendrocyte
Myelin (cut)
WHITE MATTER
Axon
Node
Axolemma
Unmyelinated axon
Basement membrane
Capillary

PNS neuroglia

- Schwann cells-myelinate axons in the PNS
- Satellite cells-exchange waste/nutrients cell body & extracellullar fluid

Fig 13.8


Nucleus
Axon hillock
Axon
Myelinated internode
Initial segment (unmyelinated)
Dendrite
Nodes
Schwa cell
Axon
Neurilemma
Schwann cell nucleus
Axolemma
Myelin covering internode
Axons
(a) Myelinated axon

Nerve impulse

- A neuron is electrically stimulated to threshold (summation @ axon hillock)
- At the threshold the cell membrane permeability to ions Na^+/K^+ changes
- This creates an action potential
- Large myelinated axon sends signals at 300 mhp!

Neural pools

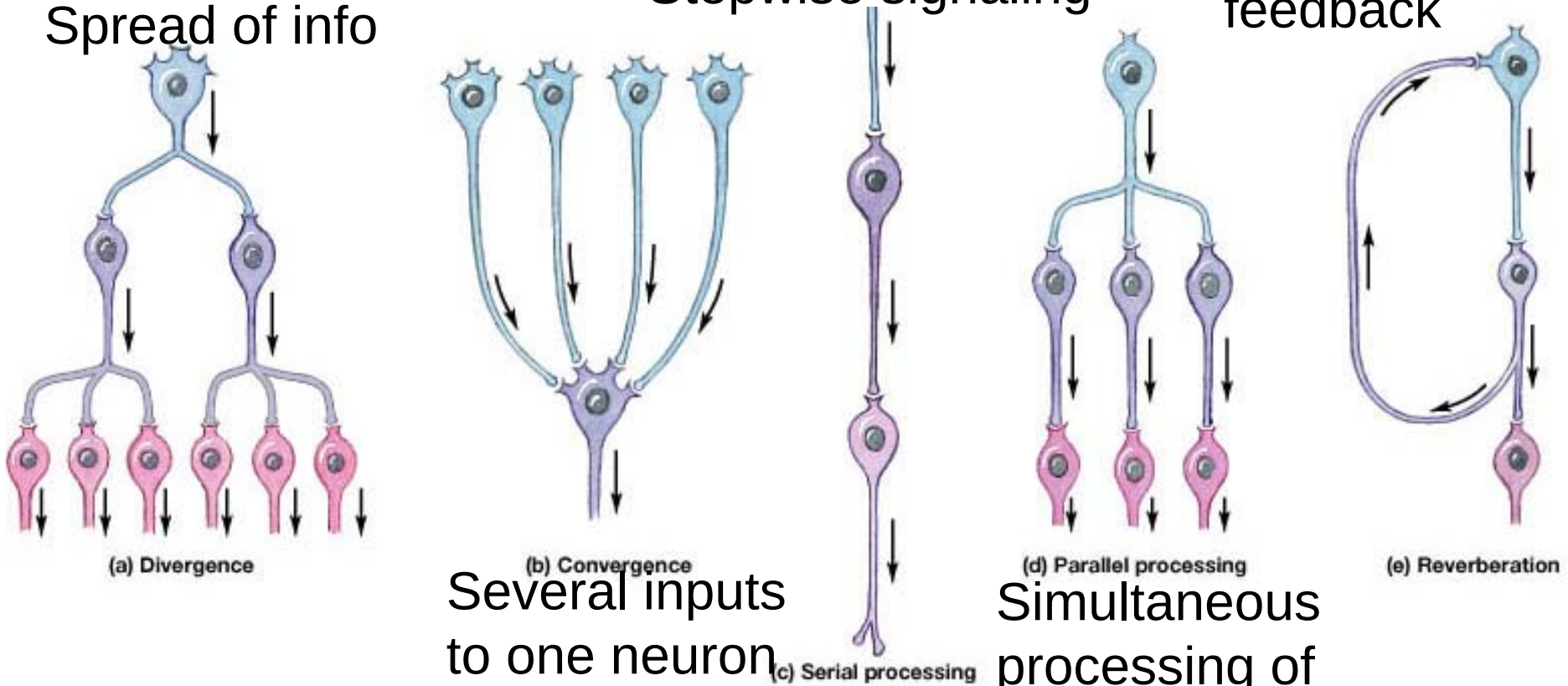
Fig 13.14

- Groups of communicating neurons

Spread of info

Stepwise signaling

Positive feedback

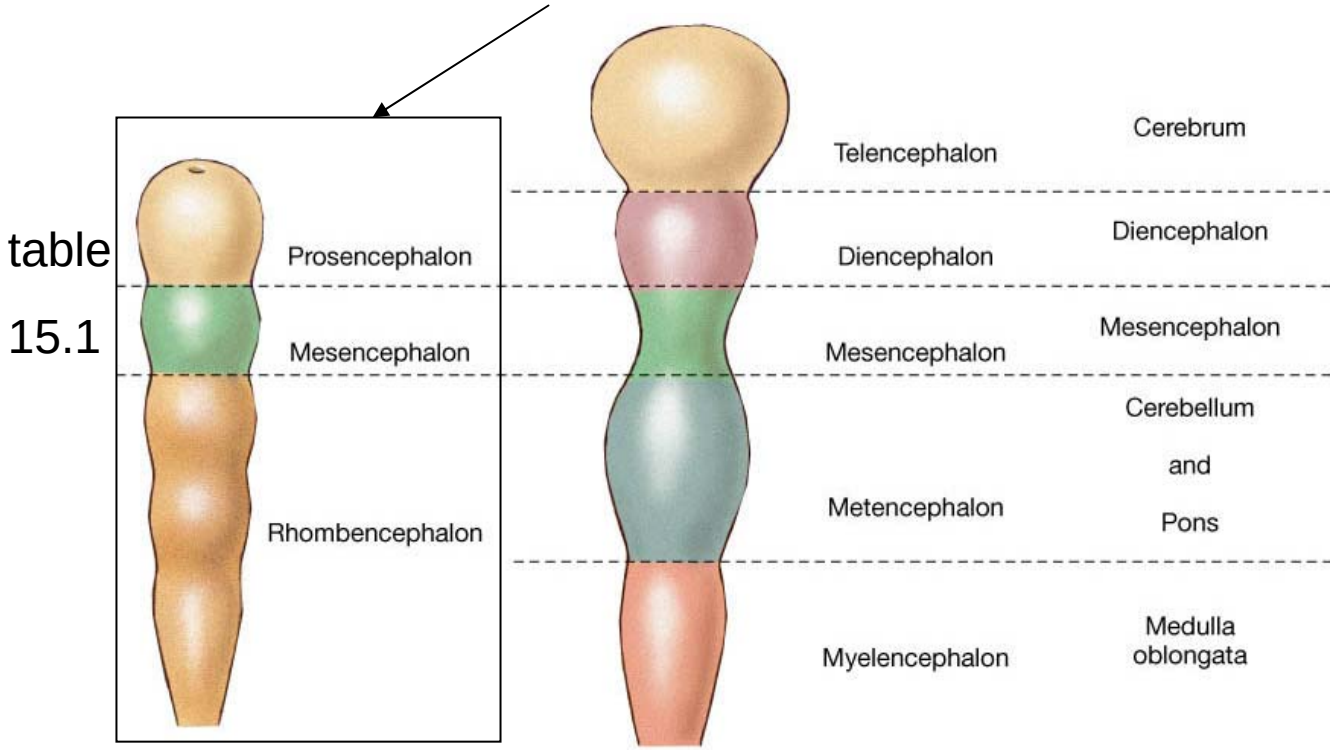


Several inputs to one neuron

Simultaneous processing of info

The brain

- Adult Contains 98% of all neural tissue
- 3 lbs, feels like jello
- 3 primary brain vesicles a 3 weeks



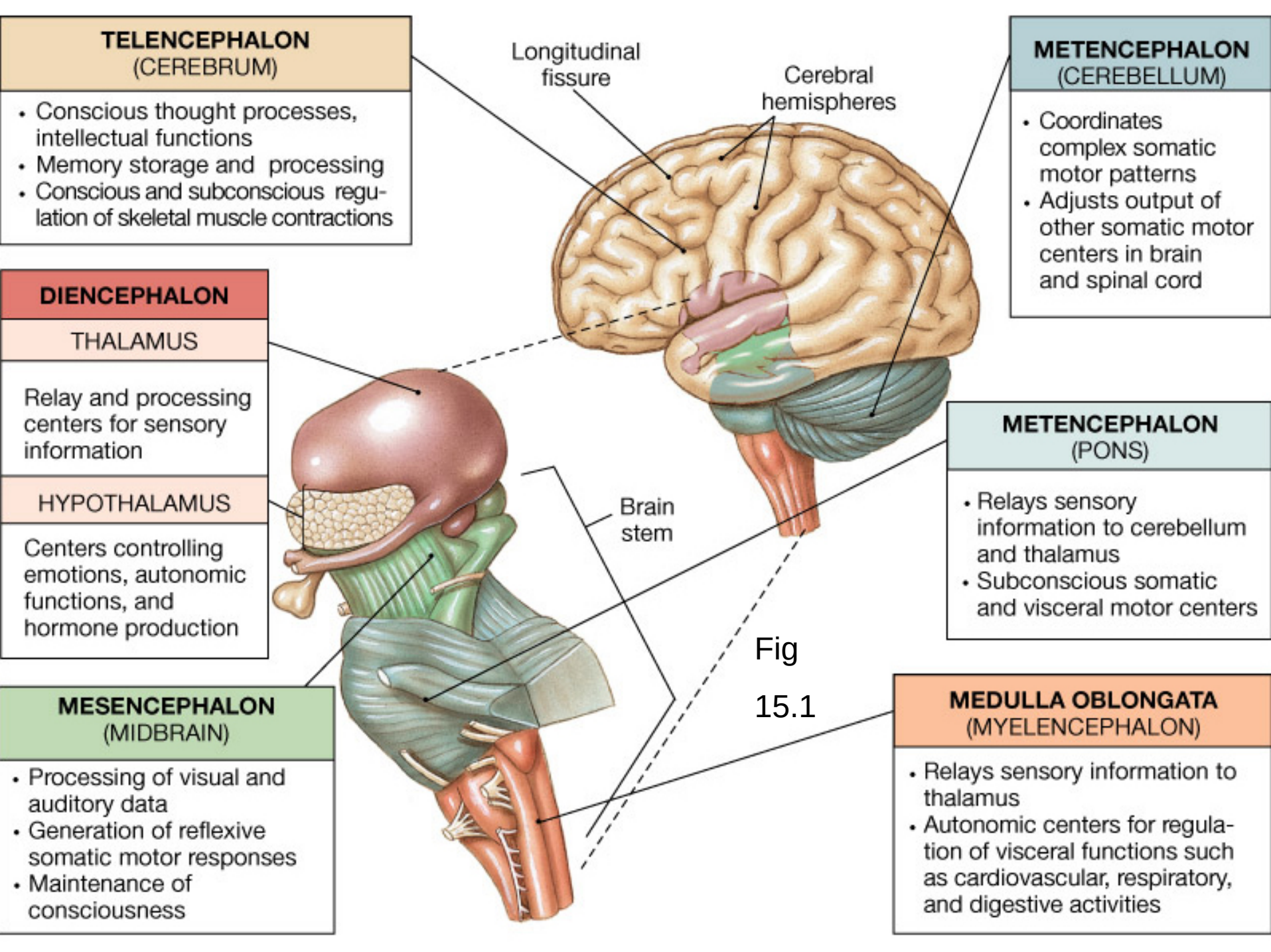
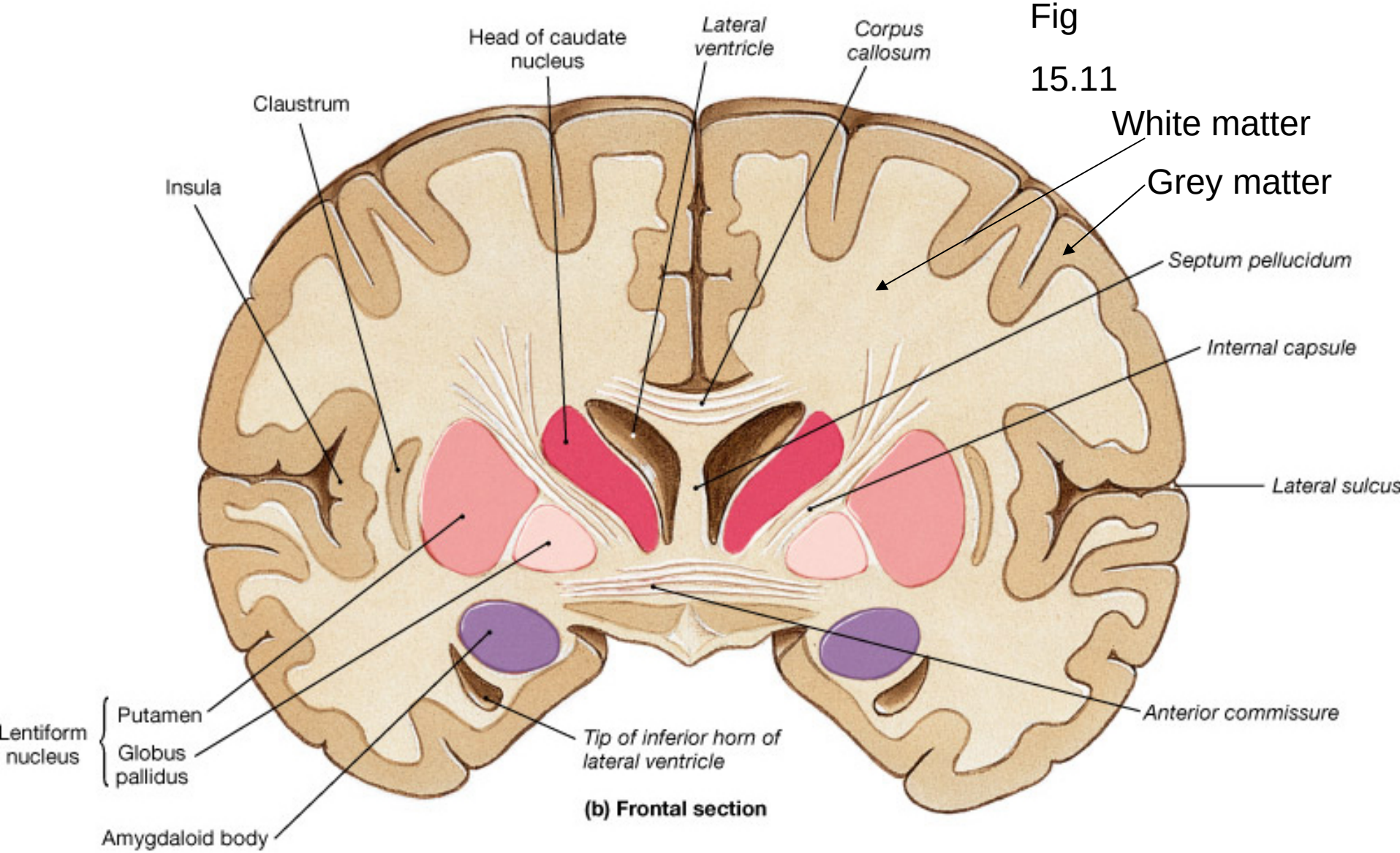

TELENCEPHALON
(CEREBRUM)
• Conscious thought processes, intellectual functions
• Memory storage and processing
• Conscious and subconscious regulation of skeletal muscle contractions
Longitudinal fissure
Cerebral hemispheres
METENCEPHALON
(CEREBELLUM)
• Coordinates complex somatic motor patterns
• Adjusts output of other somatic motor centers in brain and spinal cord
DIENCEPHALON
THALAMUS
Relay and processing centers for sensory information
HYPOTHALAMUS
Centers controlling emotions, autonomic functions, and hormone production
Brain stem
METENCEPHALON
(PONS)
• Relays sensory information to cerebellum and thalamus
• Subconscious somatic and visceral motor centers
MESENCEPHALON
(MIDBRAIN)
• Processing of visual and auditory data
• Generation of reflexive somatic motor responses
• Maintenance of consciousness
MEDULLA OBLONGATA
(MYELENCEPHALON)
• Relays sensory information to thalamus
• Autonomic centers for regulation of visceral functions such as cardiovascular, respiratory, and digestive activities

Fig 15.1

Fig 15.11


Head of caudate nucleus
Lateral ventricle
Corpus callosum
Claustrum
Insula
White matter
Grey matter
Septum pellucidum
Internal capsule
Lateral sulcus
Lentiform nucleus
Putamen
Globus pallidus
Amygdaloid body
Tip of inferior horn of lateral ventricle
Anterior commissure
(b) Frontal section

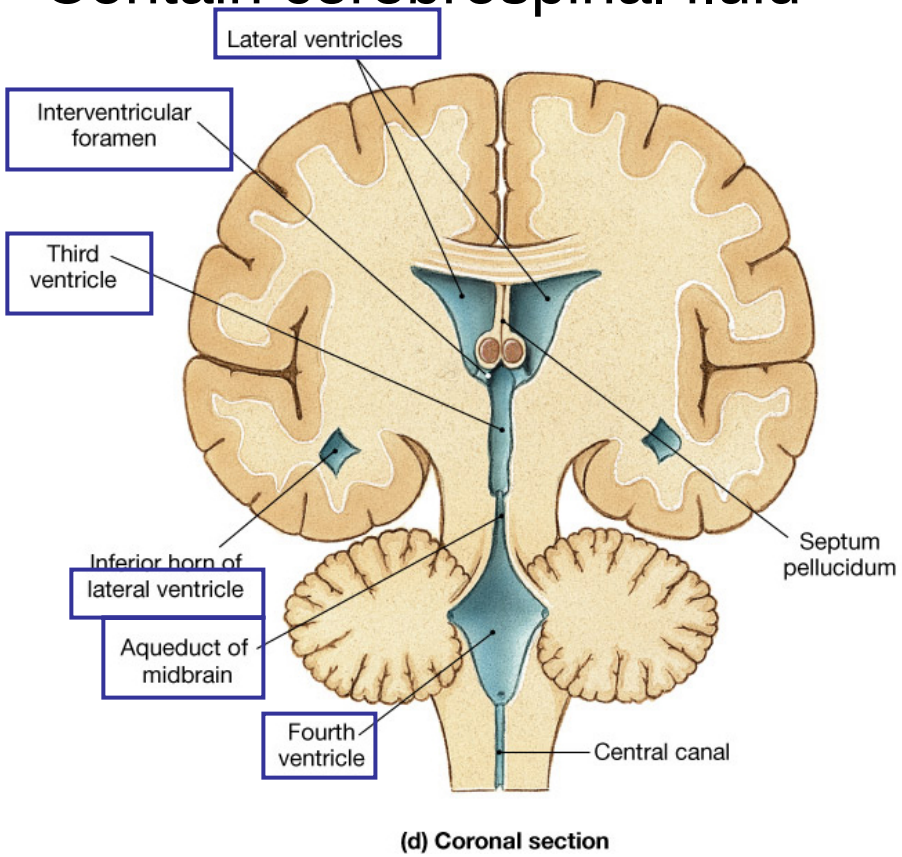
Ventricles

Fig 15.2

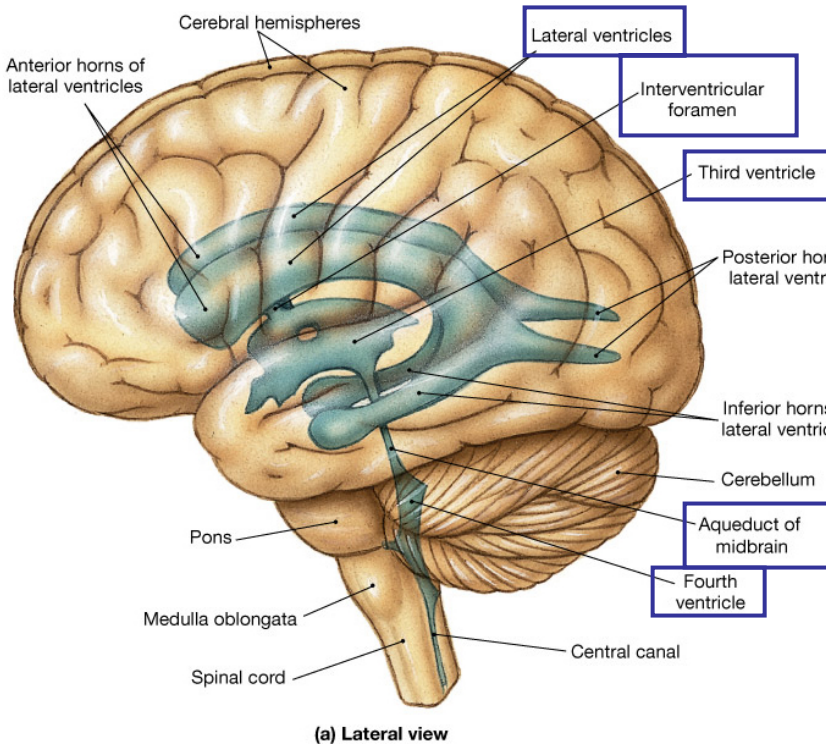
4 fluid filled cavities in the brain

Lined by ependymal cells

Contain cerebrospinal fluid



(d) Coronal section



(a) Lateral view

CSF

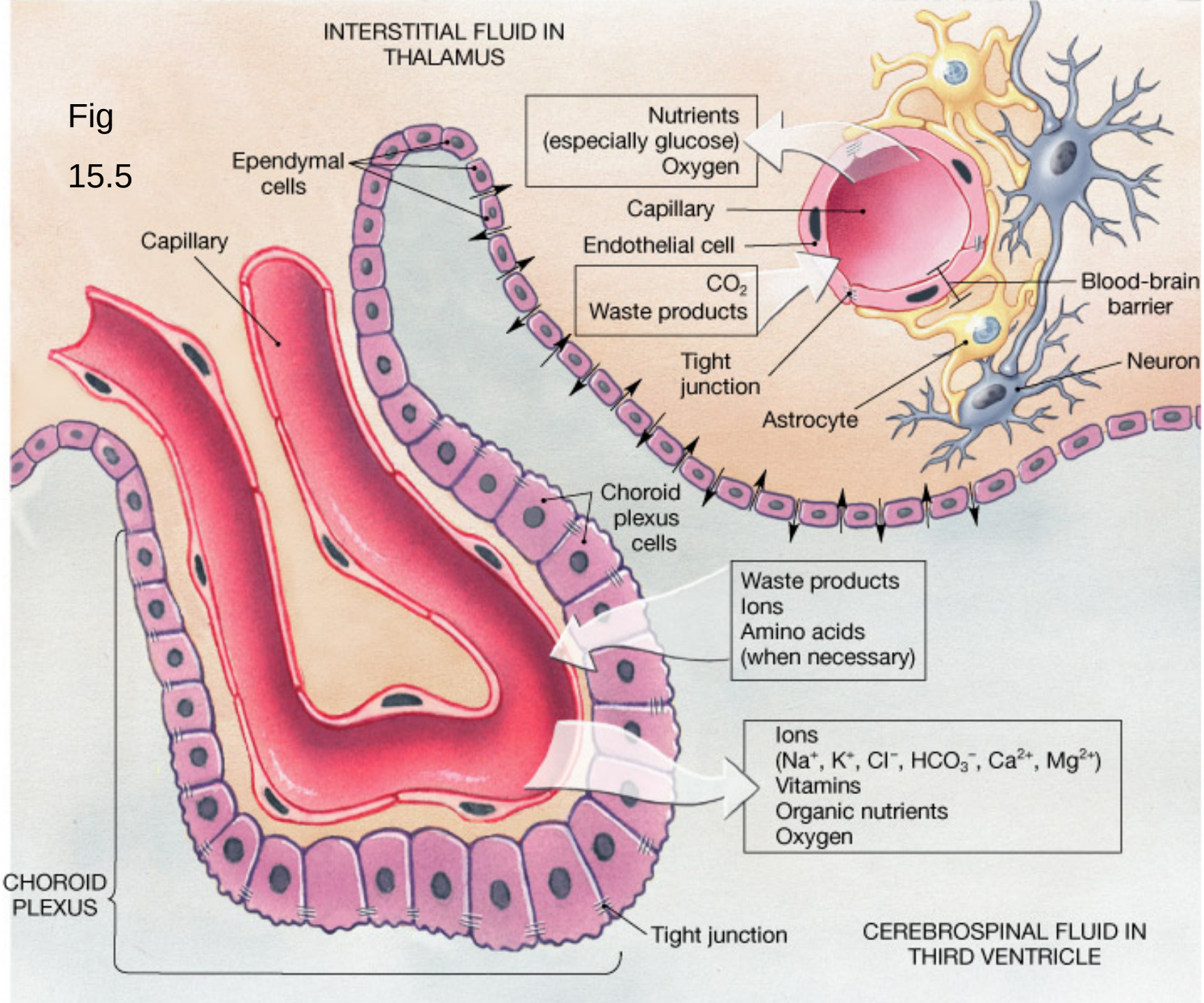
- Cushions the CNS
- Supports the brain-the brains is floating in the CSF
- Transport nutrient/wastes etc.

Choroid plexus

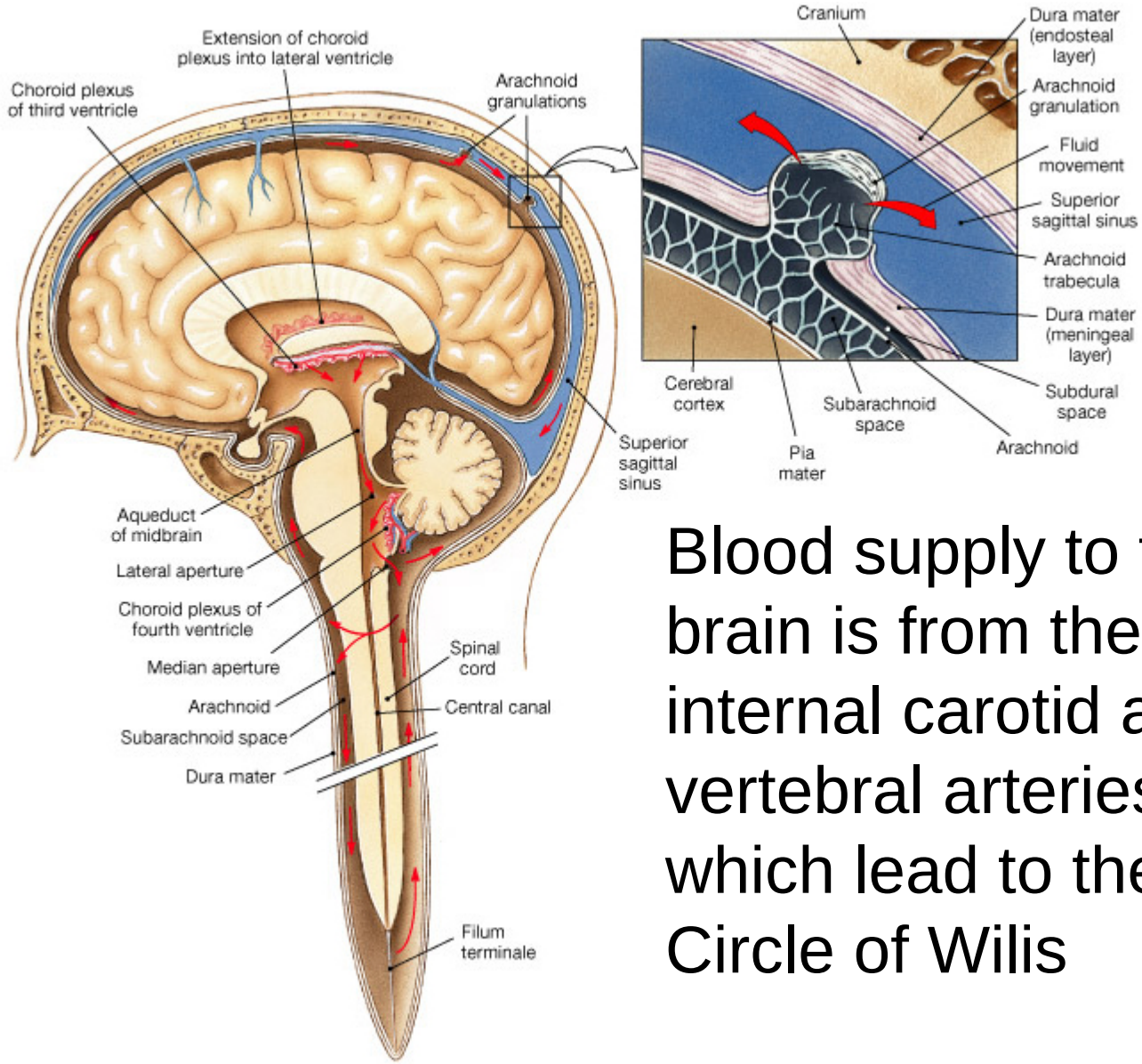
- Produces CSF 500 ml/day
- Composed of ependymal cells and capillaries (CSF is very different from plasma)
- Found in each ventricle
- Floor of lateral ventricles (2)
- Roof of 3rd ventricle
- Roof of 4^{th} ventricle

Fig

15.5


INTERSTITIAL FLUID IN THALAMUS
Nutrients (especially glucose) Oxygen
Ependymal cells
Capillary
Capillary
Endothelial cell
CO_2 Waste products
Blood-brain barrier
Tight junction
Neuron
Astrocyte
Choroid plexus cells
Waste products Ions Amino acids (when necessary)
Ions (Na^+, K^+, Cl^-, HCO_3^-, Ca^{2+}, Mg^{2+}) Vitamins Organic nutrients Oxygen
CHOROID PLEXUS
Tight junction
CEREBROSPINAL FLUID IN THIRD VENTRICLE

CSF circulation



Blood supply to the brain is from the internal carotid and vertebral arteries which lead to the Circle of Wilis

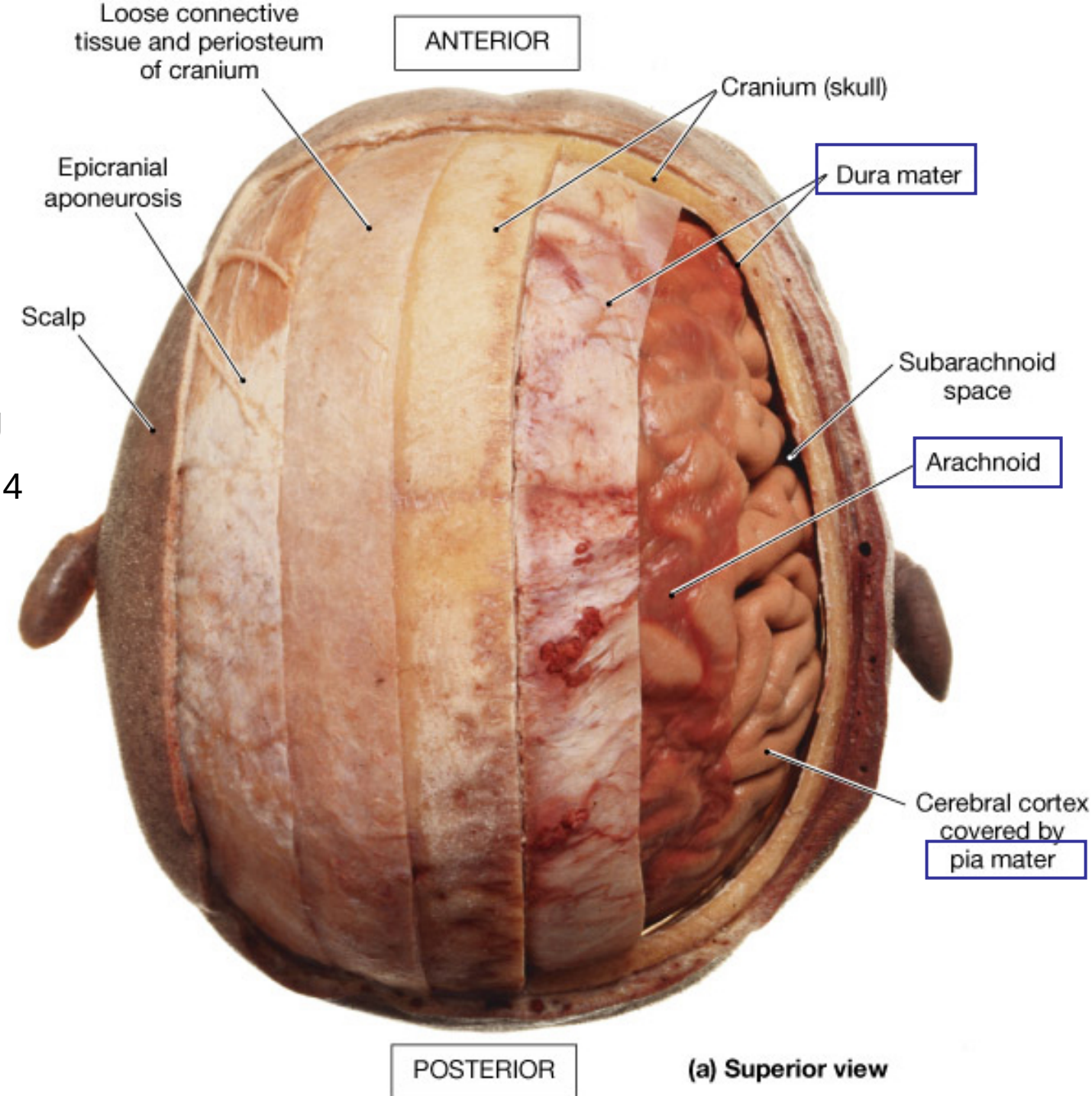
Blood brain barrier

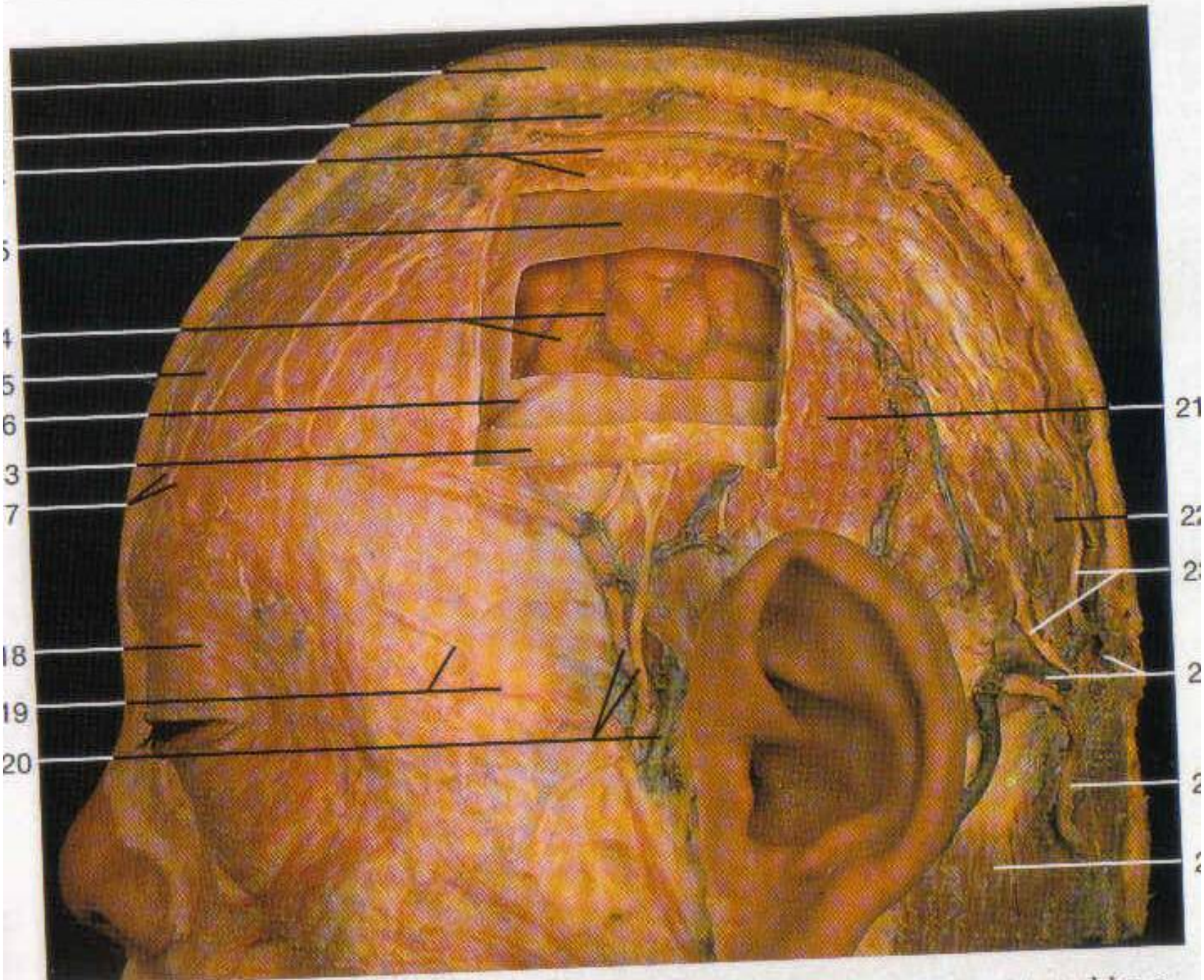
- Maintained by astrocytes
- Not found in:
  - the hypothalamus
  - Pineal gland
  - Roof of 3rd & 4th ventricles

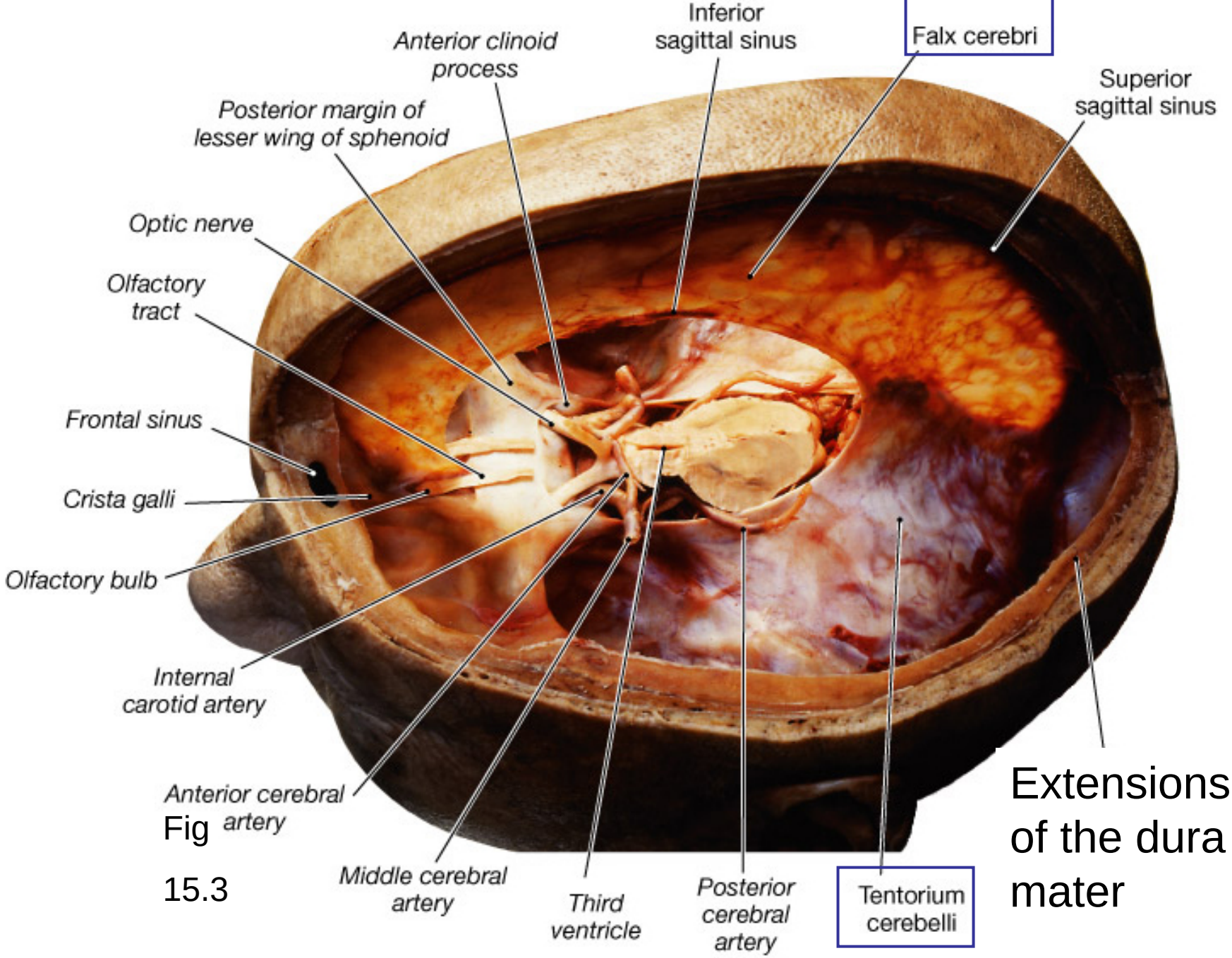
Cranial Meninges

- Protective layers of the brain & spinal cord
  - Provide physical stability and shock absorption
- Superficial
  - Dura mater-Tough fibrous layer
  - Arachnoid
  - Pia mater
- Deep

Fig 15.4


Loose connective tissue and periosteum of cranium
ANTERIOR
Cranium (skull)
Epicranial aponeurosis
Dura mater
Scalp
Subarachnoid space
Arachnoid
Cerebral cortex covered by pia mater
POSTERIOR
(a) Superior view

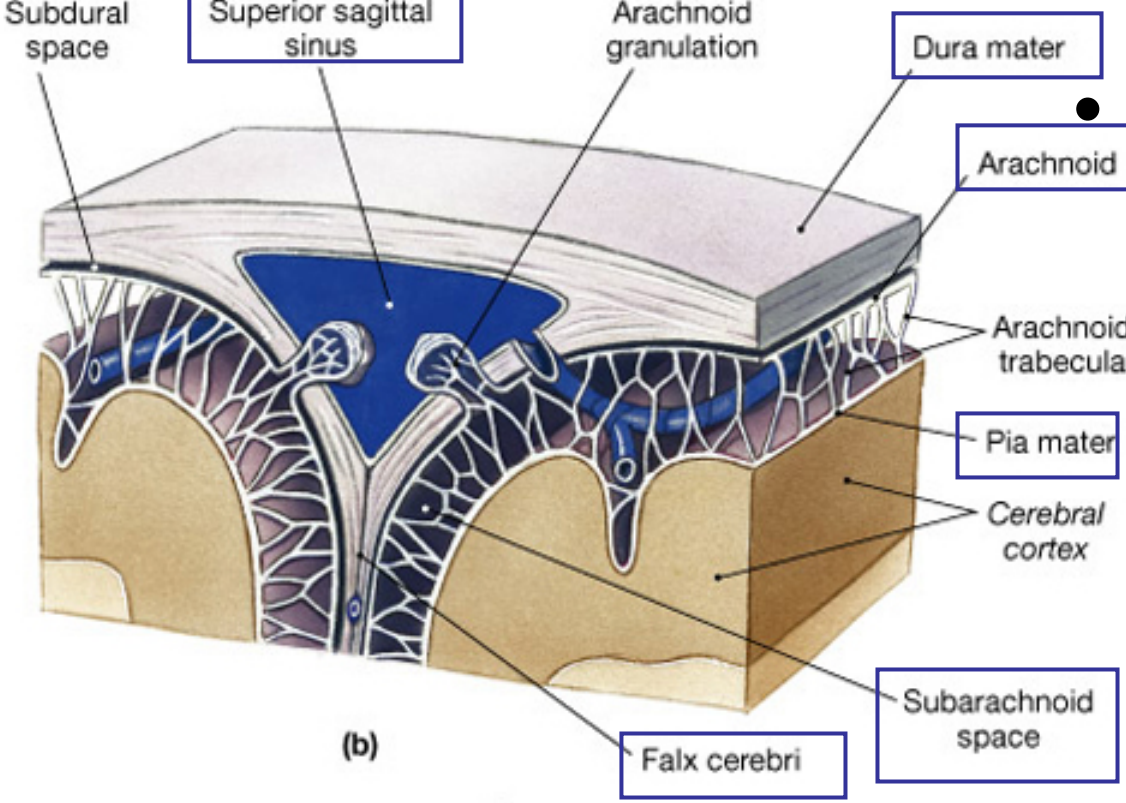




(c) Superior sectional view

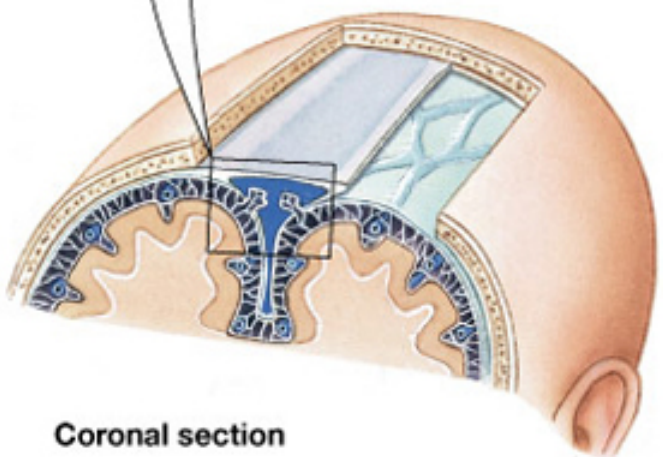
Fig 15.3

Extensions of the dura mater



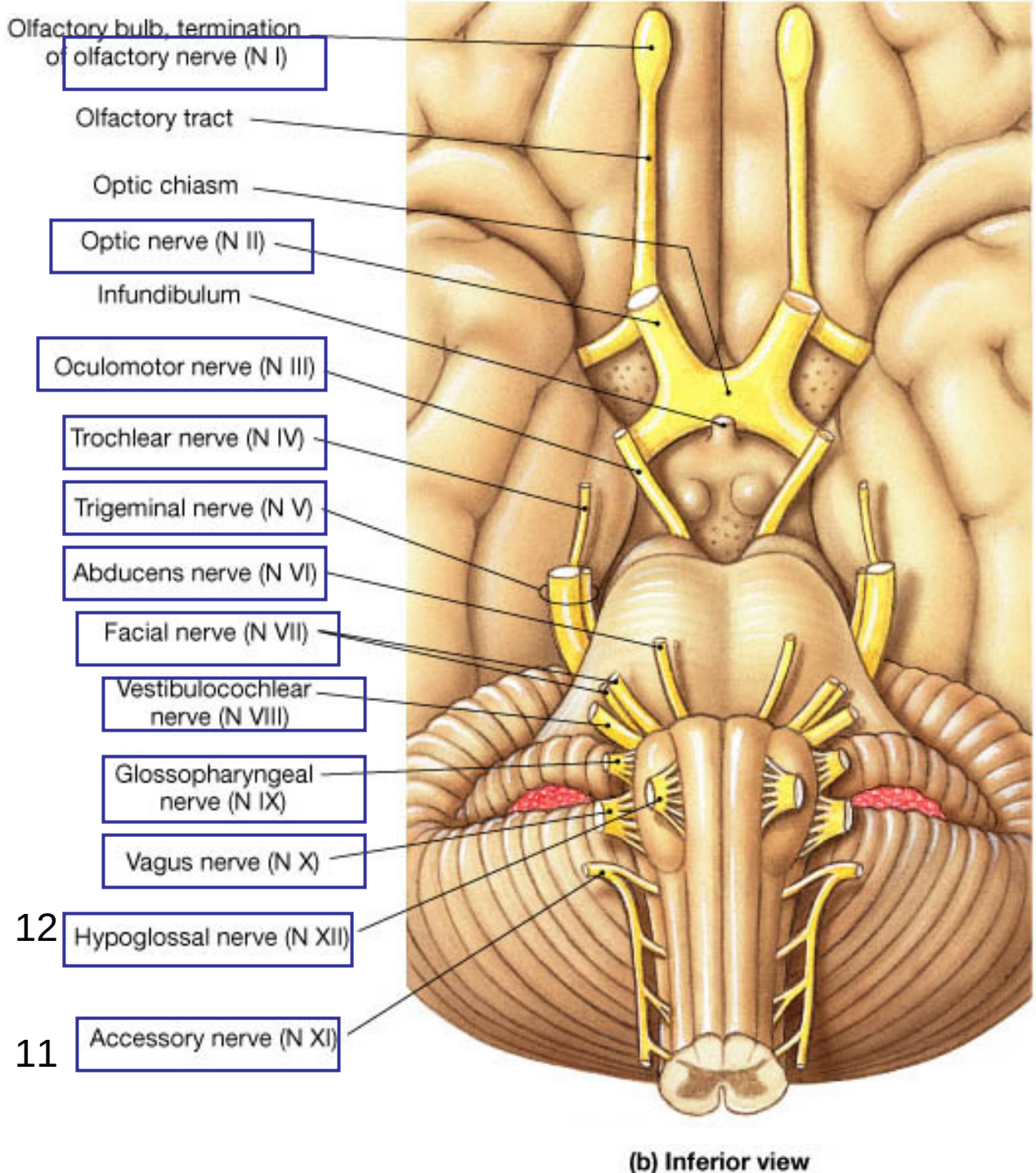
- Deep to arachnoid is subarachnoid space
  - Network of collagen and elastin fibers (arachnoid trabeculae)
  - Contains CSF

Fig 15.4



12 pairs of Cranial nerves

Fig 15.21



(b) Inferior view

1-12 Old

Owls

On

Tree

Tops Are Forever

Viewing

Green

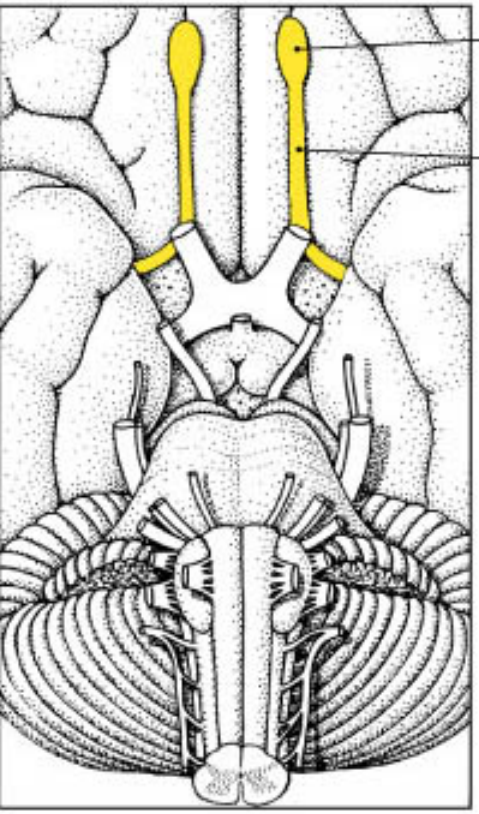
Valleys

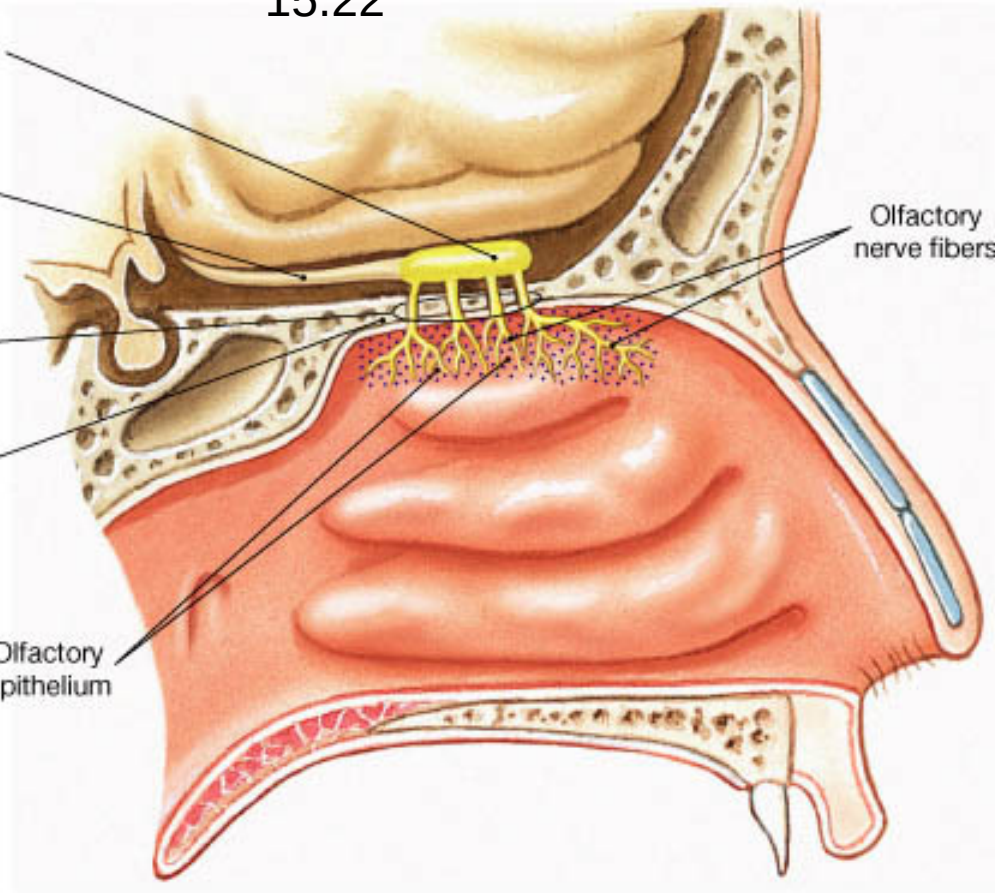
And

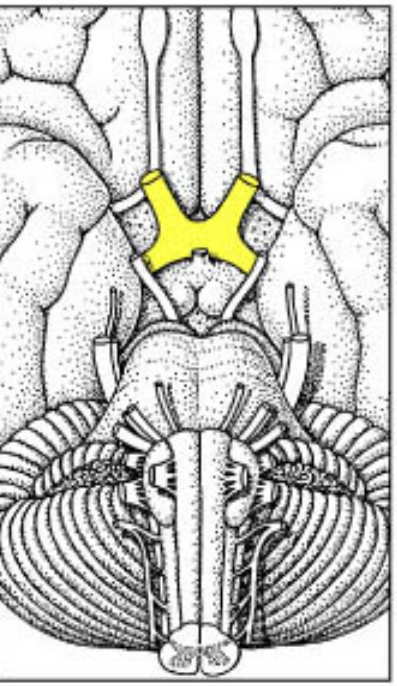
Hills

Fig

15.22




Left olfactory bulb (termination of olfactory nerve)
Olfactory tract (to olfactory cortex of cerebrum)
OLFACTORY NERVE (N I)
Cribriform plate of ethmoid
Olfactory epithelium
Olfactory nerve fibers



Fig

15.23

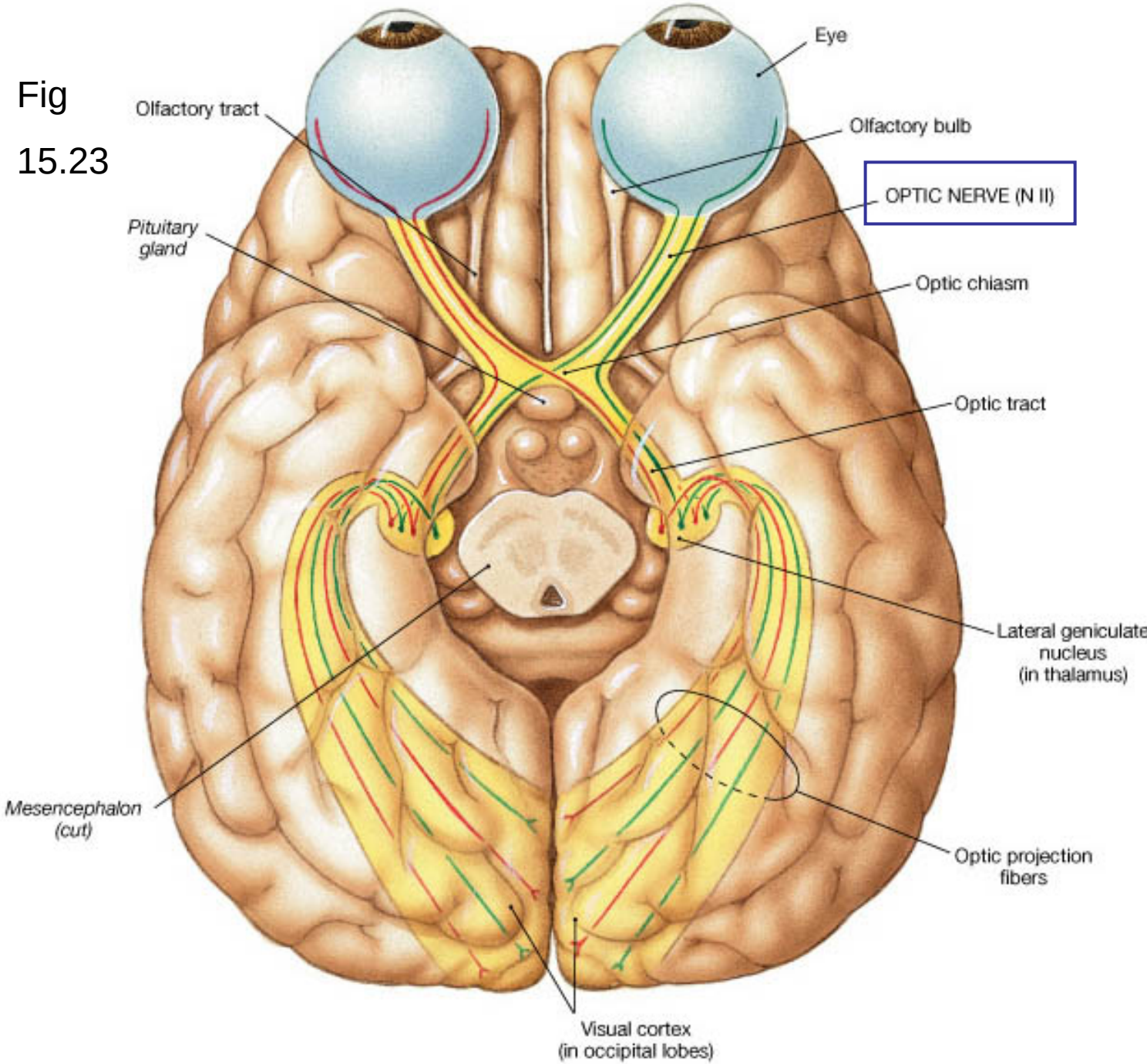
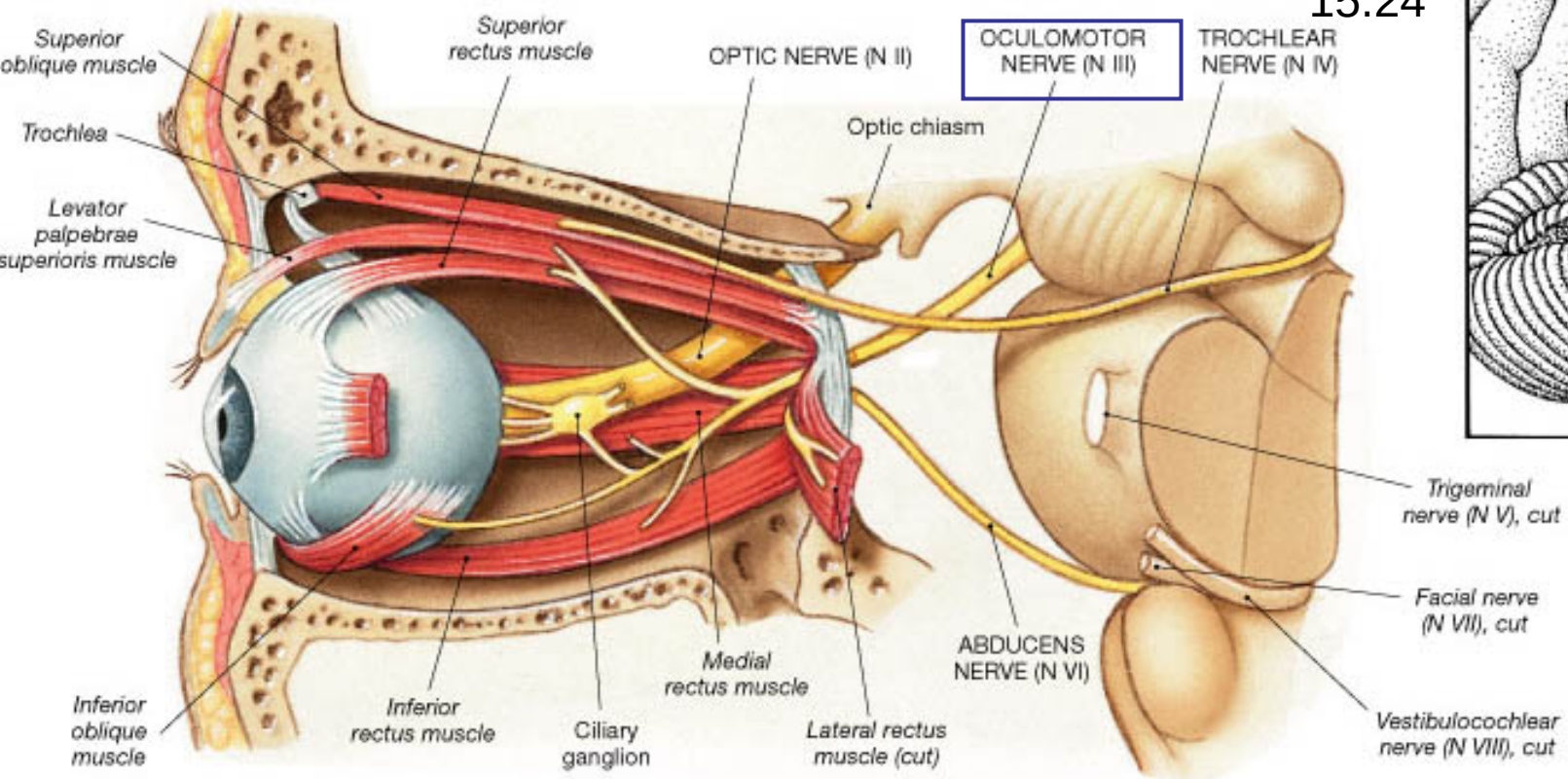

Eye
Olfactory tract
Olfactory bulb
OPTIC NERVE (N II)
Pituitary gland
Optic chiasm
Optic tract
Lateral geniculate nucleus (in thalamus)
Mesencephalon (cut)
Optic projection fibers
Visual cortex (in occipital lobes)

Fig 15.24


Superior oblique muscle
Trochlea
Levator palpebrae superioris muscle
Superior rectus muscle
OPTIC NERVE (N II)
OCULOMOTOR NERVE (N III)
TROCHLEAR NERVE (N IV)
Optic chiasm
Trigeminal nerve (N V), cut
Facial nerve (N VII), cut
Vestibulocochlear nerve (N VIII), cut
ABDUCENS NERVE (N VI)
Medial rectus muscle
Inferior oblique muscle
Inferior rectus muscle
Ciliary ganglion
Lateral rectus muscle (cut)

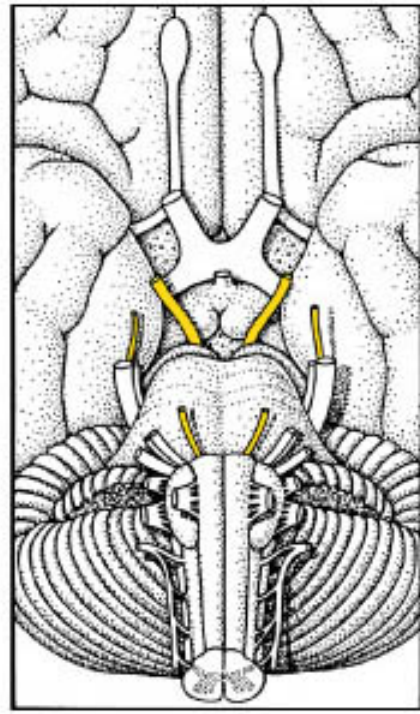
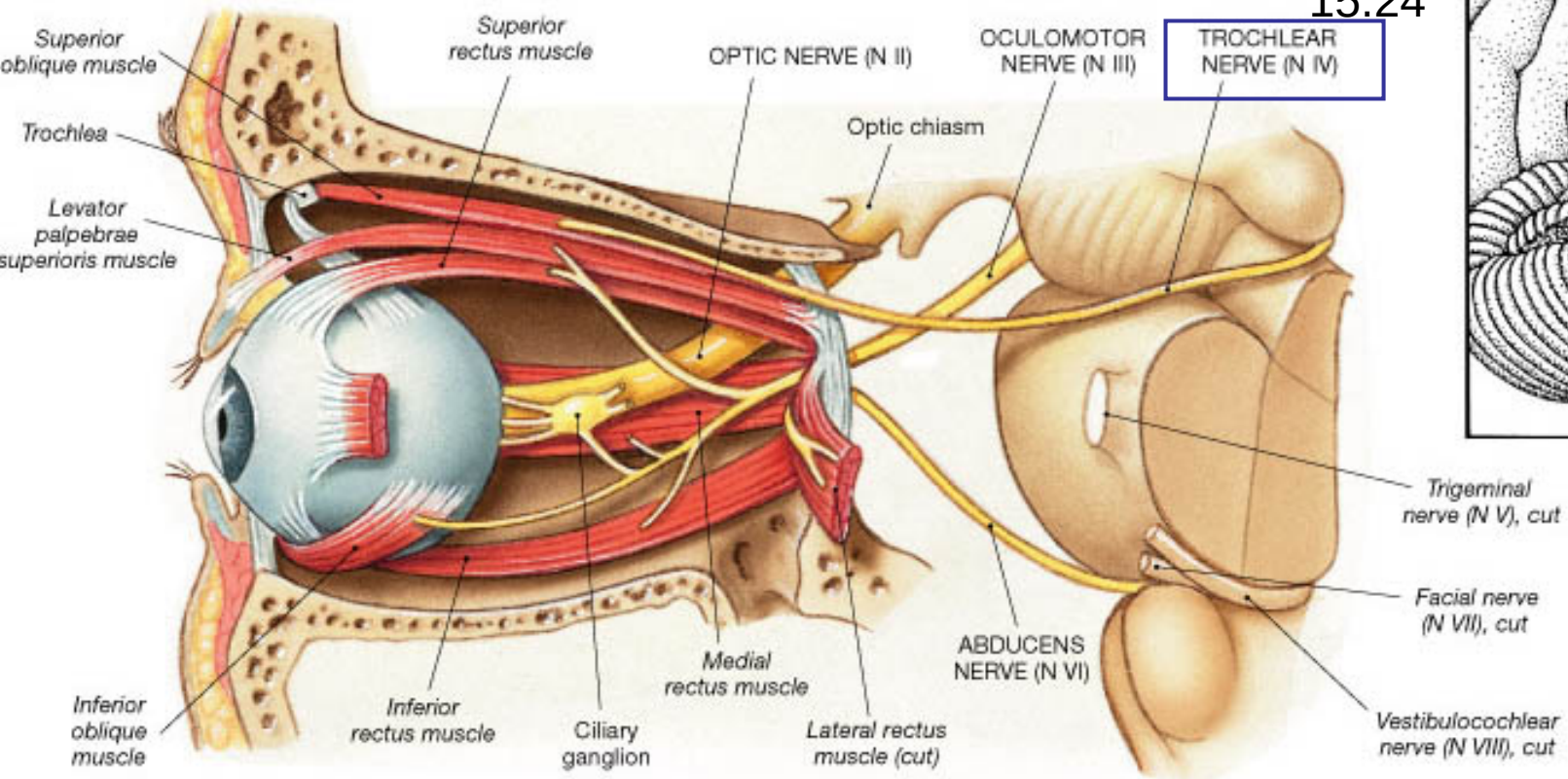


Fig 15.24


Superior oblique muscle
Trochlea
Levator palpebrae superioris muscle
Superior rectus muscle
OPTIC NERVE (N II)
Optic chiasm
OCULOMOTOR NERVE (N III)
TROCHLEAR NERVE (N IV)
Trigeminal nerve (N V), cut
Facial nerve (N VII), cut
Vestibulocochlear nerve (N VIII), cut
ABDUCENS NERVE (N VI)
Medial rectus muscle
Lateral rectus muscle (cut)
Ciliary ganglion
Inferior rectus muscle
Inferior oblique muscle

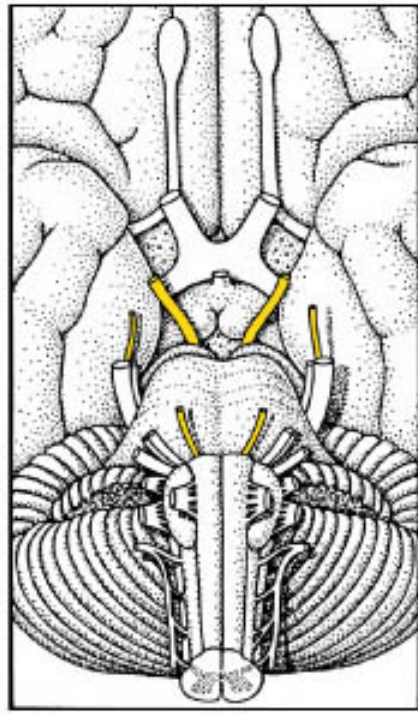
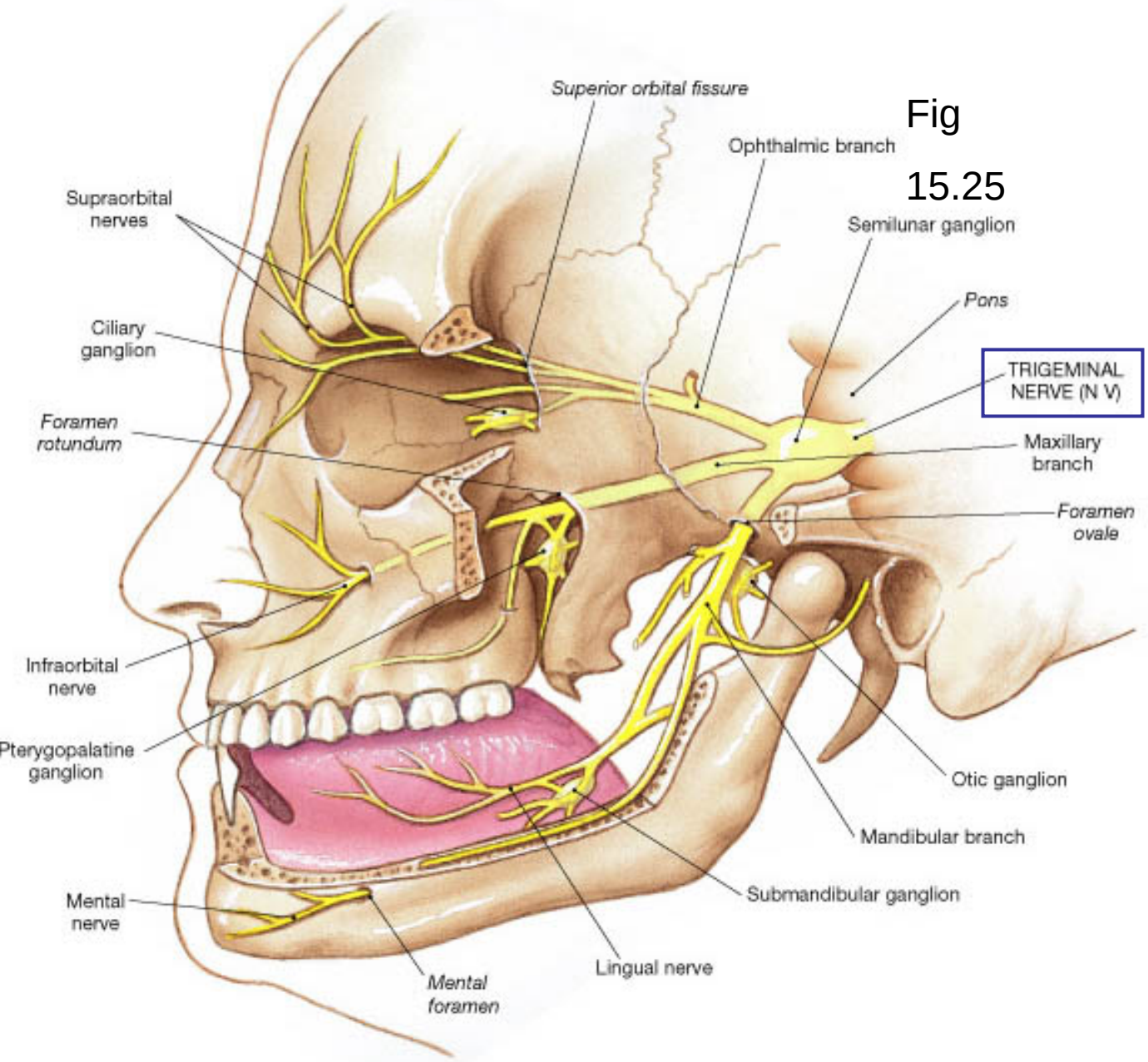


Fig 15.25


Superior orbital fissure
Ophthalmic branch
Supraorbital nerves
Semilunar ganglion
Pons
Ciliary ganglion
TRIGEMINAL NERVE (N V)
Foramen rotundum
Maxillary branch
Foramen ovale
Infraorbital nerve
Pterygopalatine ganglion
Otic ganglion
Mandibular branch
Submandibular ganglion
Mental nerve
Lingual nerve
Mental foramen

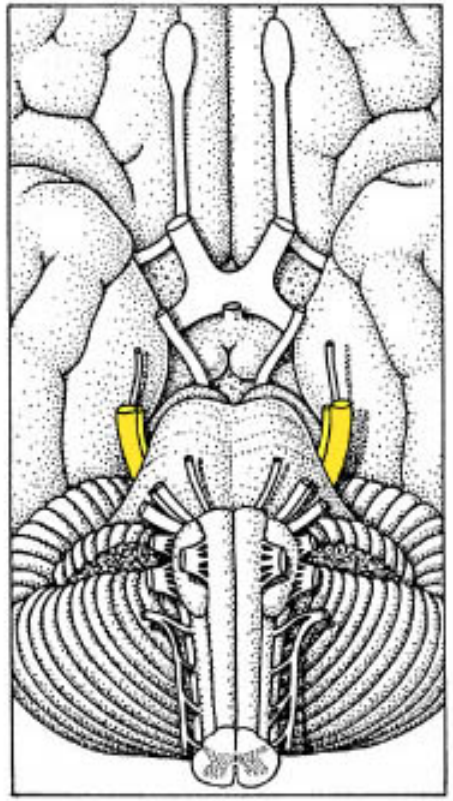
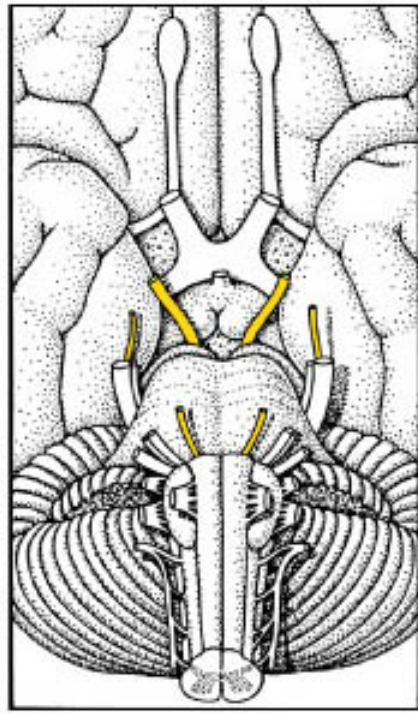


Fig 15.24



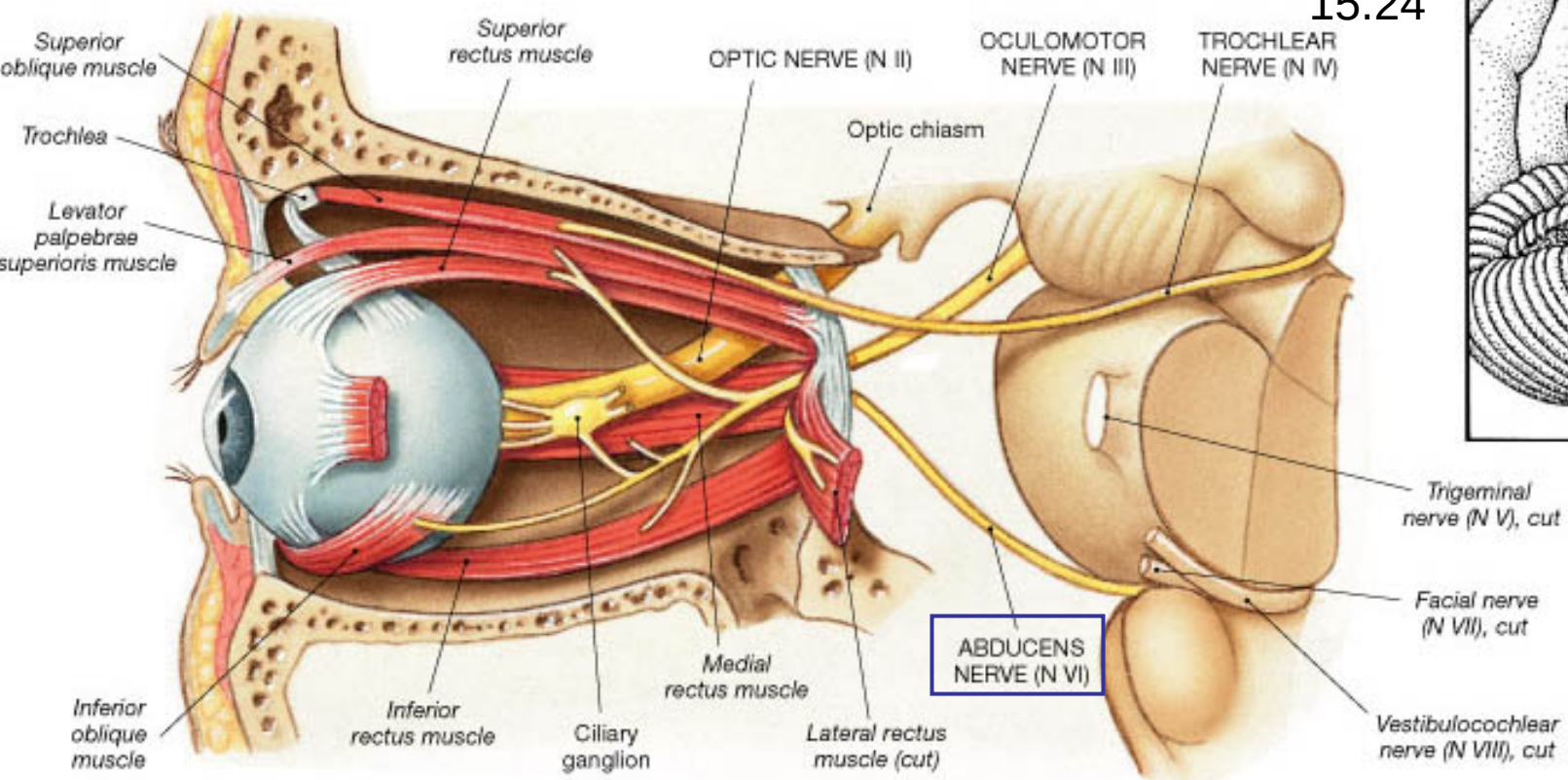
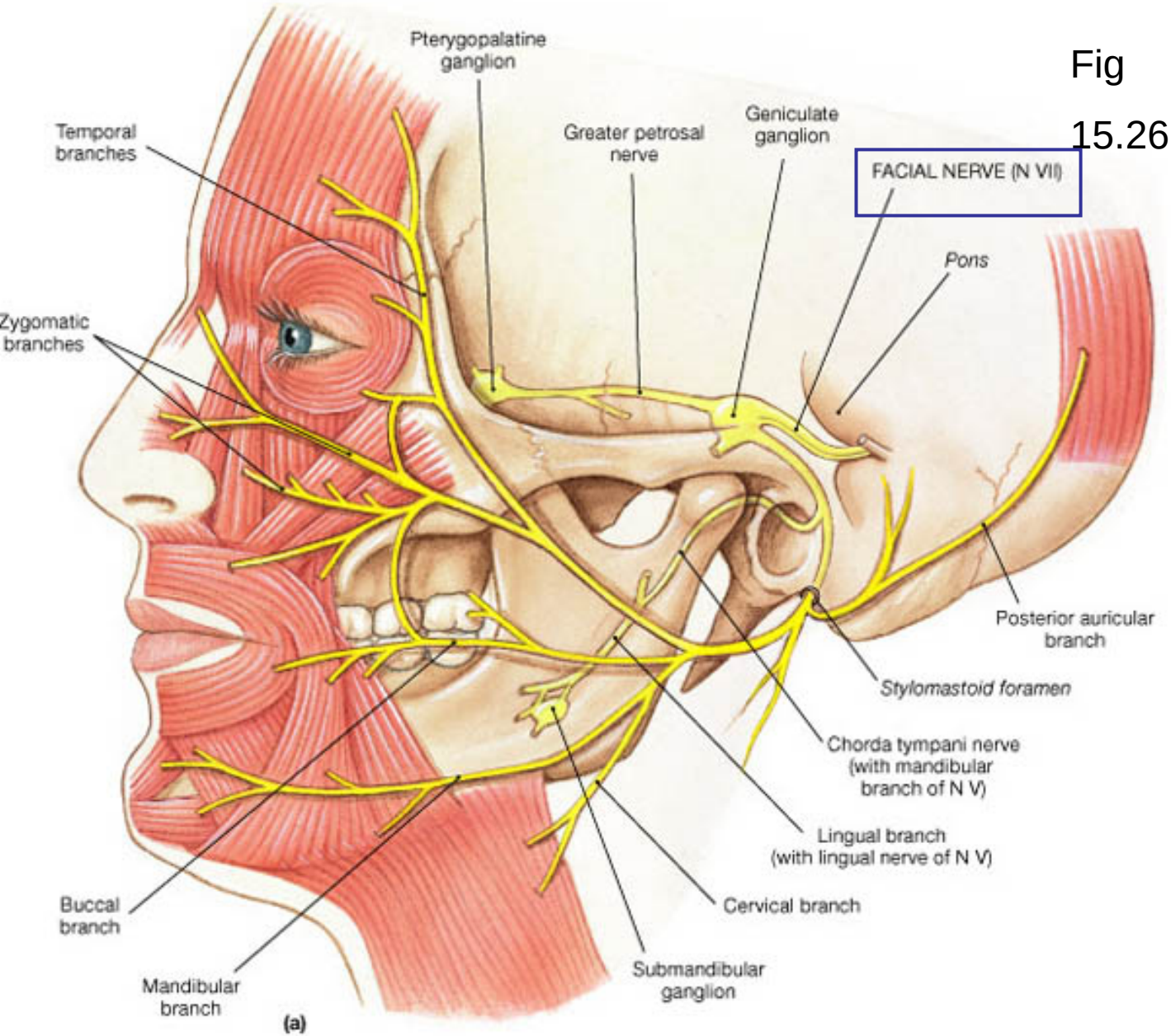

Superior oblique muscle
Trochlea
Levator palpebrae superioris muscle
Superior rectus muscle
OPTIC NERVE (N II)
Optic chiasm
OCULOMOTOR NERVE (N III)
TROCHLEAR NERVE (N IV)
Trigeminal nerve (N V), cut
Facial nerve (N VII), cut
Vestibulocochlear nerve (N VIII), cut
ABDUCENS NERVE (N VI)
Medial rectus muscle
Lateral rectus muscle (cut)
Ciliary ganglion
Inferior rectus muscle
Inferior oblique muscle

Fig 15.26


Pterygopalatine ganglion
Temporal branches
Greater petrosal nerve
Geniculate ganglion
FACIAL NERVE (N VII)
Pons
Zygomatic branches
Posterior auricular branch
Stylomastoid foramen
Chorda tympani nerve (with mandibular branch of N V)
Lingual branch (with lingual nerve of N V)
Buccal branch
Cervical branch
Submandibular ganglion
Mandibular branch
(a)

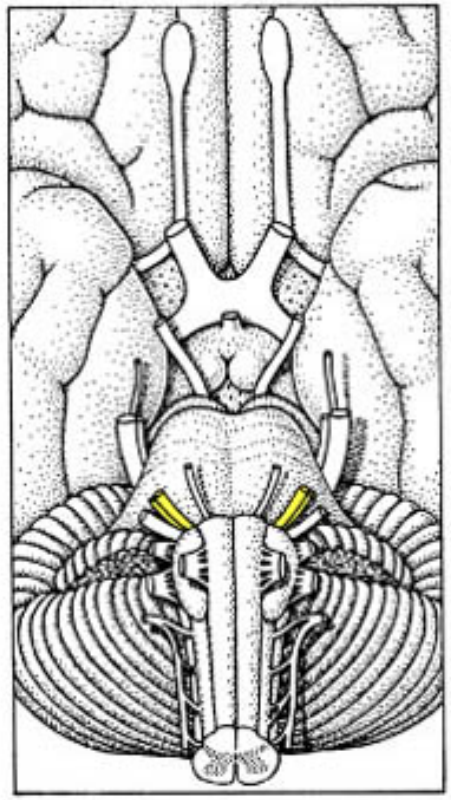
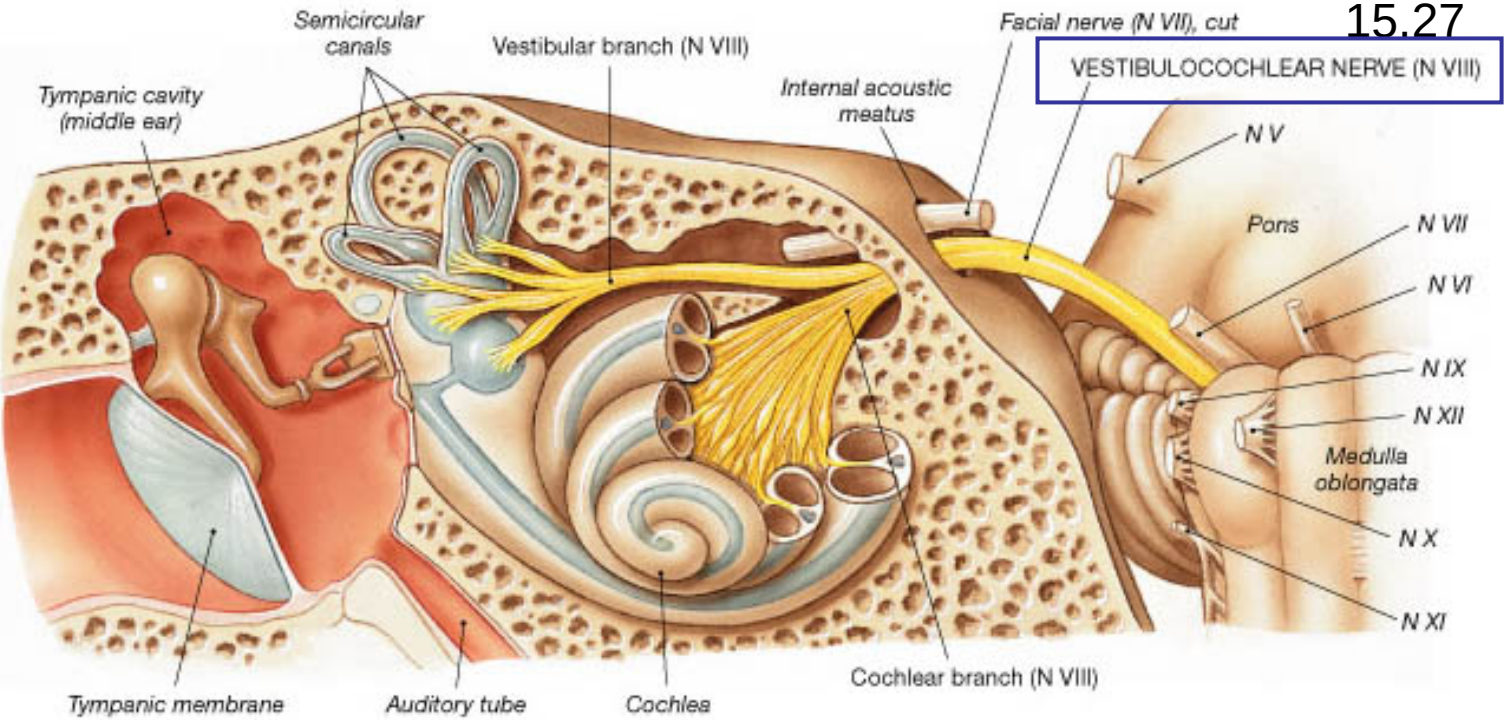
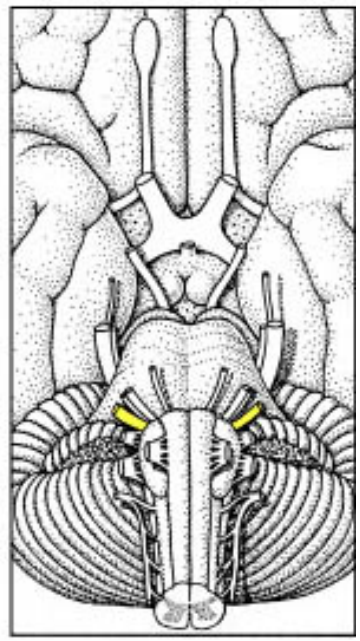


Fig 15.27


Semicircular canals
Vestibular branch (N VIII)
Facial nerve (N VII), cut
VESTIBULOCOCHLEAR NERVE (N VIII)
Tympanic cavity (middle ear)
Internal acoustic meatus
N V
Pons
N VII
N VI
N IX
N XII
Medulla oblongata
N X
N XI
Cochlear branch (N VIII)
Tympanic membrane
Auditory tube
Cochlea



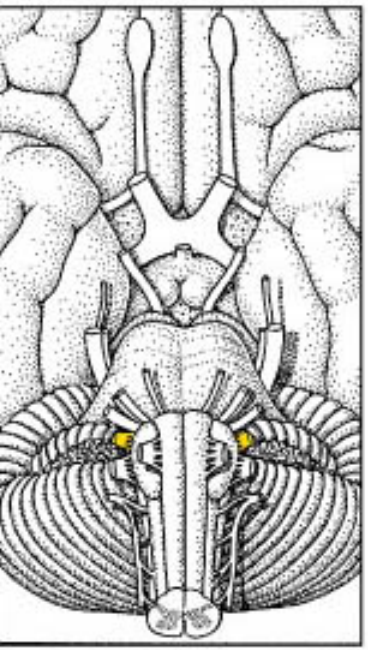
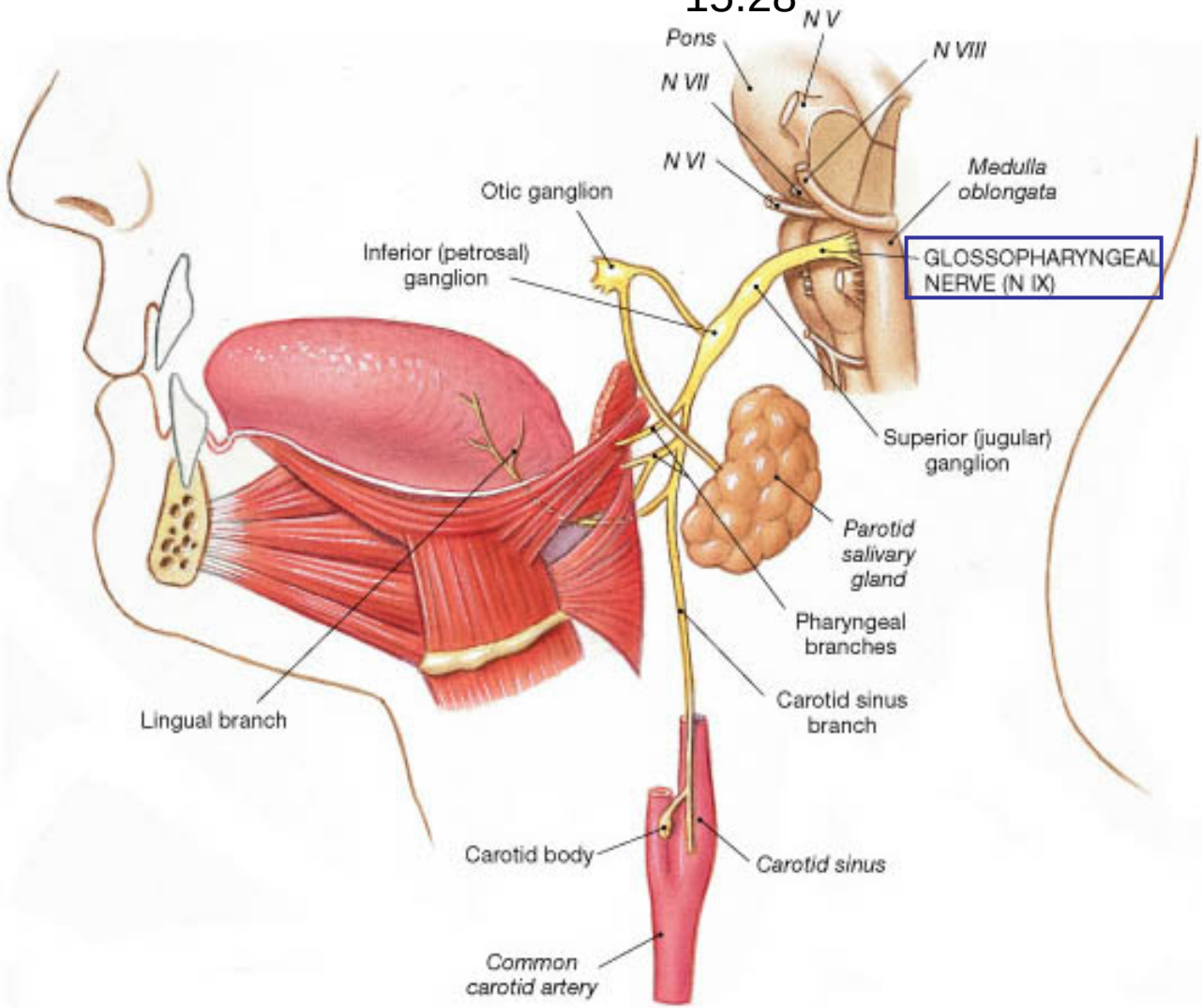
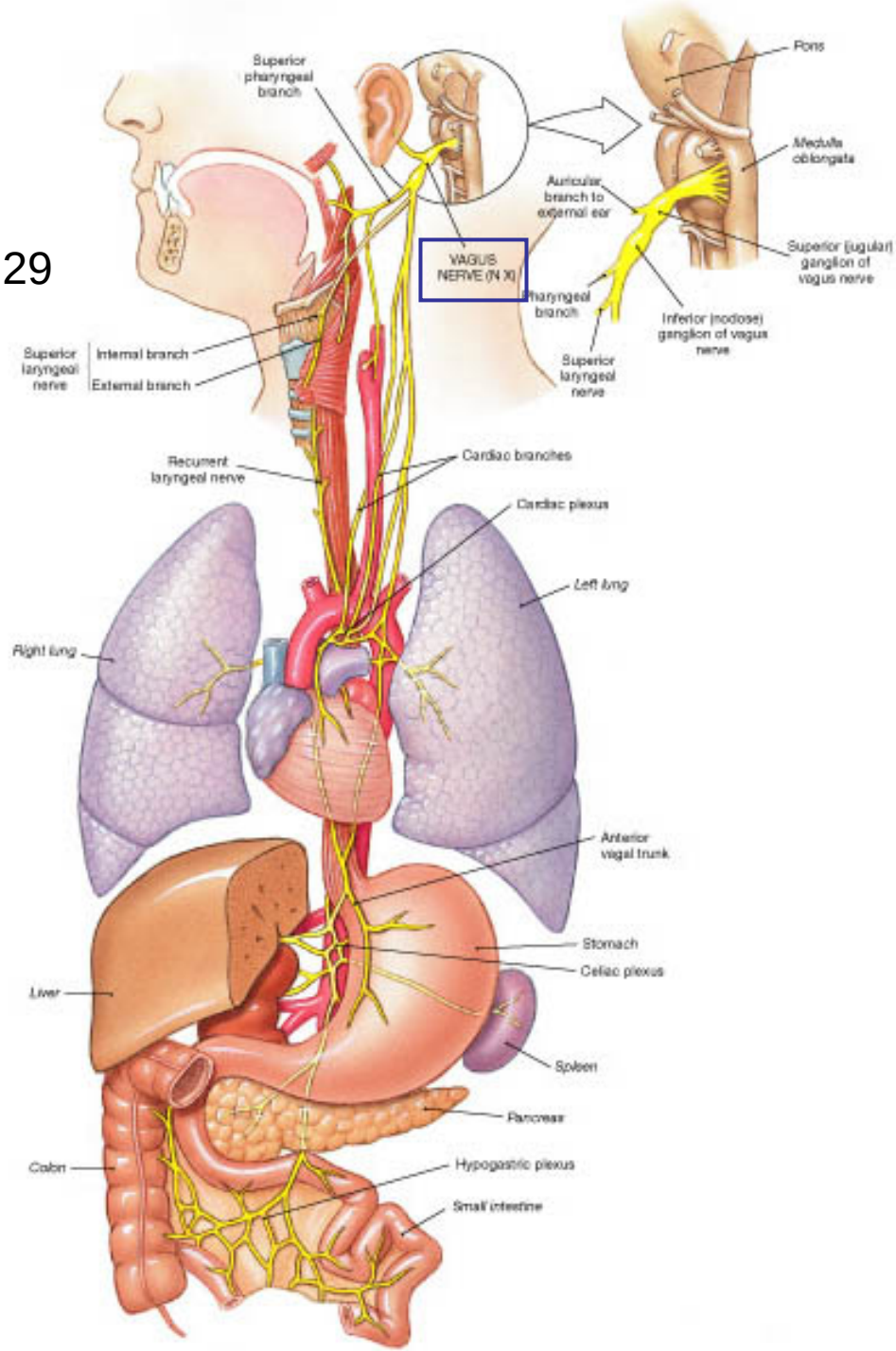


Fig 15.28


Pons
N V
N VIII
N VII
N VI
Medulla oblongata
Otic ganglion
Inferior (petrosal) ganglion
GLOSSOPHARYNGEAL NERVE (N IX)
Superior (jugular) ganglion
Parotid salivary gland
Pharyngeal branches
Carotid sinus branch
Lingual branch
Carotid body
Carotid sinus
Common carotid artery

Fig

15.29


Superior pharyngeal branch
Pons
Medulla oblongata
Auricular branch to external ear
VAGUS NERVE (N X)
Superior (jugular) ganglion of vagus nerve
Pharyngeal branch
Inferior (nodose) ganglion of vagus nerve
Superior laryngeal nerve
Superior laryngeal nerve
Internal branch
External branch
Recurrent laryngeal nerve
Cardiac branches
Cardiac plexus
Left lung
Right lung
Anterior vagal trunk
Stomach
Celiac plexus
Liver
Spleen
Pancreas
Colon
Hypogastric plexus
Small intestine

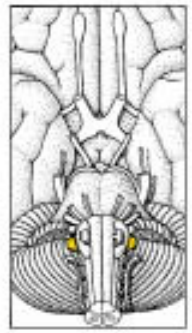
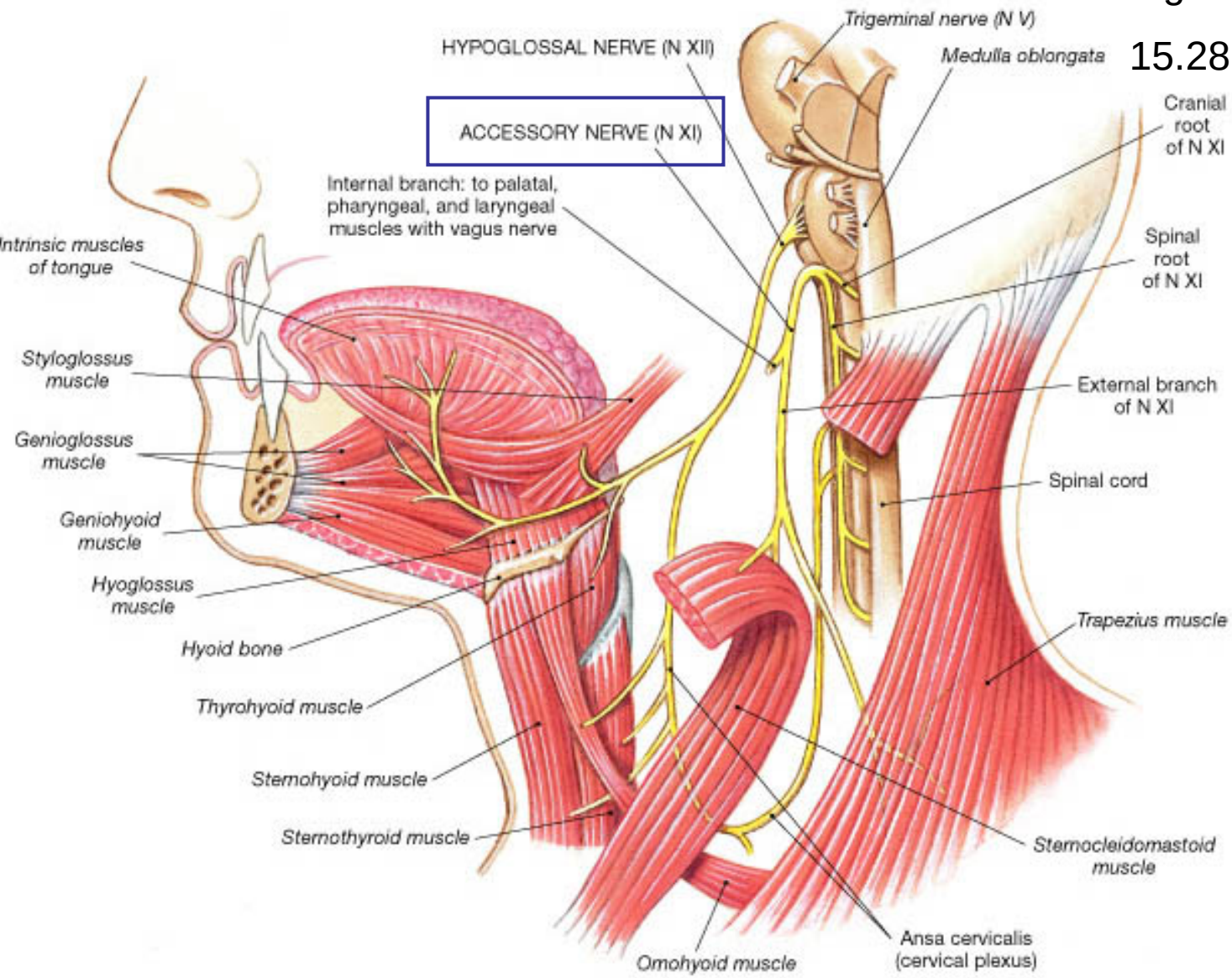


Fig 15.28


Trigeminal nerve (N V)
HYPOGLOSSAL NERVE (N XII)
Medulla oblongata
ACCESSORY NERVE (N XI)
Cranial root of N XI
Internal branch: to palatal, pharyngeal, and laryngeal muscles with vagus nerve
Intrinsic muscles of tongue
Spinal root of N XI
Styloglossus muscle
External branch of N XI
Genioglossus muscle
Spinal cord
Geniohyoid muscle
Hyoglossus muscle
Trapezius muscle
Hyoid bone
Thyrohyoid muscle
Sternohyoid muscle
Sternothyroid muscle
Sternocleidomastoid muscle
Ansa cervicalis (cervical plexus)
Omohyoid muscle

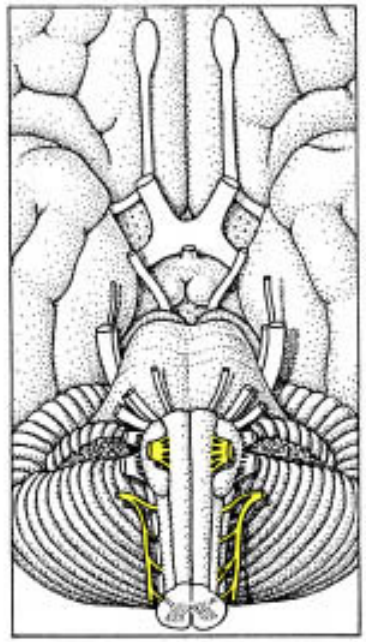
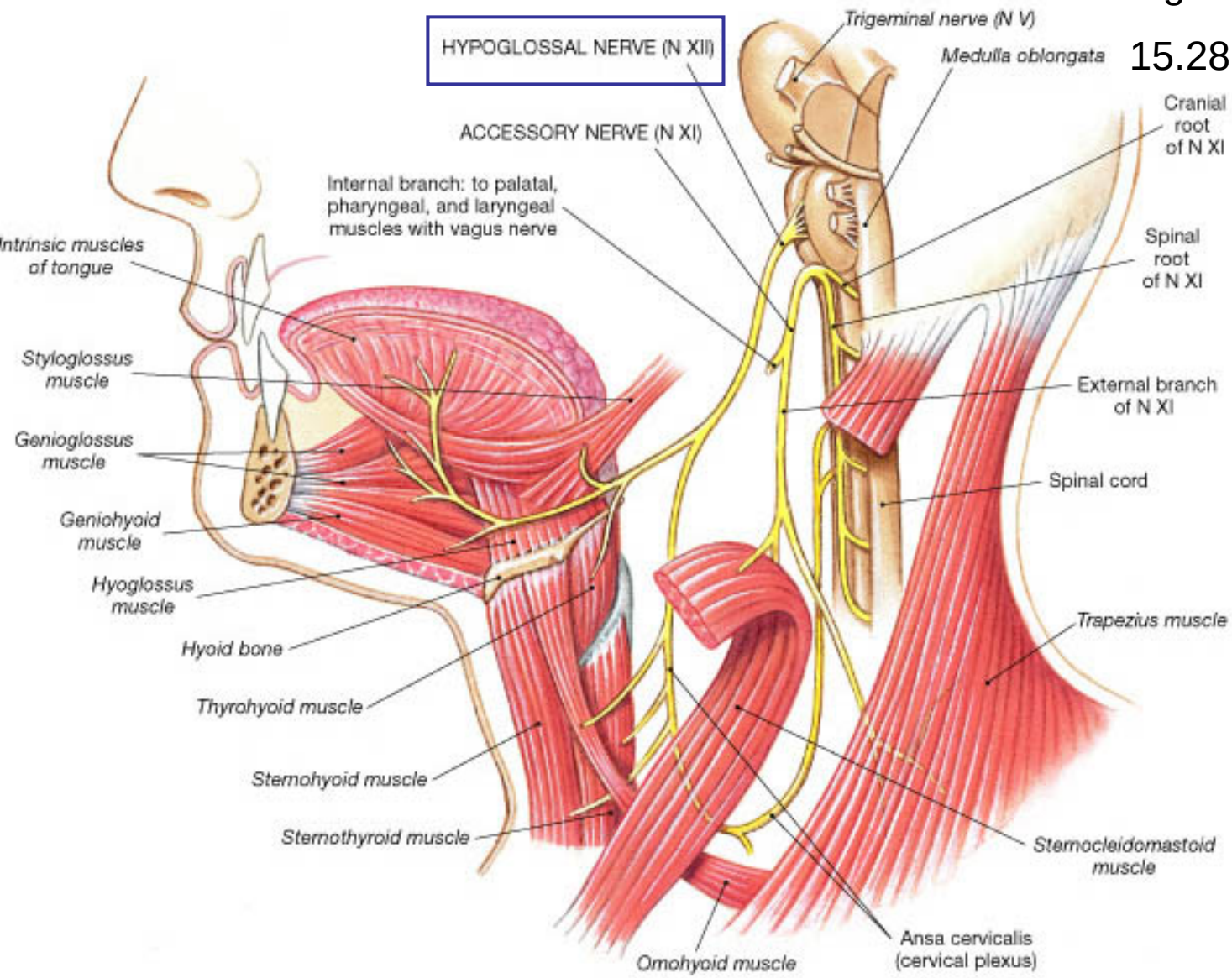
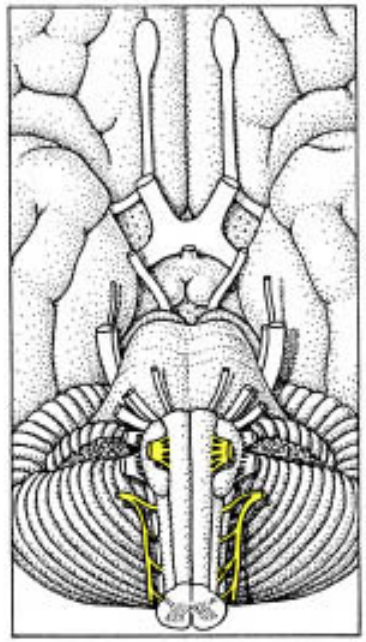
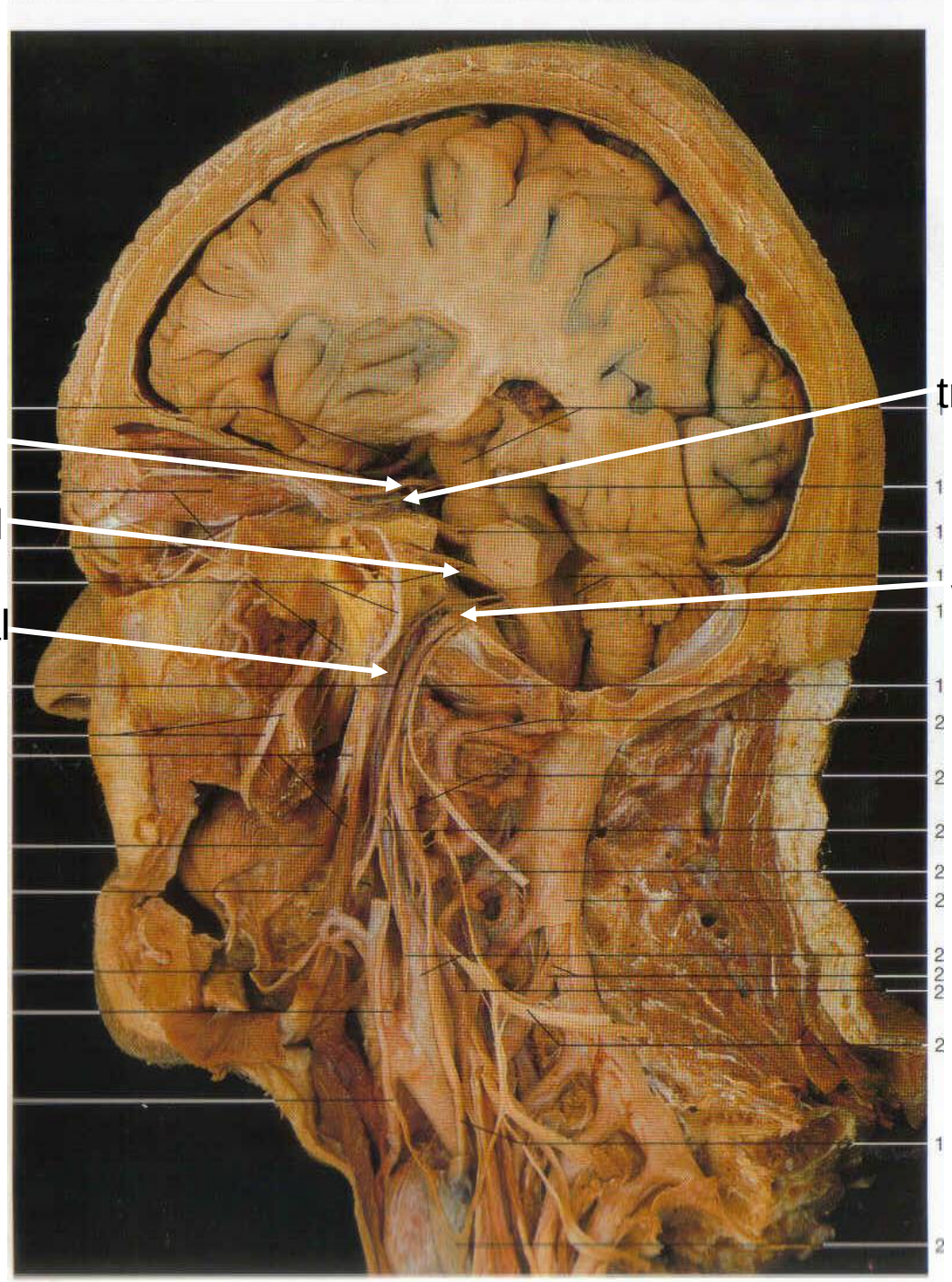


Fig 15.28


HYPOGLOSSAL NERVE (N XII)
Trigeminal nerve (N V)
Medulla oblongata
ACCESSORY NERVE (N XI)
Cranial root of N XI
Internal branch: to palatal, pharyngeal, and laryngeal muscles with vagus nerve
Intrinsic muscles of tongue
Spinal root of N XI
Styloglossus muscle
External branch of N XI
Genioglossus muscle
Spinal cord
Geniohyoid muscle
Hyoglossus muscle
Trapezius muscle
Hyoid bone
Thyrohyoid muscle
Sternohyoid muscle
Sternothyroid muscle
Sternocleidomastoid muscle
Ansa cervicalis (cervical plexus)
Omohyoid muscle





Know the primary function of each nerve

break

Cranial dissection video

- By Kevin Petti

Histology CD

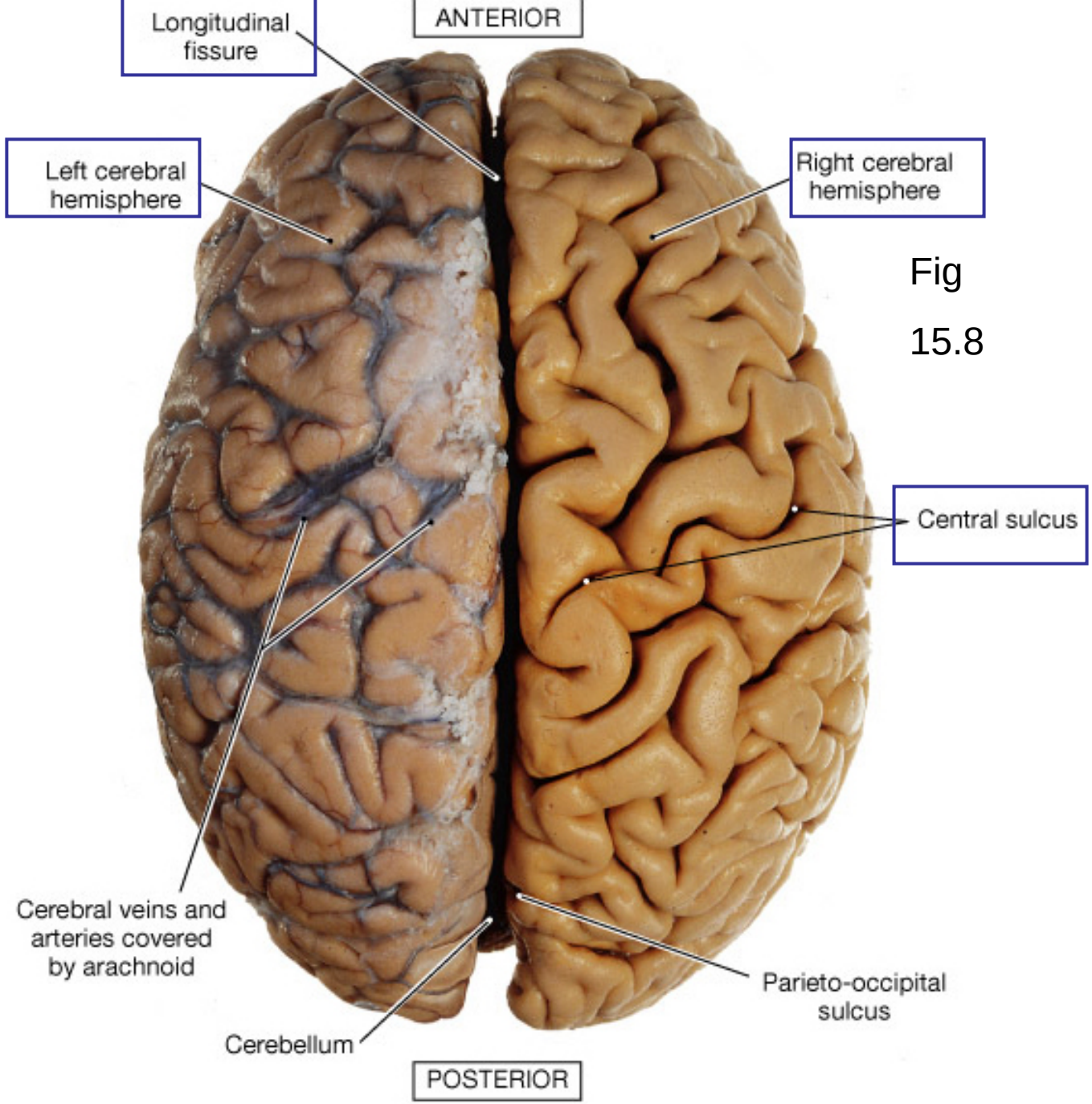


Fig 15.8

(a) Superior view

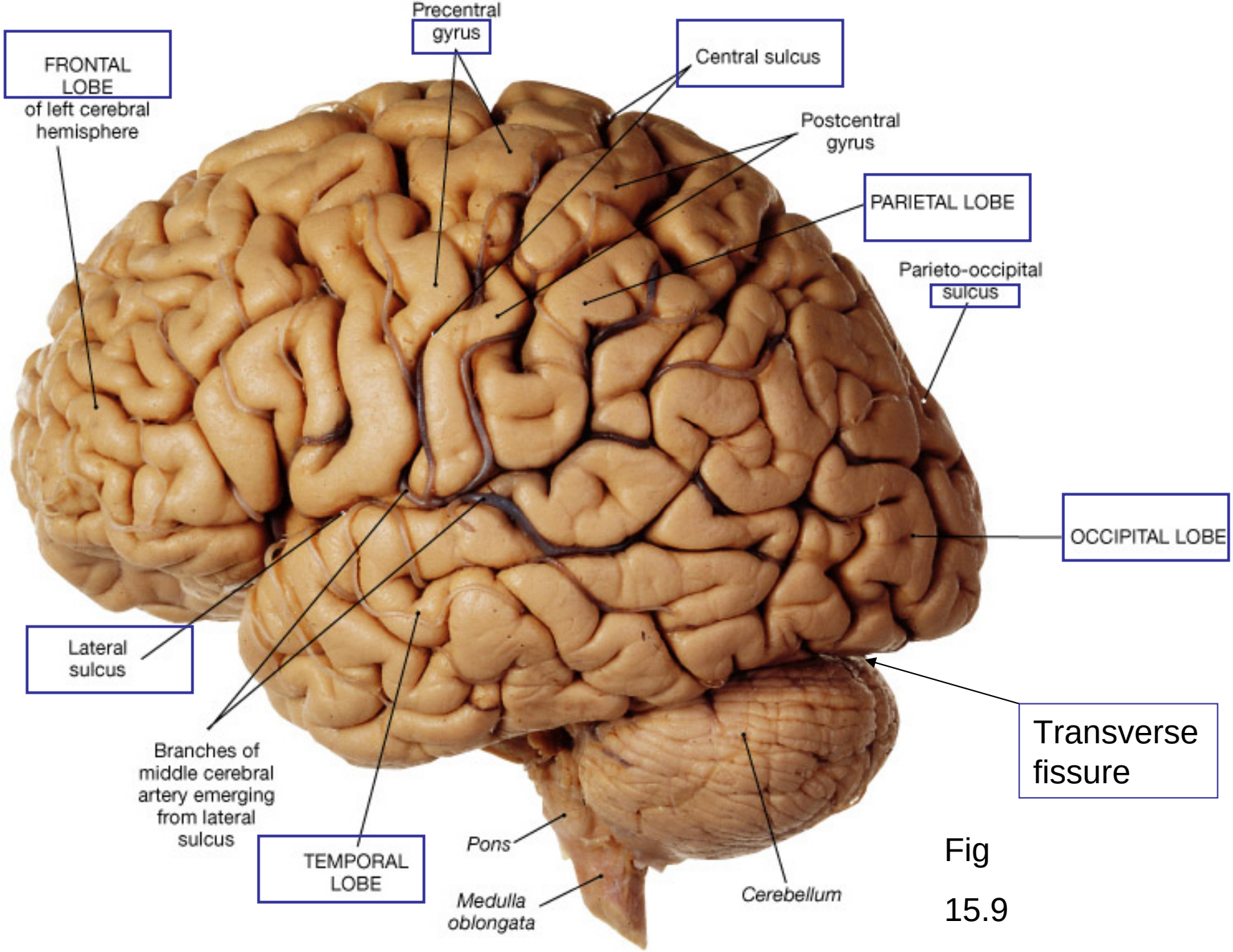
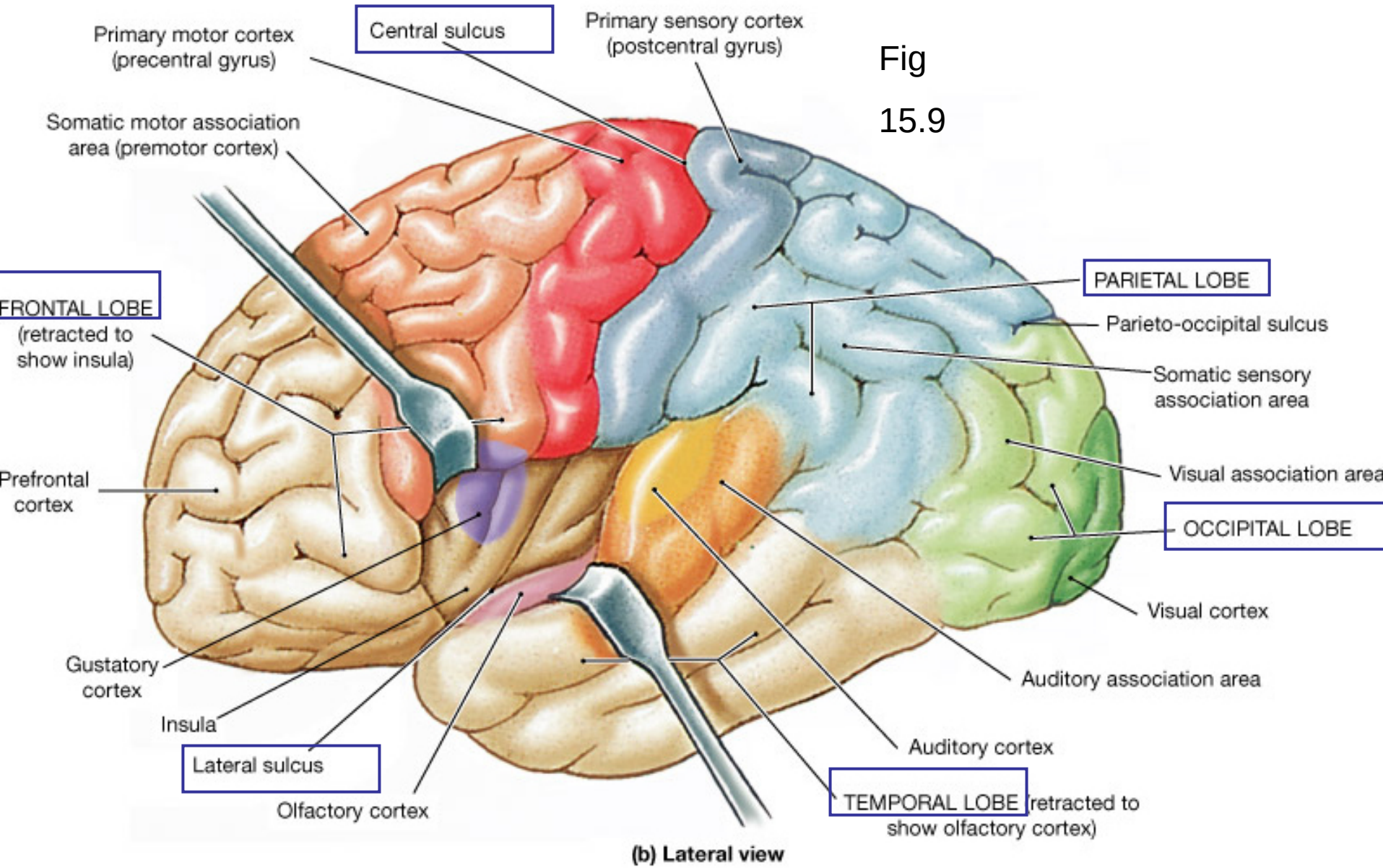

FRONTAL LOBE
of left cerebral hemisphere
Precentral gyrus
Central sulcus
Postcentral gyrus
PARIETAL LOBE
Parieto-occipital sulcus
OCCIPITAL LOBE
Lateral sulcus
Branches of middle cerebral artery emerging from lateral sulcus
TEMPORAL LOBE
Pons
Medulla oblongata
Cerebellum
Transverse fissure
(a) Lateral view

Fig 15.9

Fig

15.9



(b) Lateral view

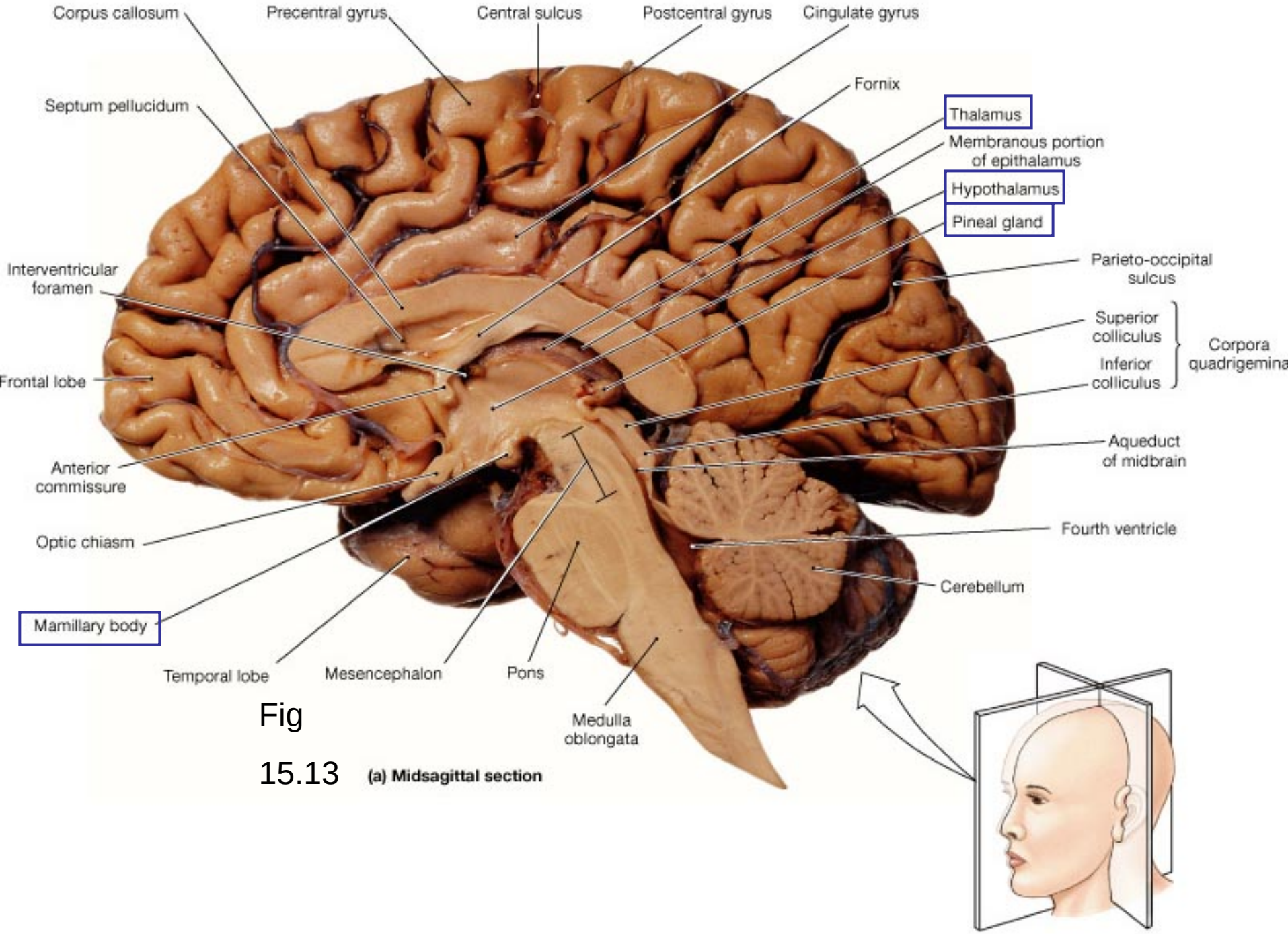
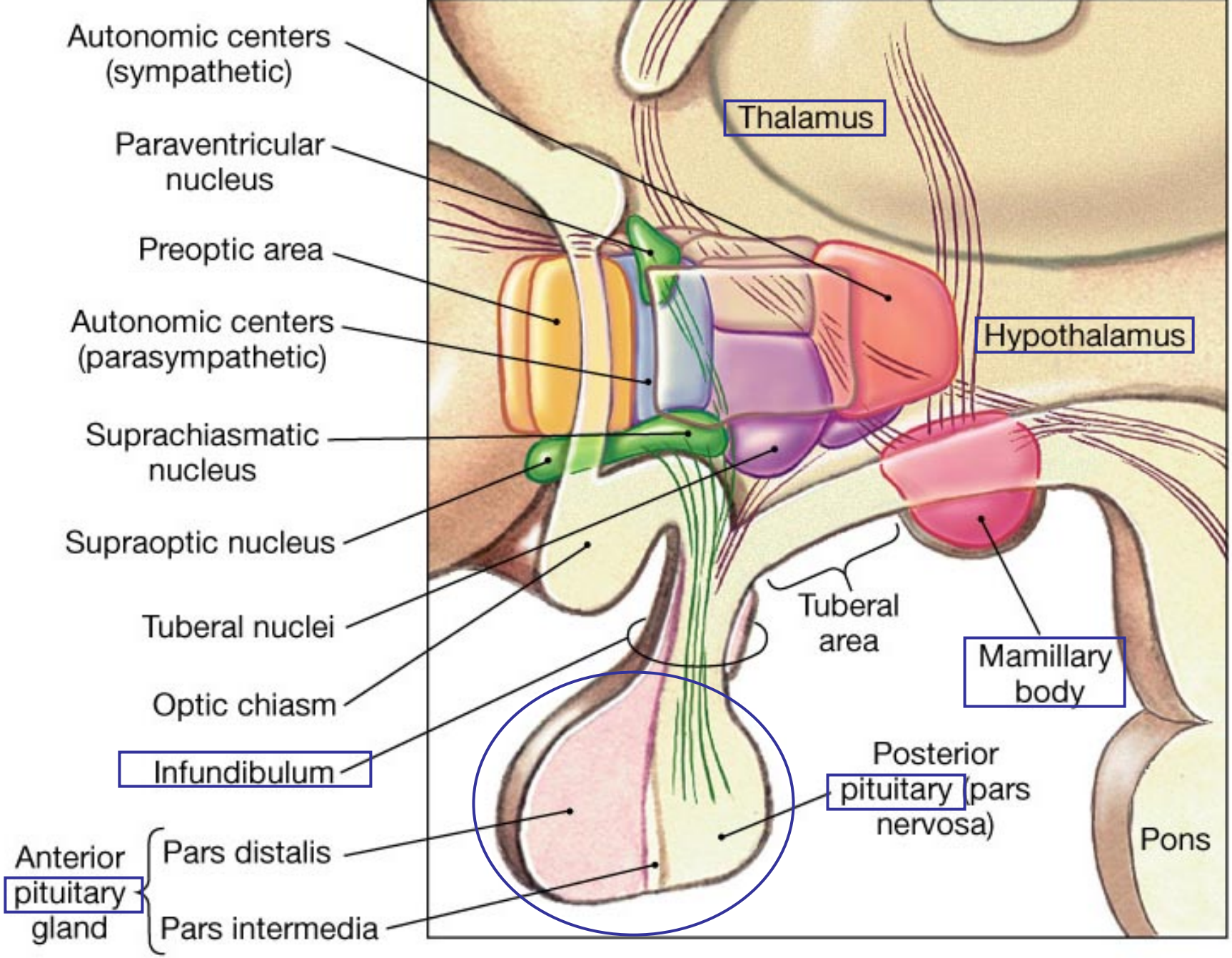


Fig 15.13 **(a) Midsagittal section**



(b) Hypothalmus

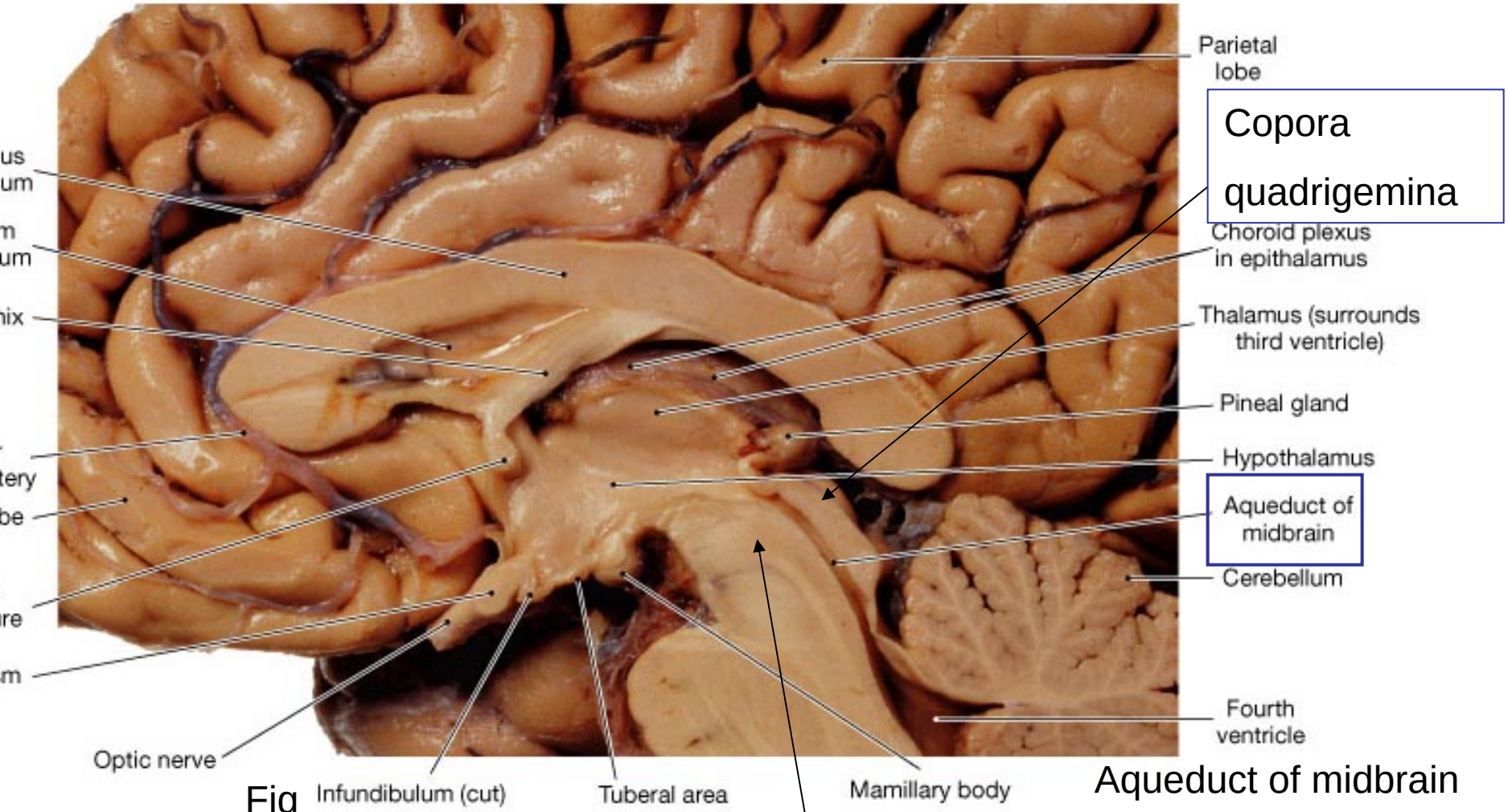


Fig 15.15

Aqueduct of midbrain or Cerebral aqueduct

Cerebral peduncles

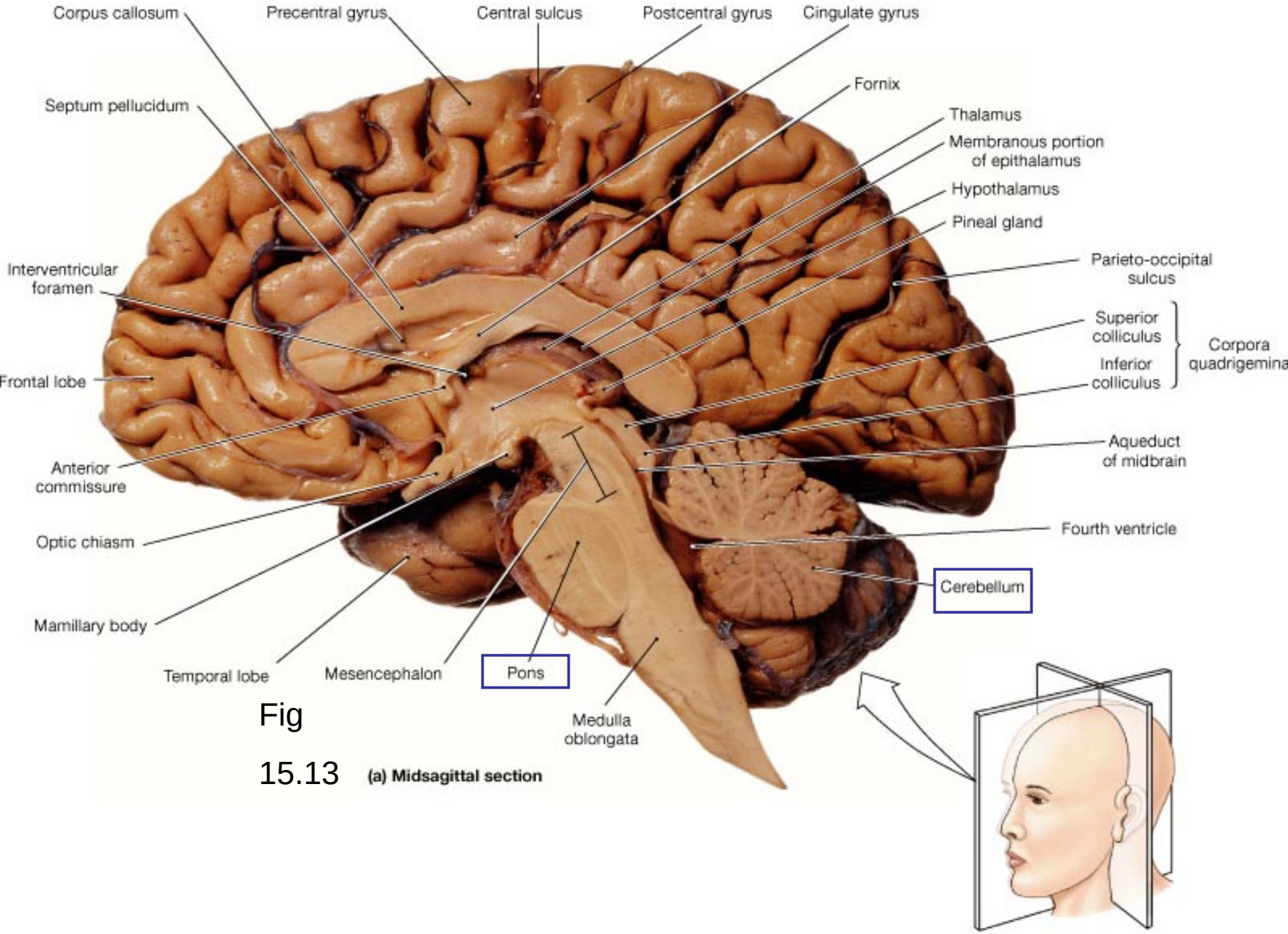
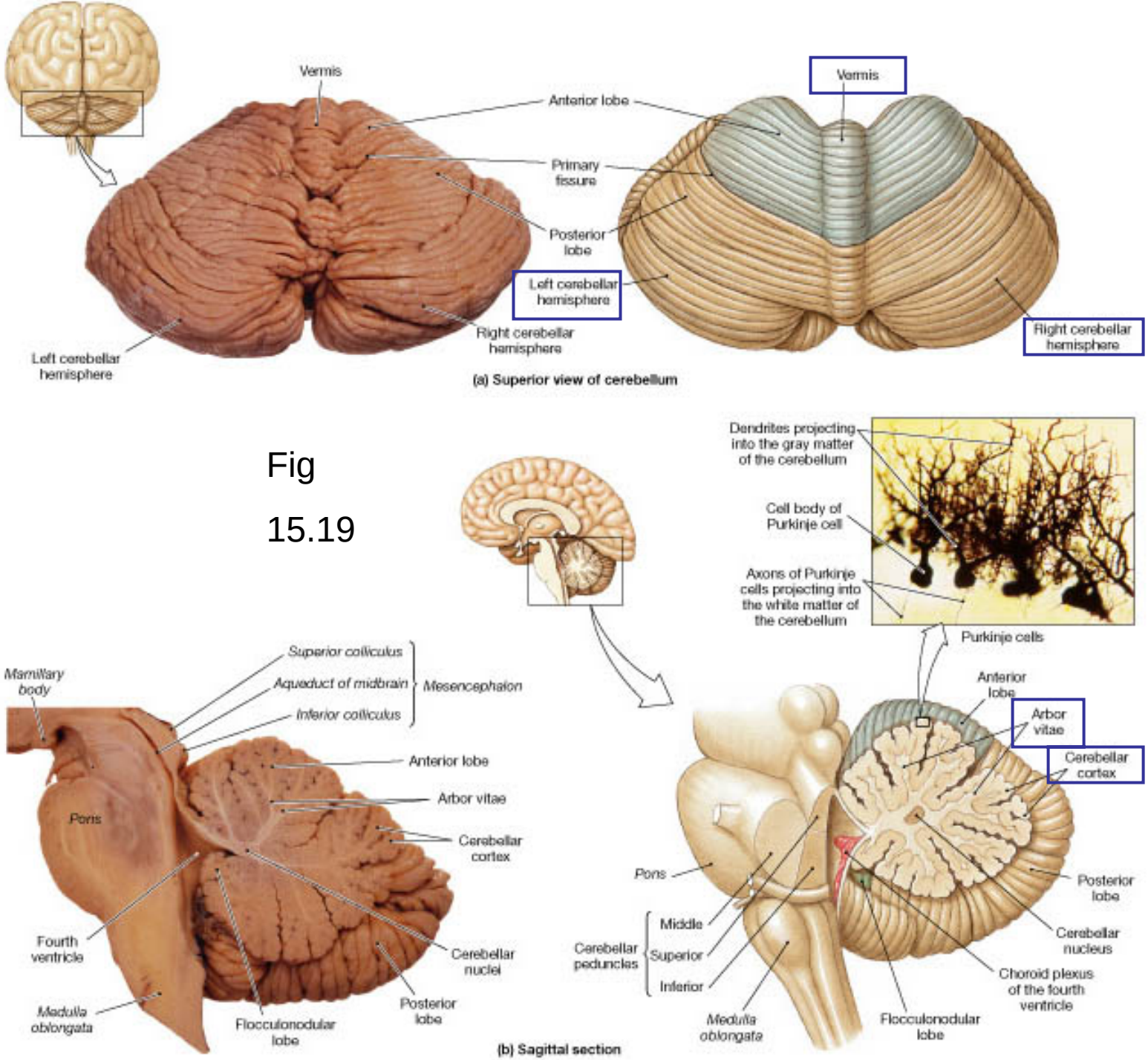


Fig 15.13 **(a) Midsagittal section**

Fig

15.19


Vermis
Anterior lobe
Primary fissure
Posterior lobe
Left cerebellar hemisphere
Right cerebellar hemisphere
Vermis
Left cerebellar hemisphere
Right cerebellar hemisphere
(a) Superior view of cerebellum
Dendrites projecting into the gray matter of the cerebellum
Cell body of Purkinje cell
Axons of Purkinje cells projecting into the white matter of the cerebellum
Purkinje cells
Mamillary body
Superior colliculus
Aqueduct of midbrain
Inferior colliculus
Mesencephalon
Anterior lobe
Arbor vitae
Cerebellar cortex
Pons
Fourth ventricle
Cerebellar nuclei
Medulla oblongata
Flocculonodular lobe
Posterior lobe
Anterior lobe
Arbor vitae
Cerebellar cortex
Pons
Posterior lobe
Cerebellar nucleus
Cerebellar peduncles
Middle
Superior
Inferior
Choroid plexus of the fourth ventricle
Medulla oblongata
Flocculonodular lobe
(b) Sagittal section

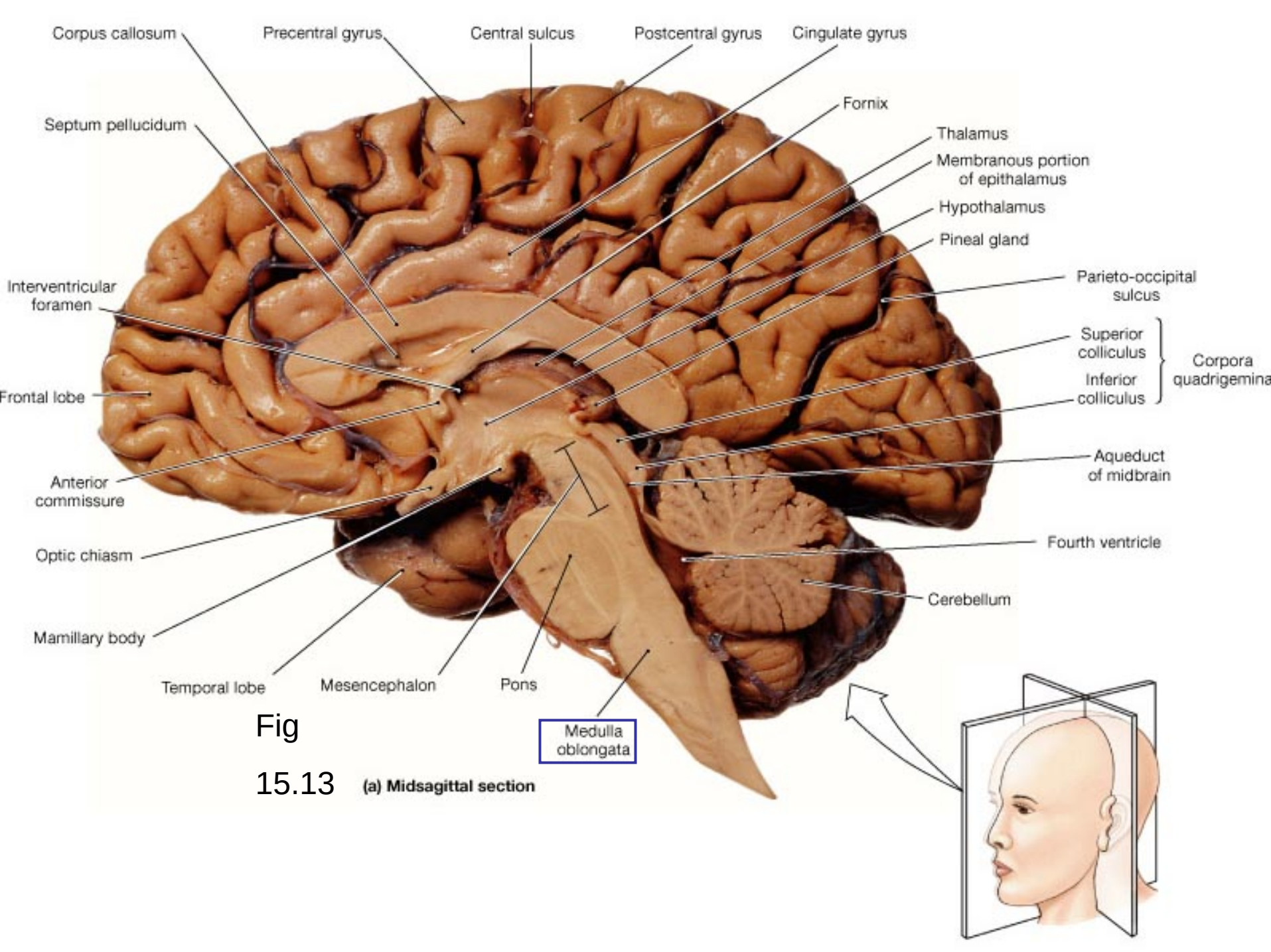
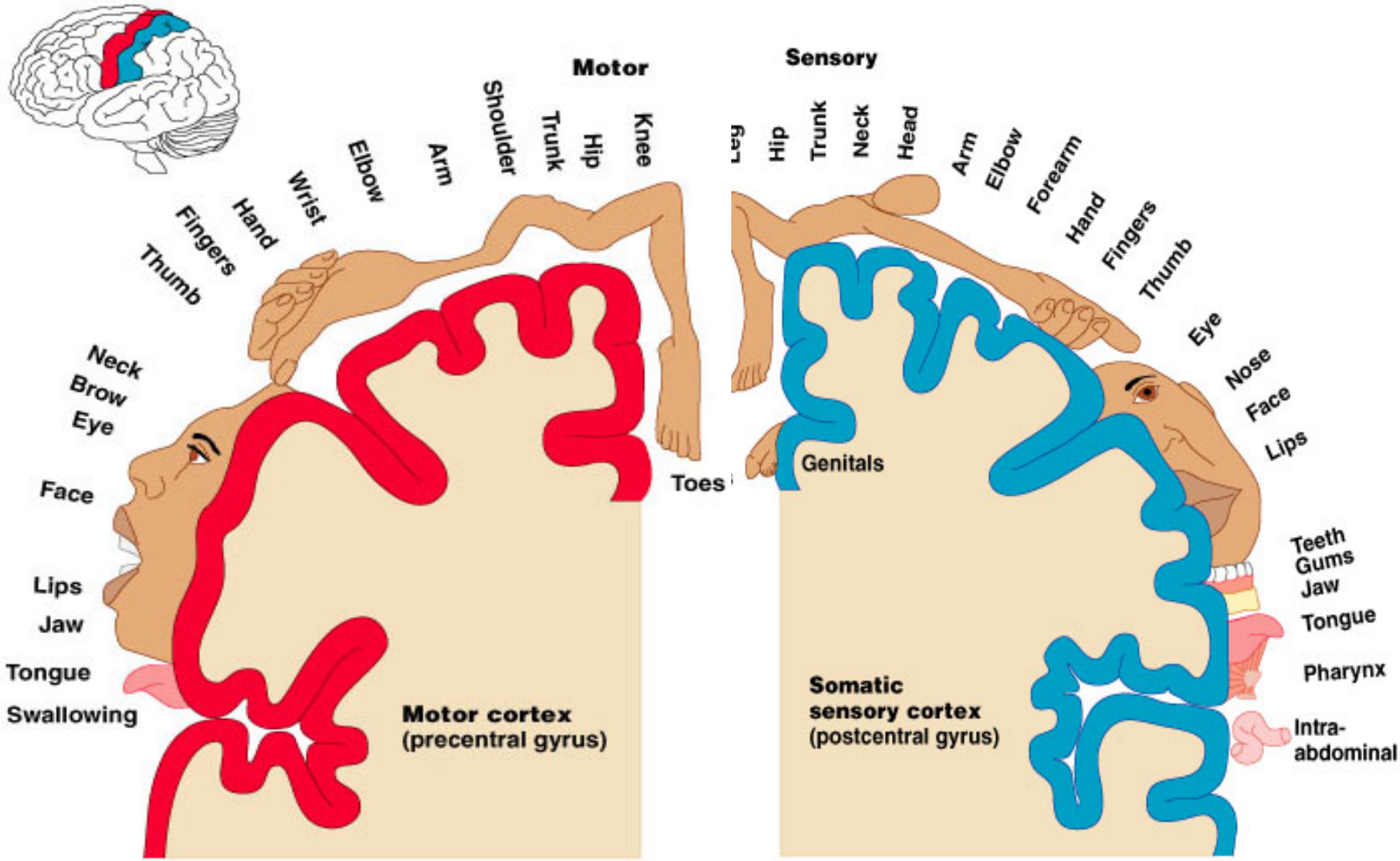
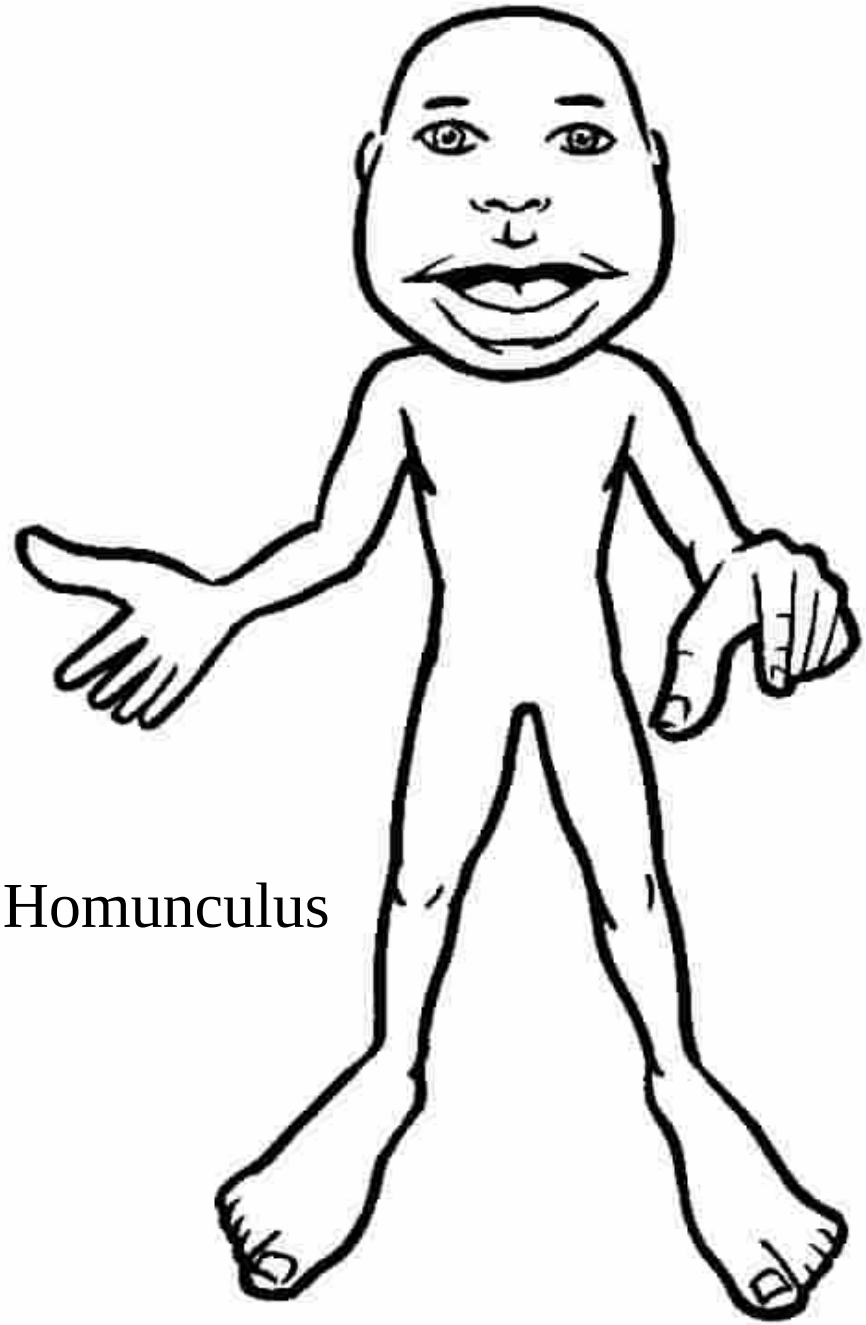


Fig 15.13 **(a) Midsagittal section**



FYI

homunculus



Homunculus

A distorted human figure drawn to reflect the space our body parts occupy on the sensory and motor cortex.

FYI