FETAL PIG VERSION

GLOBAL EDITION

Human Anatomy & Physiology Laboratory Manual

THIRTEENTH EDITION

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Anatomy and Physiology Laboratory Safety Guidelines*

1. Upon entering the laboratory, locate exits, fire extinguisher, fire blanket, chemical shower, eyewash station, first aid kit, containers for broken glass, and materials for cleaning up spills.
2. Do not eat, drink, smoke, handle contact lenses, store food, or apply cosmetics or lip balm in the laboratory. Restrain long hair, loose clothing, and dangling jewelry.
3. Students who are pregnant, are taking immunosuppressive drugs, or have any other medical conditions (e.g., diabetes, immunological defect) that might necessitate special precautions in the laboratory must inform the instructor immediately.
4. Wearing contact lenses in the laboratory is inadvisable because they do not provide eye protection and may trap material on the surface of the eye. Soft contact lenses may absorb volatile chemicals. If possible, wear regular eyeglasses instead.
5. Use safety glasses in all experiments involving liquids, aerosols, vapors, and gases.
6. Decontaminate work surfaces at the beginning and end of every lab period, using a commercially prepared disinfectant or 10% bleach solution. After labs involving dissection of preserved material, use hot soapy water or disinfectant.
7. Keep all liquids away from the edge of the lab bench to avoid spills. Clean up spills of viable materials using disinfectant or 10% bleach solution.
8. Properly label glassware and slides.
9. Use mechanical pipetting devices; mouth pipetting is prohibited.
10. Wear disposable gloves when handling blood and other body fluids, mucous membranes, and nonintact skin, and when touching items or surfaces soiled with blood or other body fluids. Change gloves between procedures. Wash hands immediately after removing gloves. (**Note:** Cover open cuts or scrapes with a sterile bandage before donning gloves.)
11. Place glassware and plasticware contaminated by blood and other body fluids in a disposable autoclave bag for decontamination by autoclaving, or place them directly into a 10% bleach solution before reuse or disposal. Place disposable materials such as gloves, mouthpieces, swabs, and toothpicks that have come into contact with body fluids into a disposable autoclave bag, and decontaminate before disposal.
12. To help prevent contamination by needlestick injuries, use only disposable needles and lancets. Do not bend the needles and lancets. Needles and lancets should be placed promptly in a labeled, puncture-resistant, leakproof container and decontaminated, preferably by autoclaving.
13. Do not leave heat sources unattended.
14. Report all spills or accidents, no matter how minor, to the instructor.
15. Never work alone in the laboratory.
16. Remove protective clothing before leaving the laboratory.

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*Adapted from:

Biosafety in Microbiological and Biomedical Laboratories (BMBL), Fifth Edition. 2007. U.S. Government Printing Office. Washington, D.C. www.cdc.gov/od/OHS/biosfty/bmbl5/bmbl5toc.htm

Centers for Disease Control. 1996. "Universal Precautions for Prevention of Transmission of HIV and Other Bloodborne Infections." Washington, D.C. www.cdc.gov/ncidod/dhqp/bp_universal_precautions.html

Johnson, Ted, and Christine Case. 2010. *Laboratory Experiments in Microbiology,* Ninth Edition. San Francisco: Pearson Benjamin Cummings.

School Chemistry Laboratory Safety Guide. 2006. U.S. Consumer Product Safety Commission. Bethesda, MD. www.cpsc.gov/CPSCPUB/PUBS/NIOSH2007107.pdf

The **corona radiata**, a spray of projection fibers coursing down from the precentral (motor) gyrus, combines with sensory fibers traveling to the sensory cortex to form a broad band of fibrous material called the **internal capsule**. The internal capsule passes between the thalamus and the basal nuclei and through parts of the basal nuclei, giving them a striped appearance. This is why the caudate nucleus and the putamen are referred to collectively as the **striatum**, or "striped body" (Figure 17.5a).

4. Examine the relationship of the lateral ventricles and corpus callosum to the thalamus and third ventricle—from the cross-sectional viewpoint (see Figure 17.5b).

Diencephalon

1. The major internal structures of the diencephalon are the thalamus, hypothalamus, and epithalamus (see Figure 17.4). The **thalamus** consists of two large lobes of gray matter that laterally enclose the narrow third ventricle of the brain. A slender stalk of thalamic tissue, the **interthalamic adhesion**, or **intermediate mass**, connects the two thalamic lobes and bridges the ventricle. The thalamus is a major integrating and relay station for sensory impulses passing upward to the cortical sensory areas for localization and interpretation. Locate also the **interventricular foramen**, a tiny opening connecting the third ventricle with the lateral ventricle on the same side.

2. The **hypothalamus** makes up the floor and the inferolateral walls of the third ventricle. It is an important autonomic center involved in regulation of body temperature, water balance, and fat and carbohydrate metabolism as well as many other activities and drives (sex, hunger, thirst). Locate again the pituitary gland, which hangs from the anterior floor of the hypothalamus by a slender stalk, the **infundibulum**. In life, the pituitary rests in the hypophyseal fossa of the sella turcica of the sphenoid bone.

Anterior to the pituitary, identify the optic chiasma portion of the optic pathway to the brain. The **mammillary bodies**, relay stations for olfaction, bulge exteriorly from the floor of the hypothalamus just posterior to the pituitary gland.

3. The **epithalamus** forms the roof of the third ventricle and is the most dorsal portion of the diencephalon. Important structures in the epithalamus are the **pineal gland**, and the **choroid plexus** of the third ventricle.

Brain Stem

1. Now trace the short midbrain from the mammillary bodies to the rounded pons below. (Continue to refer to Figure 17.4). The **cerebral aqueduct** is a slender canal traveling through the midbrain; it connects the third ventricle to the fourth ventricle. The cerebral peduncles and the rounded corpora quadrigemina make up the midbrain tissue anterior and posterior (respectively) to the cerebral aqueduct.

2. Locate the hindbrain structures. Trace the rounded pons to the medulla oblongata below, and identify the fourth ventricle posterior to these structures. Attempt to identify the single median aperture and the two lateral apertures, three openings found in the walls of the fourth ventricle. These apertures serve as passageways for cerebrospinal fluid to circulate into the subarachnoid space from the fourth ventricle.

Cerebellum

Examine the cerebellum. Notice that it is composed of two lateral hemispheres, each with three lobes (*anterior*, *posterior*, and a deep *flocculonodular*) connected by a midline lobe called the **vermis** (**Figure 17.6**). As in the cerebral hemispheres, the cerebellum has an outer cortical area of gray matter and an inner area of white matter. The treelike branching of the cerebellar white matter is referred to as the **arbor vitae**, or "tree of life." The cerebellum controls the unconscious coordination of skeletal muscle activity along with balance and equilibrium.

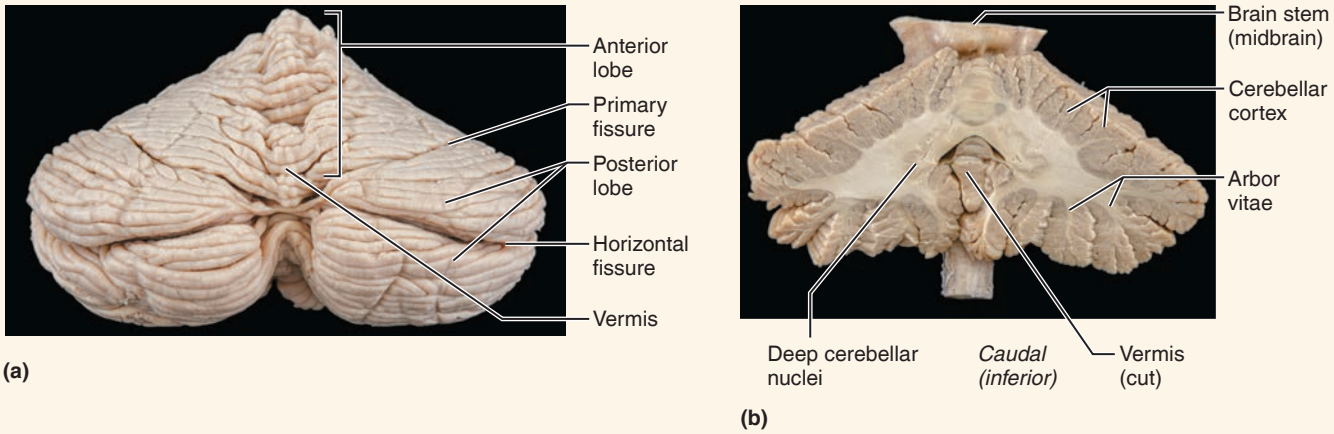

Figure 17.6 Cerebellum. (a) Posterior (dorsal) view. **(b)** Sectioned to reveal the cerebellar cortex. (The cerebellum is sectioned frontally, and the brain stem is sectioned transversely, in this posterior view.)

Instructors may assign this figure as an Art Labeling Activity using Mastering A&P™

Meninges of the Brain

The brain and spinal cord are covered and protected by three connective tissue membranes called **meninges** (Figure 17.7). The outermost meninx is the leathery **dura mater**, a double-layered membrane. One of its layers (the *periosteal layer*) is attached to the inner surface of the skull, forming the periosteum. The other (the *meningeal layer*) forms the outermost brain covering and is continuous with the dura mater of the spinal cord.

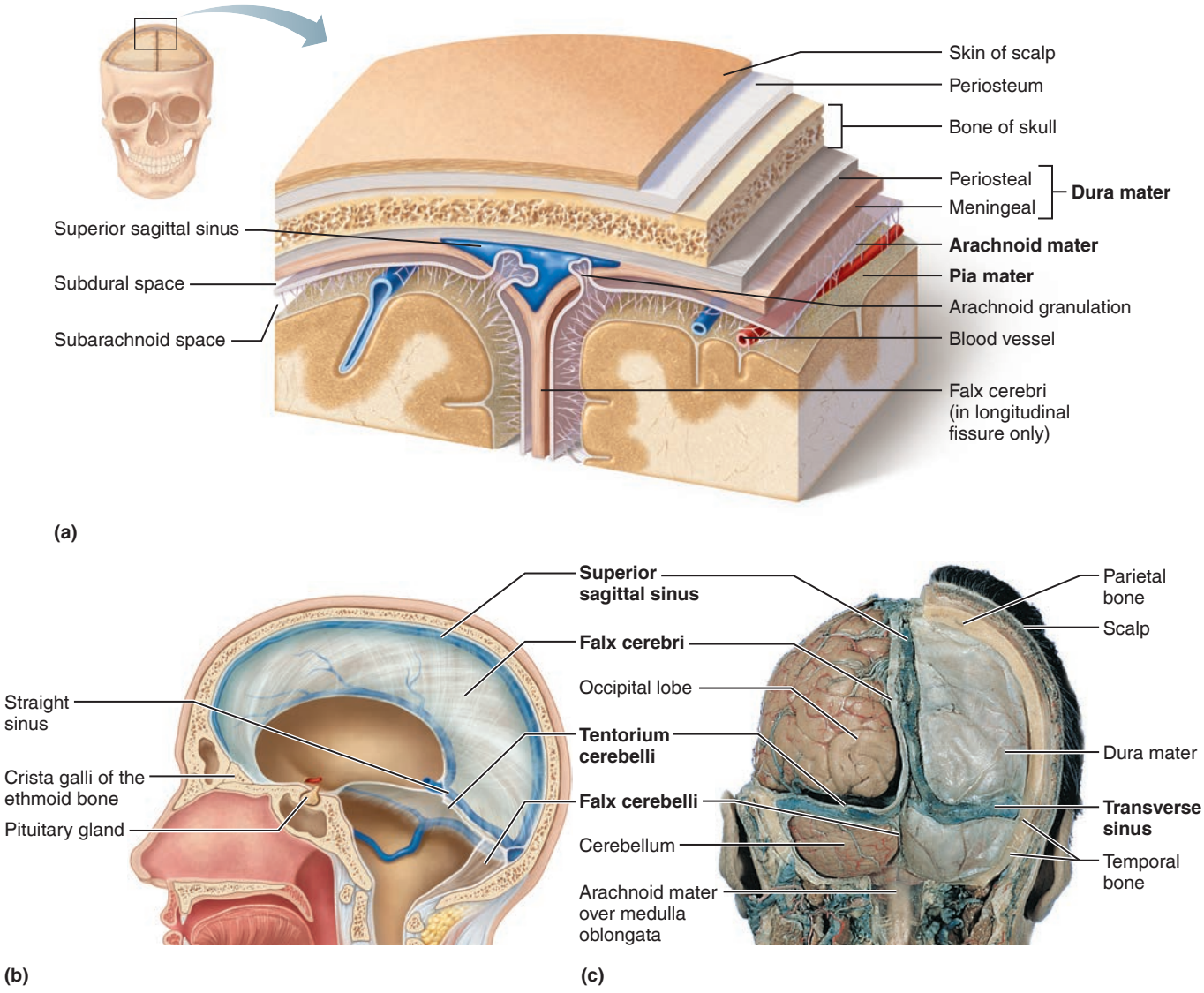

Figure 17.7 Meninges of the brain. **(a)** Three-dimensional frontal section showing the relationship of the dura mater, arachnoid mater, and pia mater. The meningeal dura forms the falx cerebri fold, which extends into the longitudinal fissure and attaches the brain to the ethmoid bone of the skull. The superior sagittal sinus is enclosed by the dural membranes superiorly. Arachnoid granulations, which return cerebrospinal fluid to the dural venous sinus, are also shown. **(b)** Midsagittal view showing the position of the dural folds: the falx cerebri, tentorium cerebelli, and falx cerebelli. **(c)** Posterior view of the brain in place, surrounded by the dura mater. Sinuses between periosteal and meningeal dura contain venous blood.

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The dural layers are fused together except in three places where the inner membrane extends inward to form a septum that secures the brain to structures inside the cranial cavity. One such extension, the **falx cerebri**, dips into the longitudinal fissure between the cerebral hemispheres to attach to the crista galli of the ethmoid bone of the skull (Figure 17.7a). The cavity created at this point is the large **superior sagittal sinus**, which collects blood draining from the brain tissue. The **falx cerebelli**, separating the two cerebellar hemispheres, and the **tentorium cerebelli**, separating the cerebrum from the cerebellum below, are two other important inward folds of the inner dural membrane.

The middle meninx, the weblike **arachnoid mater**, underlies the dura mater and is partially separated from it by the **subdural space**. Threadlike projections bridge the **subarachnoid space** to attach the arachnoid to the innermost meninx, the **pia mater**. The delicate pia mater is highly vascular and clings tenaciously to the surface of the brain, following its gyri.

In life, the subarachnoid space is filled with cerebrospinal fluid. Specialized projections of the arachnoid tissue called **arachnoid granulations** protrude through the dura mater. These granulations allow the cerebrospinal fluid to drain back into the venous circulation via the superior sagittal sinus and other dural venous sinuses.

Meningitis, inflammation of the meninges, is a serious threat to the brain because of the intimate association between the brain and meninges. Should infection spread to the neural tissue of the brain itself, life-threatening **encephalitis** may occur. Meningitis is often diagnosed by taking a sample of cerebrospinal fluid (via a spinal tap) from the subarachnoid space. ✚

Cerebrospinal Fluid

The cerebrospinal fluid (CSF), much like plasma in composition, is continually formed by the **choroid plexuses**, small capillary knots hanging from the roof of the ventricles of the brain. The cerebrospinal fluid in and around the brain forms a watery cushion that protects the delicate brain tissue against blows to the head.

Within the brain, the cerebrospinal fluid circulates from the two lateral ventricles (in the cerebral hemispheres) into the third ventricle via the **interventricular foramina**, and then through the cerebral aqueduct of the midbrain into the fourth ventricle (**Figure 17.8**). CSF enters the subarachnoid space through the paired **lateral apertures** in the side walls of the fourth ventricle and the **median aperture** in its roof. There it bathes the outer surfaces of the brain and spinal cord. The fluid returns to the blood in the dural venous sinuses via the arachnoid granulations.

Ordinarily, cerebrospinal fluid forms and drains at a constant rate. However, under certain conditions—for example, obstructed drainage or circulation resulting from tumors or anatomical deviations—cerebrospinal fluid accumulates and exerts increasing pressure on the brain which, uncorrected, causes neurological damage in adults. In infants, **hydrocephalus** (literally, "water on the brain") is indicated by a gradually enlarging head. The infant's skull is still flexible and contains fontanelles, so it can expand to accommodate the increasing size of the brain. ✚

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Cranial Nerves

The **cranial nerves** are part of the peripheral nervous system and not part of the brain proper, but they are most appropriately identified while studying brain anatomy. The 12 pairs of cranial nerves primarily serve the head and neck. Only one pair, the vagus nerves, extends into the thoracic and abdominal cavities. All but the first two pairs (olfactory and optic nerves) arise from the brain stem and pass through foramina in the base of the skull to reach their destination.

The cranial nerves are numbered consecutively, and in most cases their names reflect the major structures they control. The cranial nerves are described by name, number (Roman numeral), origin, course, and function in the list (**Table 17.2**, pp. 298–300). This information should be committed to memory. A mnemonic device that might be helpful for remembering the cranial nerves in order is "*O*n *o*ccasion, *o*ur *t*rusty *t*ruck *a*cts *f*unny—*v*ery *g*ood *v*ehicle *a*ny*h*ow." The first letter of each word and the "a" and "h" of the final word "anyhow" will remind you of the first letter of the cranial nerve name.

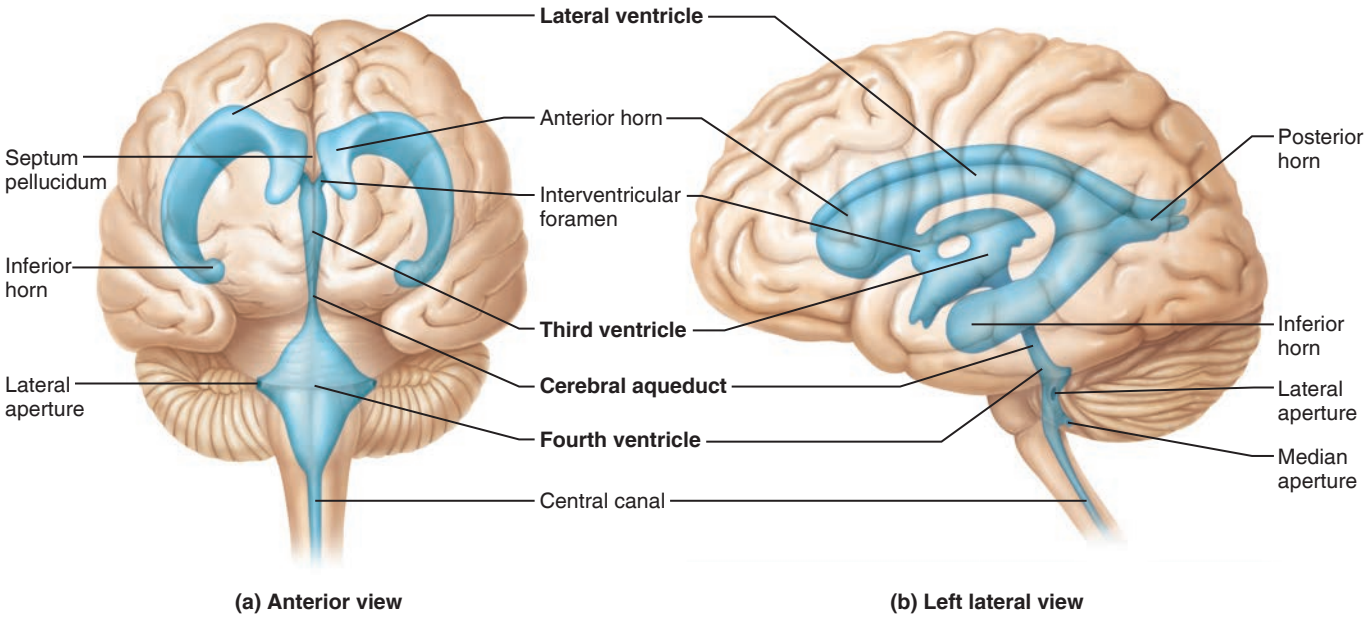
Most cranial nerves are mixed nerves (containing both motor and sensory fibers). But close scrutiny of the list (Table 17.2) will reveal that two pairs of cranial nerves (optic and olfactory) are purely sensory in function.

Activity 3

Identifying and Testing the Cranial Nerves

1. Observe the ventral surface of the brain model to identify the cranial nerves. (**Figure 17.9** on p. 298 may also aid you in this study.) Notice that the first (olfactory) cranial nerves are not visible on the model because they consist only of short axons that run from the nasal mucosa through the cribriform foramina of the ethmoid bone. (However, the synapse points of the first cranial nerves, the *olfactory bulbs*, are visible on the model.)

Text continues on p. 298 ➔



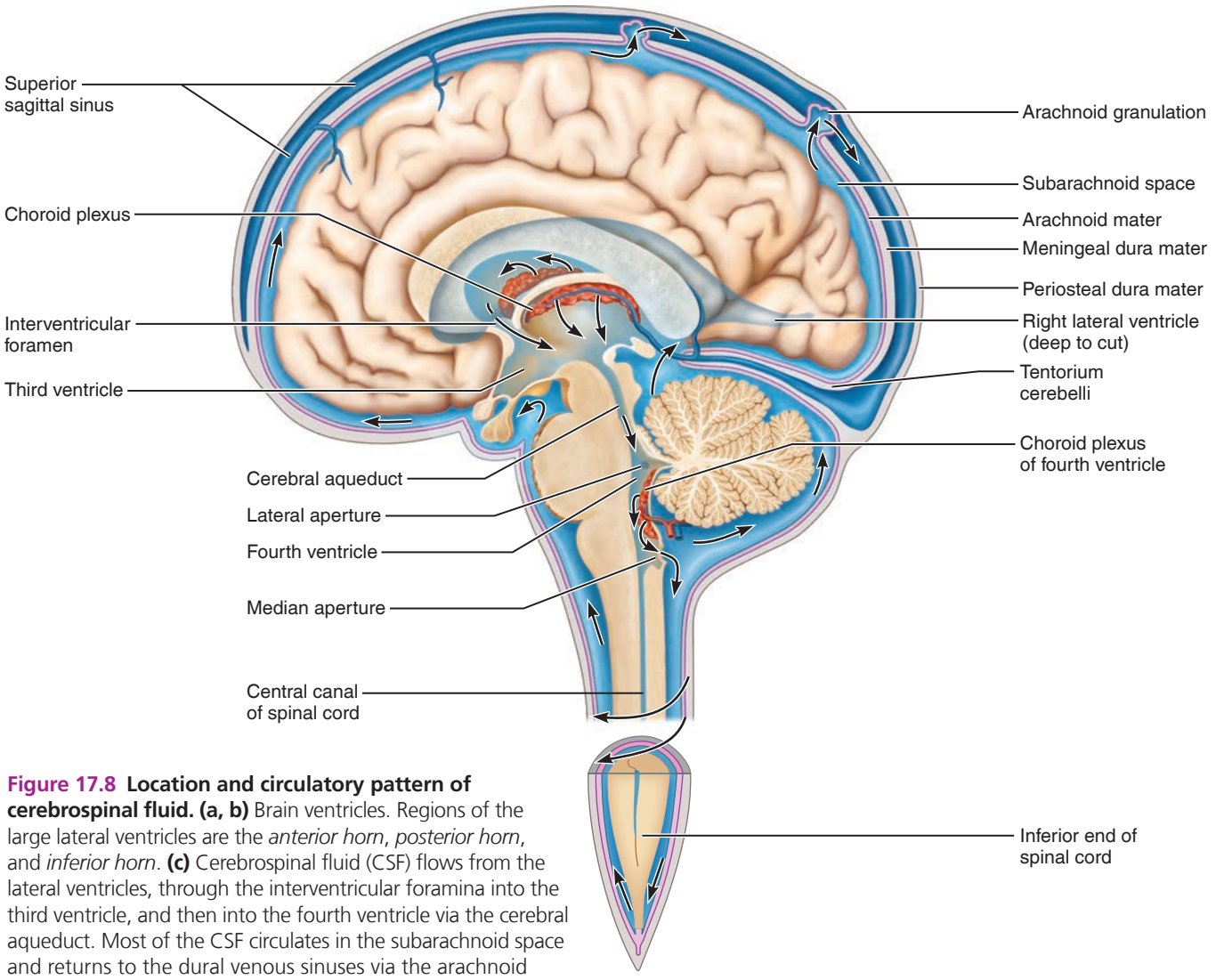


Figure 17.8 Location and circulatory pattern of cerebrospinal fluid. (a, b) Brain ventricles. Regions of the large lateral ventricles are the *anterior horn*, *posterior horn*, and *inferior horn*. **(c)** Cerebrospinal fluid (CSF) flows from the lateral ventricles, through the interventricular foramina into the third ventricle, and then into the fourth ventricle via the cerebral aqueduct. Most of the CSF circulates in the subarachnoid space and returns to the dural venous sinuses via the arachnoid granulations.

Instructors may assign this figure as an Art Labeling Activity using Mastering A&P™

2. Testing cranial nerves is an important part of any neurological examination. See the last column of Table 17.2 for techniques you can use for such tests. Conduct tests of cranial nerve function following directions given in the "testing" column of the table. The results may help you understand cranial nerve function, especially as it pertains to some aspects of brain function.

3. Several cranial nerve ganglia are named in the **Activity 3 chart**. *Using your textbook or an appropriate reference*, fill in the chart by naming the cranial nerve the ganglion is associated with and stating the ganglion location.

Activity 3: Cranial Nerve Ganglia		
Cranial nerve ganglion	**Cranial nerve**	**Site of ganglion**
Trigeminal		
Geniculate		
Inferior		
Superior		
Spiral		
Vestibular		

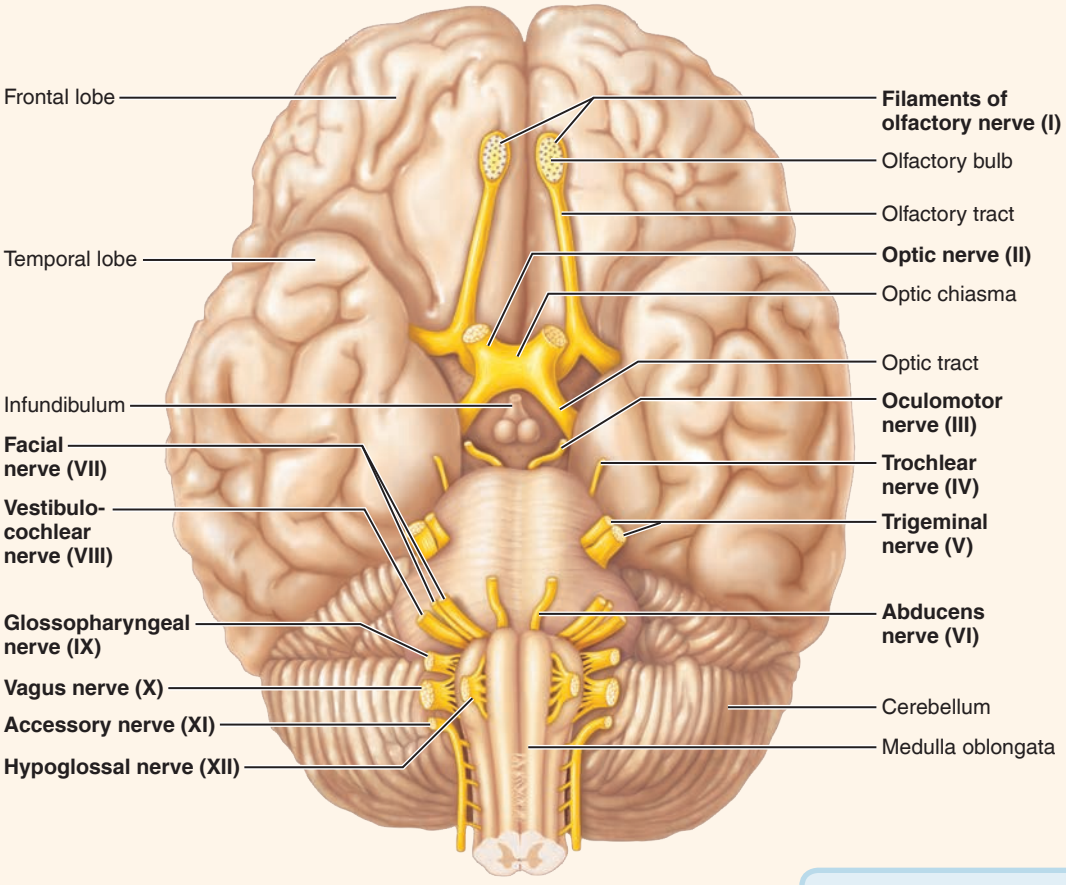


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Figure 17.9 Ventral aspect of the human brain, showing the cranial nerves. (See also Figure 17.3.)

Table 17.2 The Cranial Nerves (Figure 17.9)

Number and name	Origin and course	Function*	Testing
I. Olfactory	Fibers arise from olfactory epithelium and run through cribriform foramina of ethmoid bone to synapse in olfactory bulb.	Purely sensory—carries afferent impulses for sense of smell.	Person is asked to sniff aromatic substances, such as oil of cloves and vanilla, and to identify each.

Table 17.2 ***(continued)***

Number and name	Origin and course	Function*	Testing
II. Optic	Fibers arise from retina of eye and pass through optic canal of sphenoid bone. Fibers partially cross over at the optic chiasma and continue on to the thalamus as the optic tracts. Final fibers of this pathway travel from the thalamus to the primary visual cortex as the optic radiation.	Purely sensory—carries afferent impulses associated with vision.	Vision and visual field are determined with eye chart and by testing the point at which the person first sees an object (finger) moving into the visual field. Fundus of eye viewed with ophthalmoscope to detect papilledema (swelling of optic disc, or point at which optic nerve leaves the eye) and to observe blood vessels.
III. Oculomotor	Fibers emerge from ventral midbrain and course ventrally to enter the orbit. They exit from skull via superior orbital fissure.	Primarily motor—somatic motor fibers to inferior oblique and superior, inferior, and medial rectus muscles, which direct eyeball, and to levator palpebrae muscles of the superior eyelid; parasympathetic fibers to smooth muscle controlling lens shape and pupil size.	Pupils are examined for size, shape, and equality. Pupillary reflex is tested with penlight (pupils should constrict when illuminated). Convergence for near vision is tested, as is subject's ability to follow objects with the eyes.
IV. Trochlear	Fibers emerge from midbrain and exit from skull via superior orbital fissure.	Primarily motor—provides somatic motor fibers to superior oblique muscle that moves the eyeball.	Tested with cranial nerve III.
V. Trigeminal	Fibers run from face to pons and form three divisions: mandibular division fibers pass through foramen ovale in sphenoid bone, maxillary division fibers pass via foramen rotundum in sphenoid bone, and ophthalmic division fibers pass through superior orbital fissure of sphenoid bone.	Mixed—major sensory nerve of face; conducts sensory impulses from skin of face and anterior scalp, from mucosae of mouth and nose, and from surface of eyes; mandibular division also contains motor fibers that innervate muscles of mastication and muscles of floor of mouth.	Sensations of pain, touch, and temperature are tested with safety pin and hot and cold probes. Corneal reflex tested with wisp of cotton. Motor branch assessed by asking person to clench the teeth, open mouth against resistance, and move jaw side to side.
VI. Abducens	Fibers leave inferior pons and exit from skull via superior orbital fissure.	Primarily motor—carries somatic motor fibers to lateral rectus muscle that abducts the eyeball.	Tested with cranial nerve III.
VII. Facial	Fibers leave pons and travel through temporal bone via internal acoustic meatus, exiting via stylomastoid foramen to reach the face.	Mixed—supplies somatic motor fibers to muscles of facial expression and the posterior belly of the digastric muscle; parasympathetic motor fibers to lacrimal and salivary glands; carries sensory fibers from taste receptors of anterior tongue.	Anterior two-thirds of tongue is tested for ability to taste sweet (sugar), salty, sour (vinegar), and bitter (quinine) substances. Symmetry of face is checked. Subject is asked to close eyes, smile, whistle, and so on. Tearing is assessed with ammonia fumes.
VIII. Vestibulocochlear	Fibers run from inner ear equilibrium and hearing apparatus, housed in temporal bone, through internal acoustic meatus to enter pons.	Mostly sensory—vestibular branch transmits impulses associated with sense of equilibrium from vestibular apparatus and semicircular canals; cochlear branch transmits impulses associated with hearing from cochlea. Small motor component adjusts the sensitivity of the sensory receptors.	Hearing is checked by air and bone conduction using tuning fork.
IX. Glossopharyngeal	Fibers emerge from medulla oblongata and leave skull via jugular foramen to run to throat.	Mixed—somatic motor fibers serve pharyngeal muscles, and parasympathetic motor fibers serve salivary glands; sensory fibers carry impulses from pharynx, tonsils, posterior tongue (taste buds), and from chemoreceptors and pressure receptors of carotid artery.	A tongue depressor is used to check the position of the uvula. Gag and swallowing reflexes are checked. Subject is asked to speak and cough. Posterior third of tongue may be tested for taste.

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