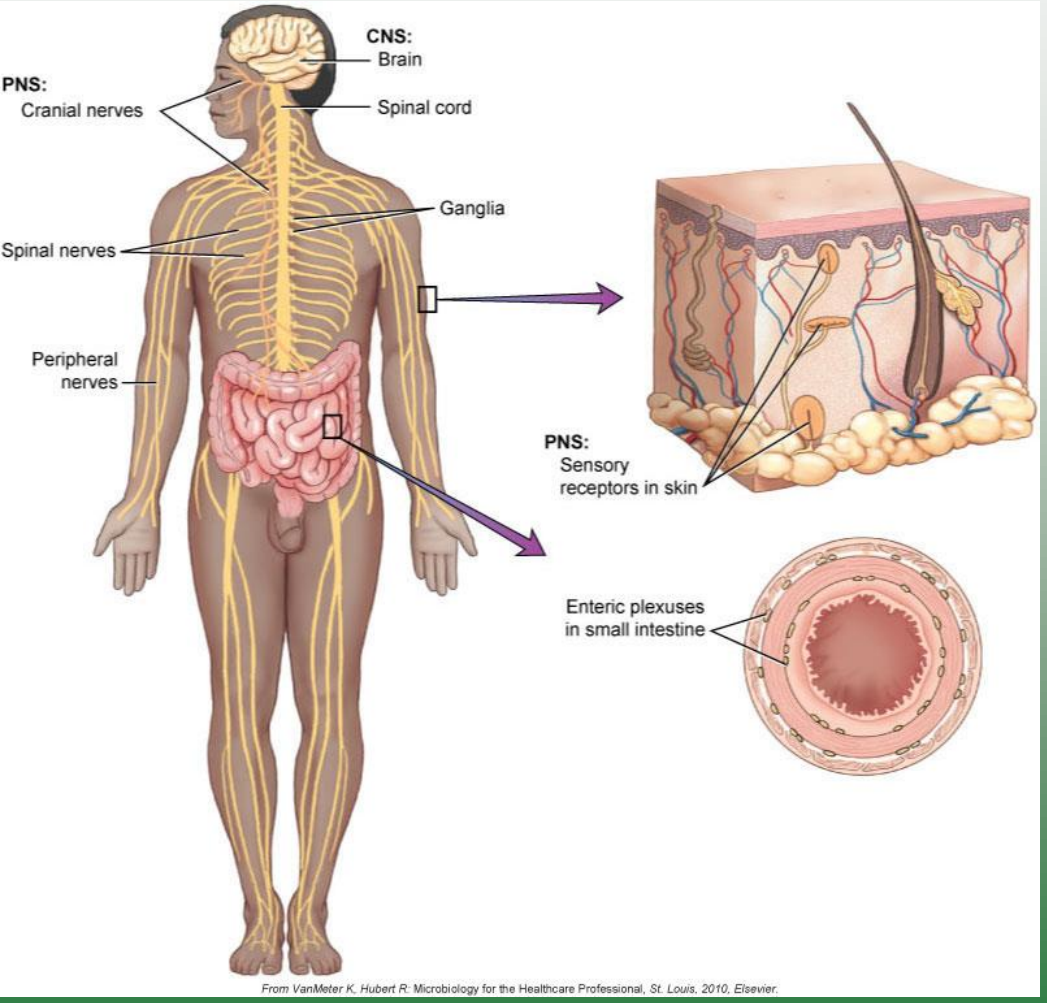
Chapter 14

Nervous System Disorders

Review of the Nervous System

Components

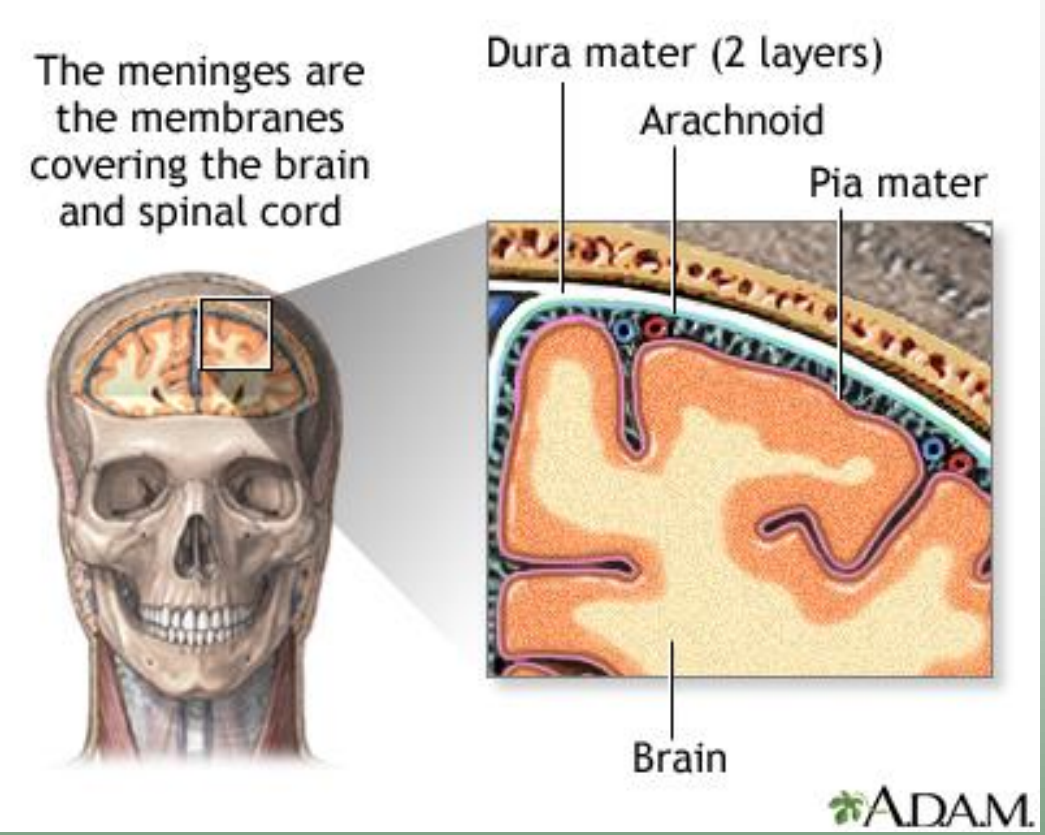


- Central nervous system
  - Brain and spinal cord
- Peripheral nervous system
  - Cranial and spinal nerves
  - Sensory neurons
  - Neuromuscular junctions

Brain

- Communication and control center of the body
- Receives, processes, evaluates inputs
- Decides which action to be taken
- Initiates response
  - Involuntary actions
    - To maintain homeostasis
    - Regulated by the autonomic nervous system (ANS)
  - Voluntary actions
  - Reflex activities

Protection of the Brain



Epidural:
Above dura, between dura and bone.

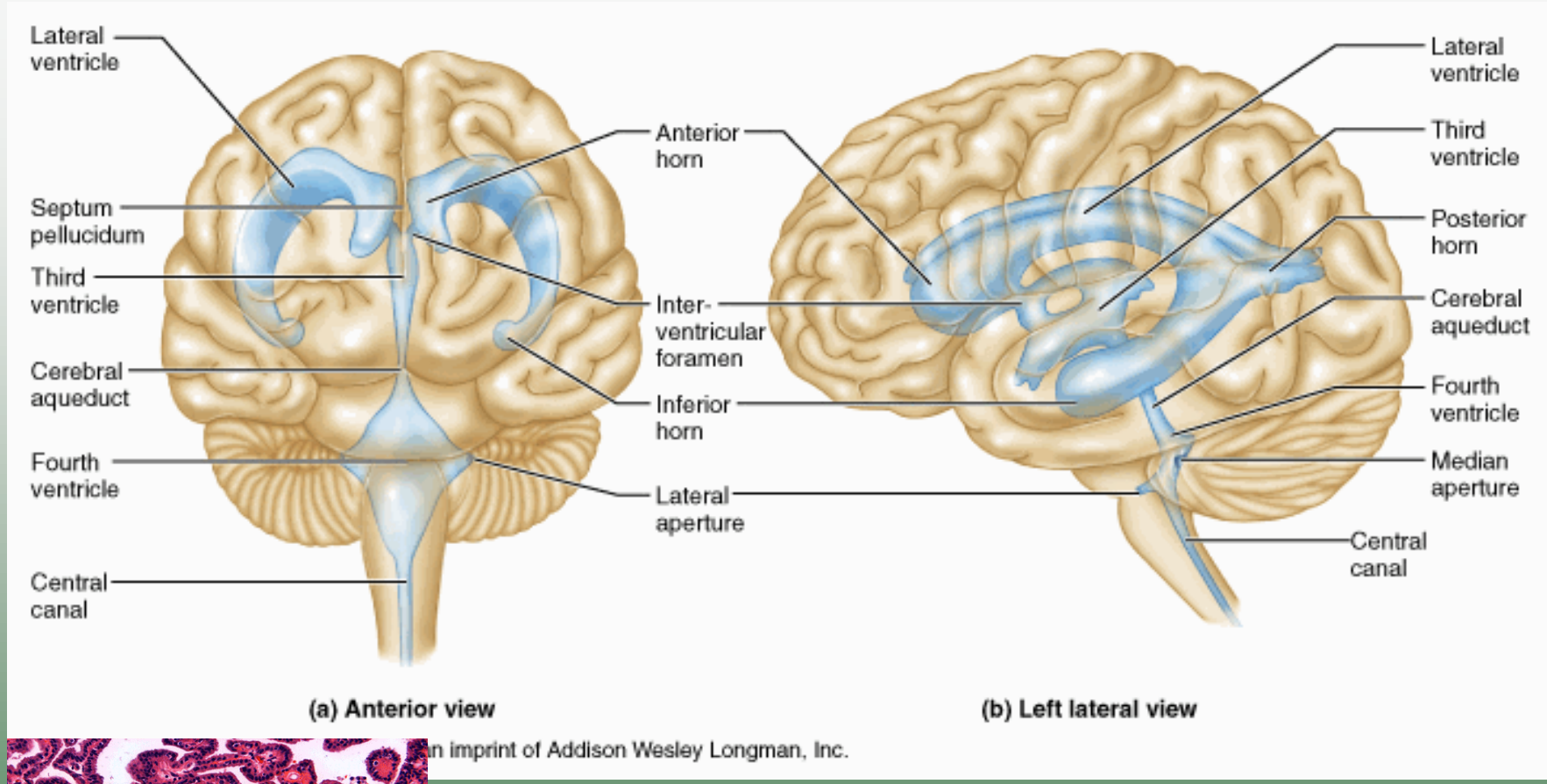
Subdural:
Beneath dura, above arachnoid.

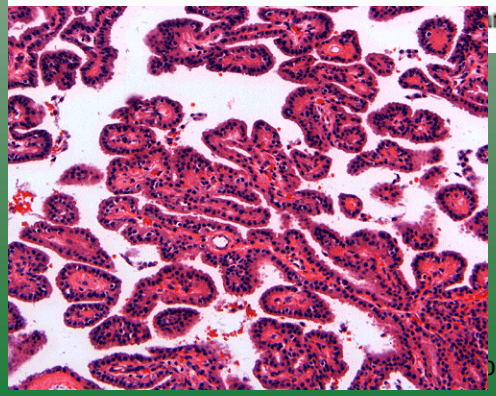
Subarachnoid:
Beneath arachnoid.

Pachymeninges: Dura mater ("tough mother") thick layer, adherent to bone, forms sac that holds brain.

Leptomeninges: Pia and arachnoid ("spidery") layers, delicate, thin, transparent membranes that are closely applied to the brain.

Ventricles in Brain





Choroid plexus – papillary vascular tissue that makes CSF

Protection of the Brain (Cont.)

- CSF
  - Provides cushion for brain and spinal cord
  - Similar to plasma in appearance
    - Different electrolyte, glucose, protein concentrations
  - Change in characteristics of CSF is diagnostic tool
  - Formed constantly by choroid plexuses of the ventricles
  - Flows though ventricles into subarachnoid space
  - Equal amounts of CSF need to be produced and reabsorbed to maintain intracranial pressure (ICP).

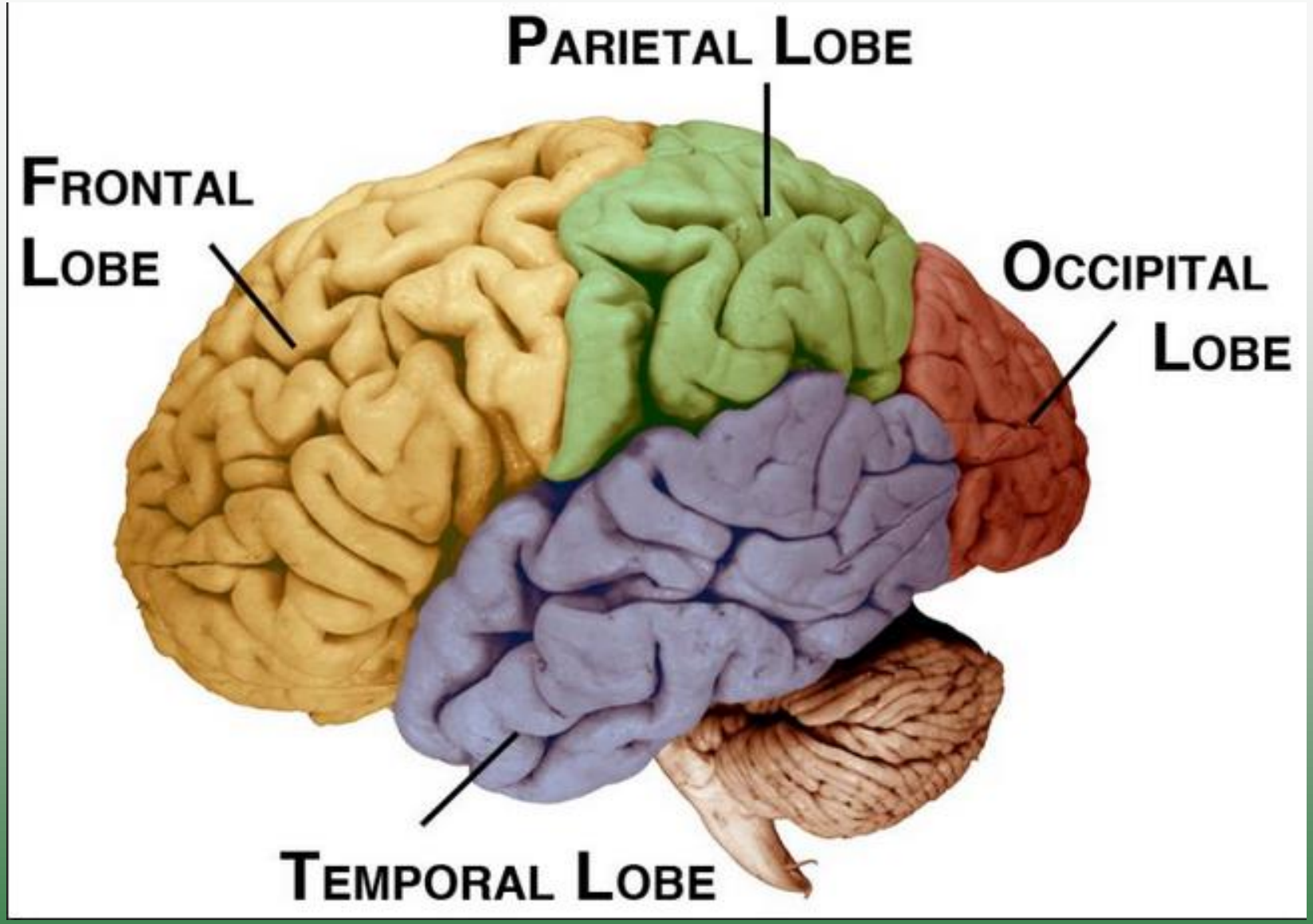
Characteristics of Normal CSF

TABLE 14-1 Characteristics of Normal Cerebrospinal Fluid

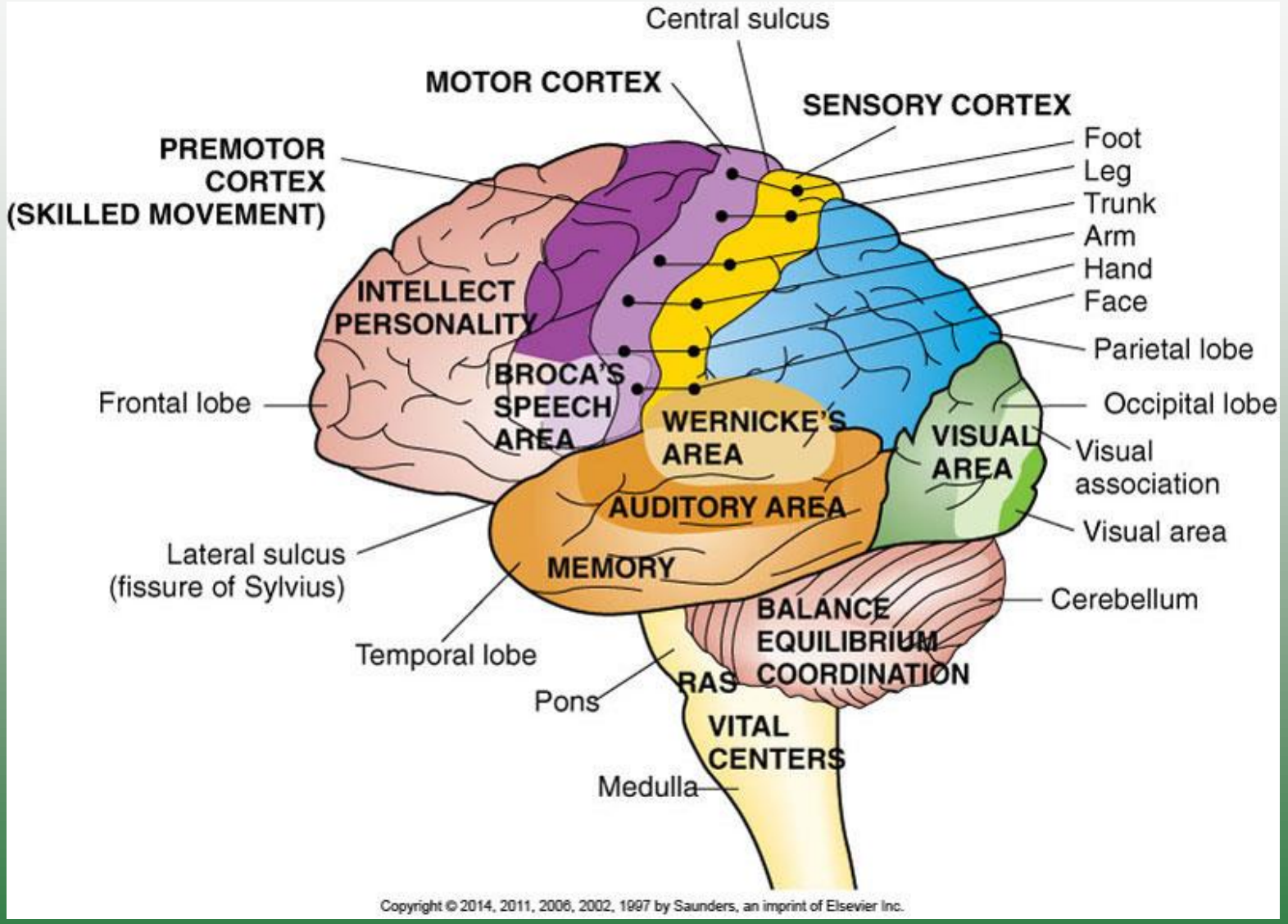
Appearance	Clear and colorless
Pressure	9-14 mmHg or 150 mm H_2O
Red blood cells	None
White blood cells	Occasional
Protein	15-45 mg/dL
Glucose	45-75 mg/dL
Sodium	140 mEq/L
Potassium	3 mEq/L
Specific gravity	1.007
pH	7.32-7.35
Volume in the system at one time	125-150 mL
Volume formed in 24 hours	500-800 mL

Protection of the Brain (Cont.)

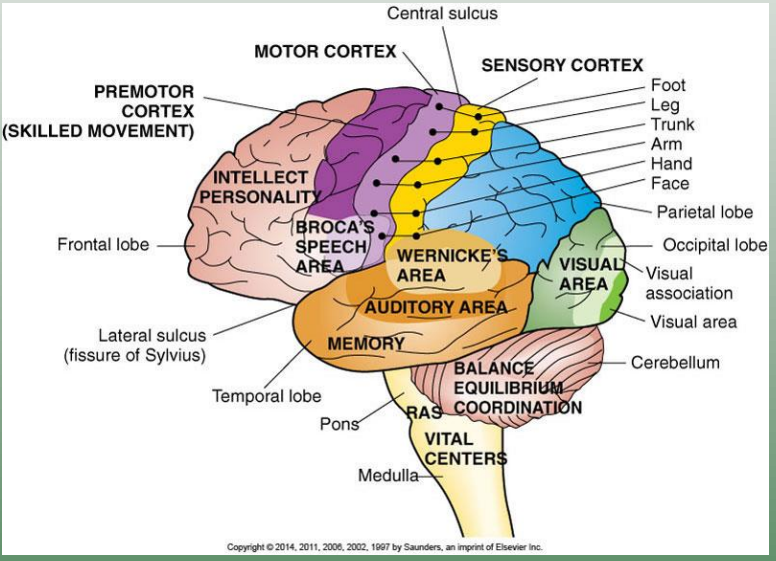
- Blood-brain barrier
  - At capillaries in the brain
  - Limits passage of materials into the brain
  - Controls balance of electrolytes, glucose, and proteins in the brain
  - Lipid-soluble substances can easily pass.
  - Poorly developed in neonates
- Blood-CSF barrier
  - Located at the choroid plexus
  - Controls constituents of CSF



Functional Areas of the Brain

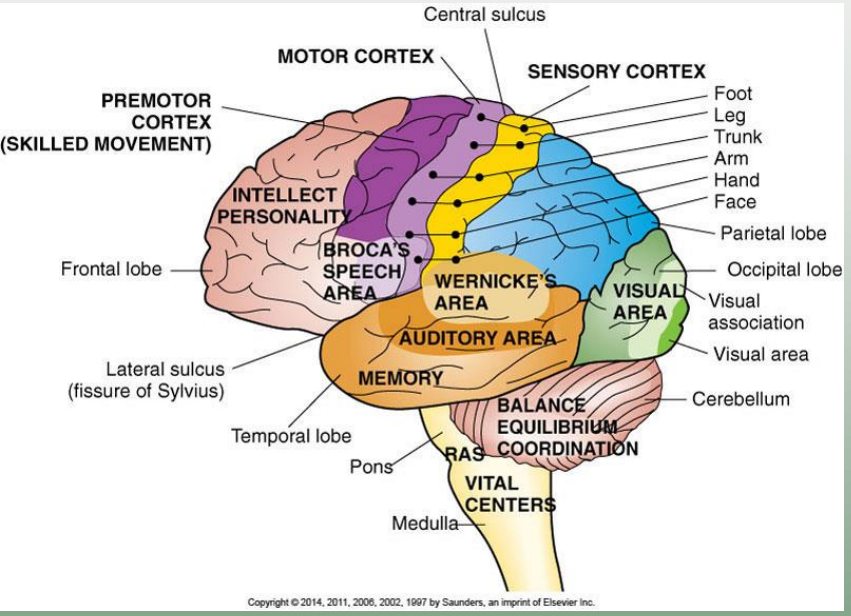


Functional Areas: Cerebral Hemispheres



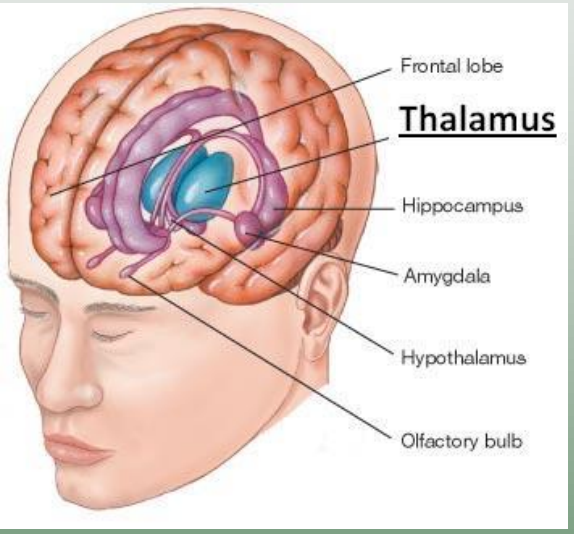
- Right and left hemispheres similar in structure, not necessarily in function
- Dominant hemisphere
  - Side of brain that controls language
  - Left hemisphere in most people
  - Broca's area
    - Motor or expressive speech area
  - Wernicke's area
    - Integration center
    - Comprehends language received

Functional Areas: Cerebral Hemispheres



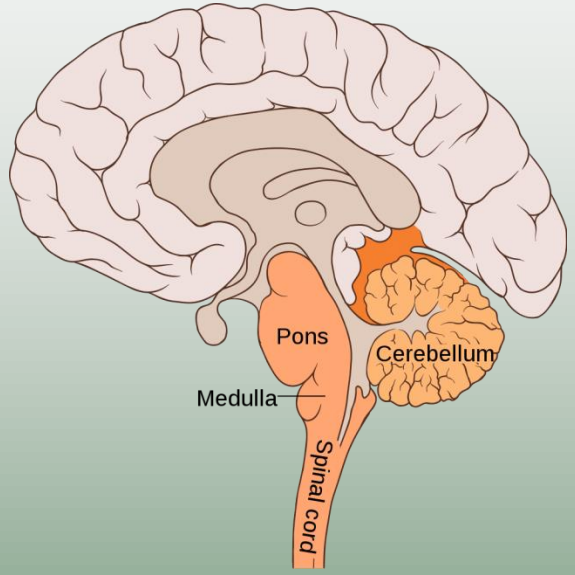
- Prefrontal cortex
  - Coordinates complex cognitive behavior
  - Components for expression of personality
- Limbic system
  - Consists of many nuclei and connecting fibers
  - Responsible for emotional reactions or feelings

Functional Areas: Diencephalon



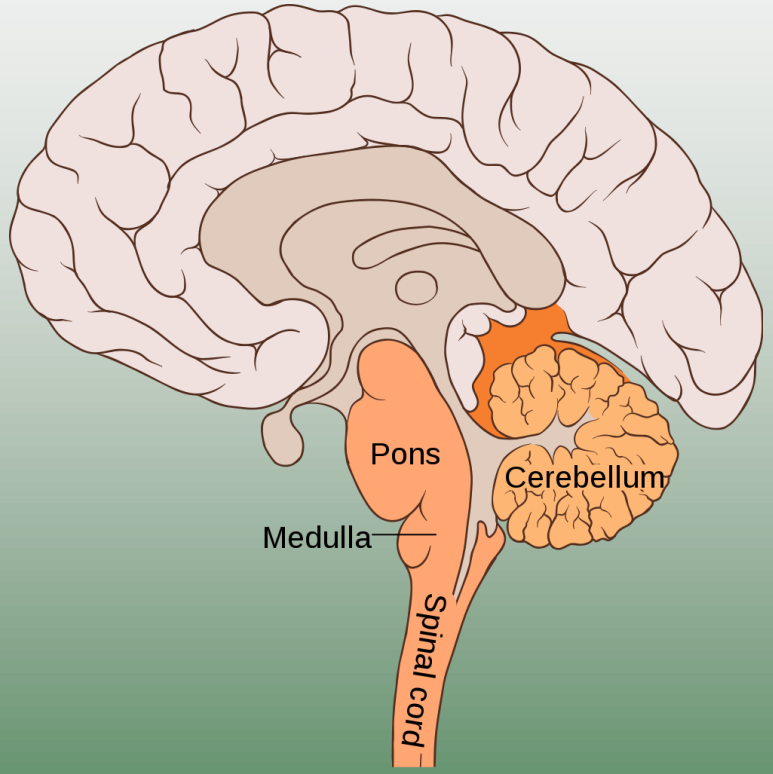
- Central portion of the brain
- Contains the thalamus and hypothalamus
- Thalamus
  - Relay station for incoming sensory impulses
- Hypothalamus
  - Key role in maintaining homeostasis of the body
  - Controls autonomic nervous system and much of the endocrine system
  - Regulates body temperature, fluid and food intake, regulation of sleep cycles, stress response, emotional responses, sex drive

Functional Areas: Brainstem



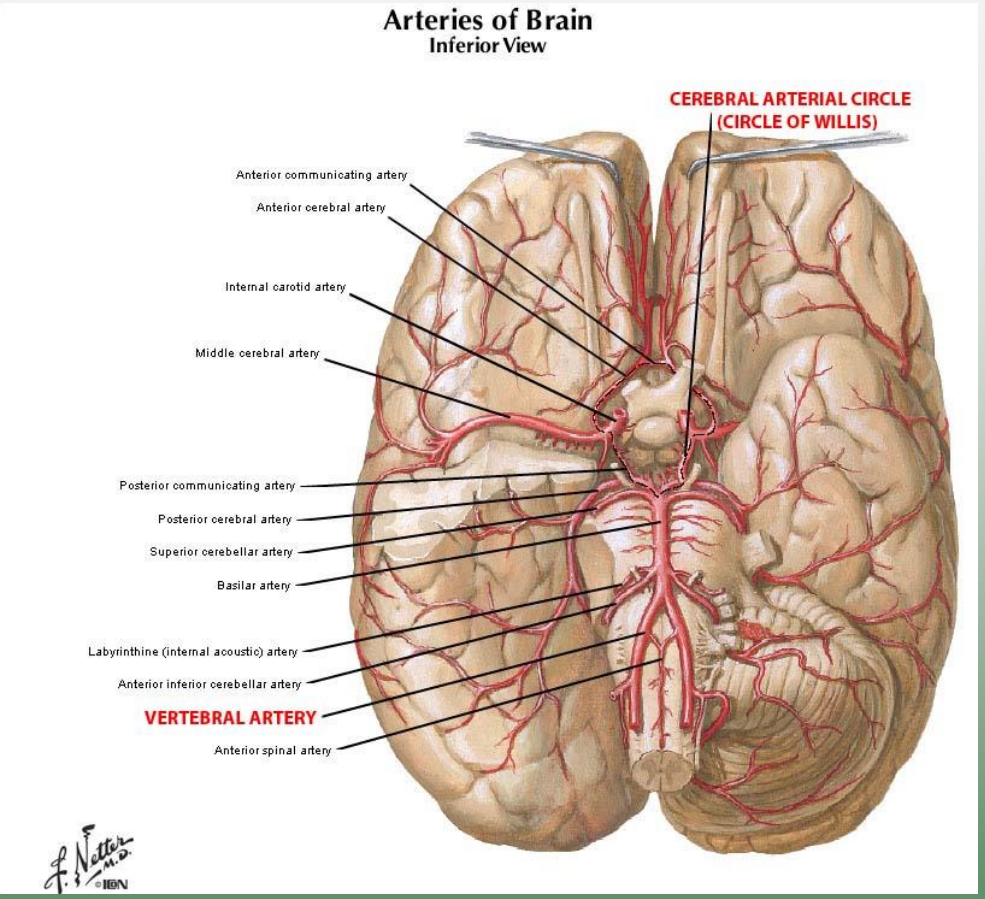
- Connecting link to spinal cord
- Pons
  - Bundles of afferent and efferent fibers
  - Several nuclei of cranial nerves
- Medulla oblongata
  - Control center for respiratory and cardiovascular function
  - Coordination of cough reflex, swallowing, vomiting
  - Nuclei for several cranial nerves

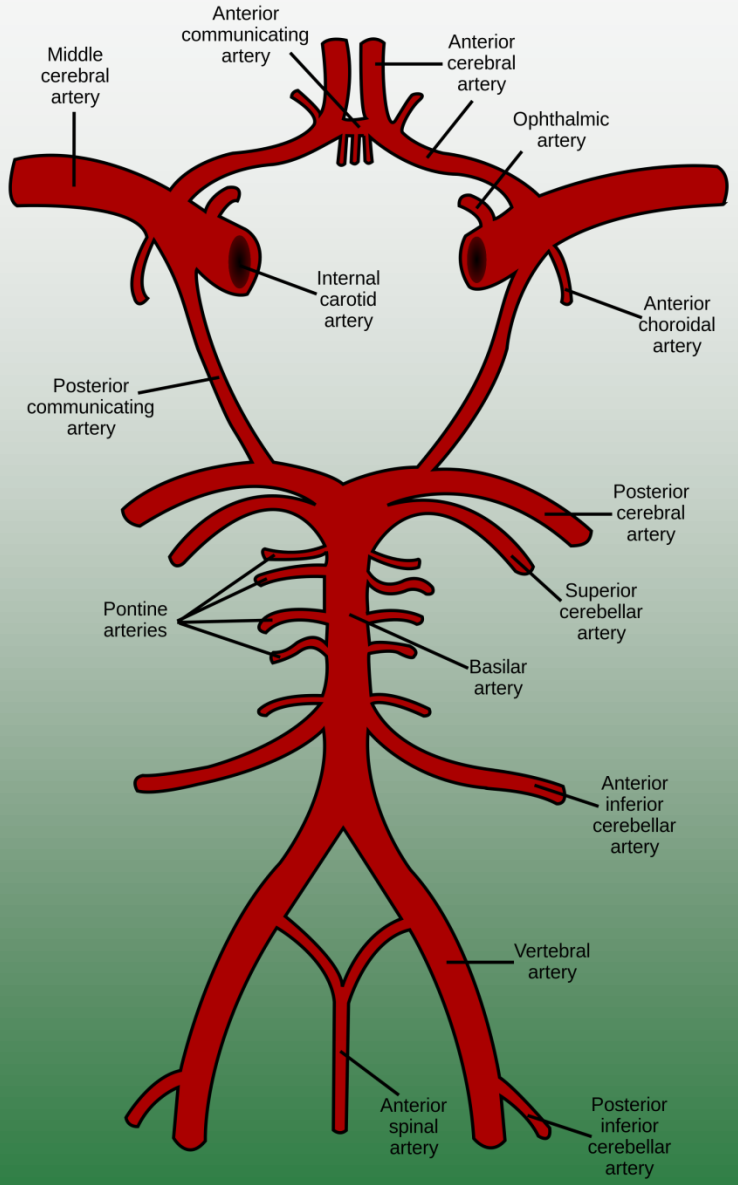
Functional Areas: Cerebellum



- Functions
  - Coordination of movements
  - **Maintenance of posture**
  - **Maintenance of equilibrium**
  - Receives input from proprioceptors in muscles and joints
  - Receives input from visual and vestibular pathways

Blood Supply to the Brain





Blood Supply to the Brain

Two main supplies to the brain:

1. Internal carotid arteries.

2. Vertebral arteries (branches off subclavians).

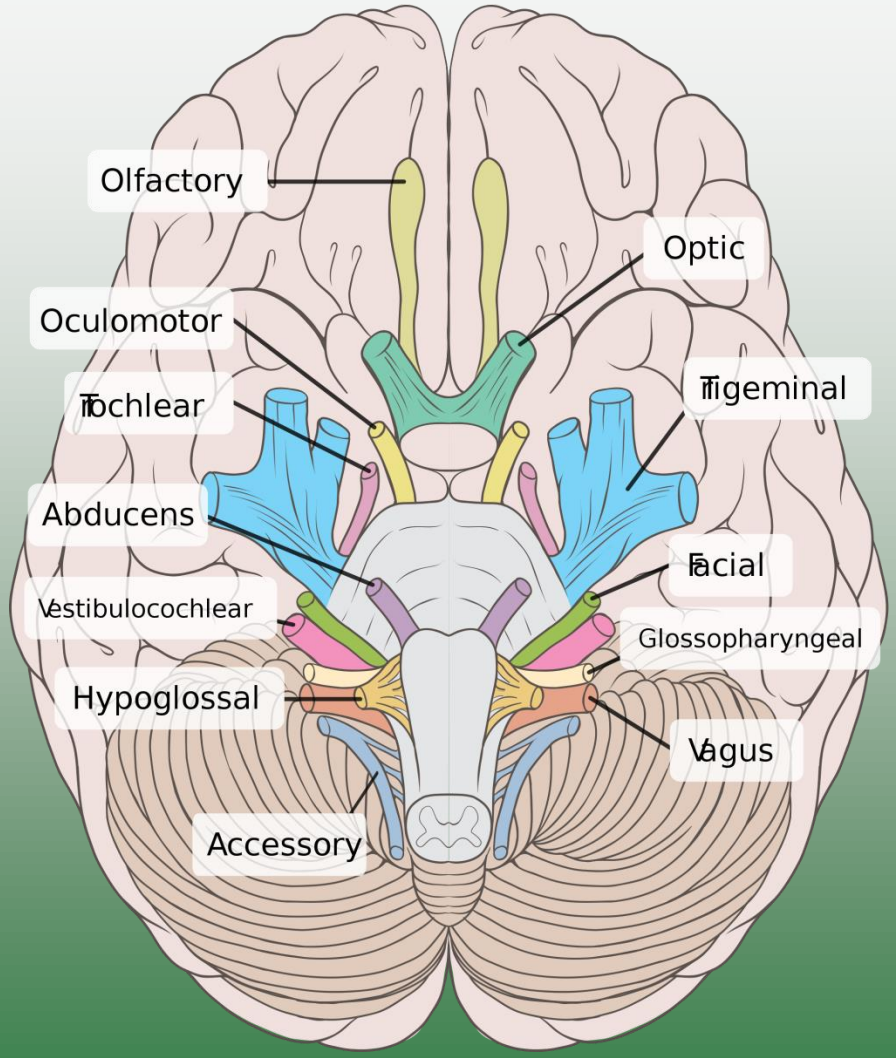
Both feed the circle of Willis.

Vertebral arteries join to make the basilar artery that gives rise to cerebellar arteries and terminates in a bifurcation giving rise to posterior cerebral arteries.

The internal carotid arteries give rise to the middle and anterior cerebral arteries.

Circle if Willis is connected by communicating arteries.

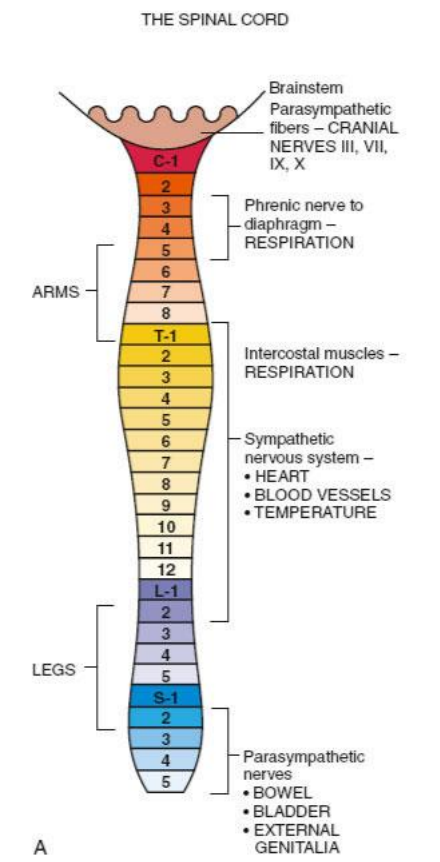
Cranial Nerves

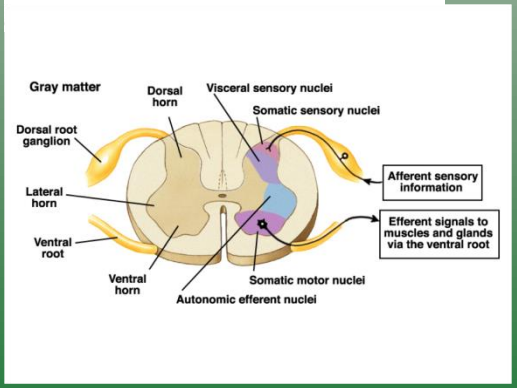


- 12 pairs
- Originate from various parts of the brain.
- Numbered from ventral to dorsal
- Cranial nerves may contain:
  - Motor fibers only
  - Sensory fibers only
  - Both motor and sensory fibers (mixed nerve)

Spinal Cord and Spinal Nerves

Spinal Cord

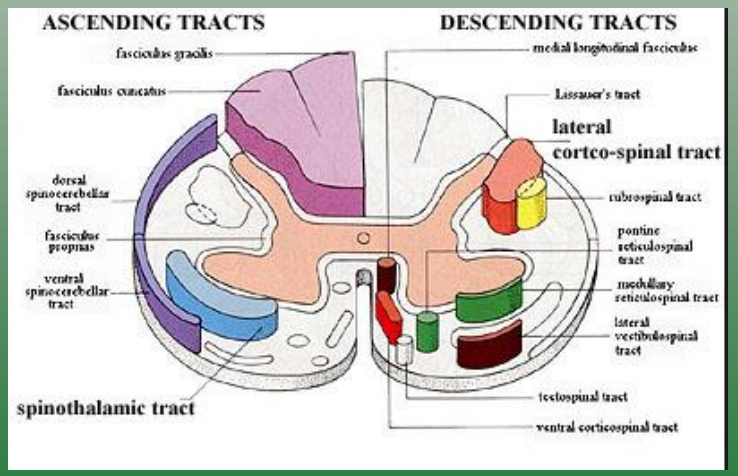




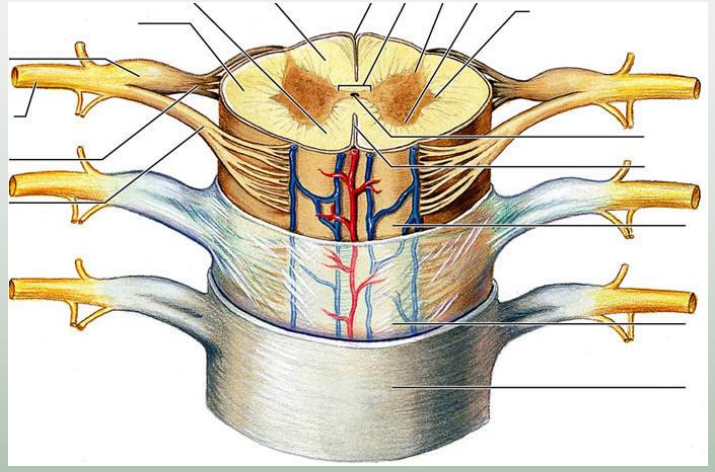
- Protected by vertebral column, meninges, CSF
- Continuous with medulla oblongata
- Ends at lower border of the first lumbar vertebra
  - Extends as bundle of nerve roots—cauda equina
- White matter and gray matter (core)
- Gray matter
  - Anterior horns
    - Cell bodies of motor neurons
  - Posterior horns
    - Interneurons (association neurons)
  - Lateral horns
    - Visceral motor neurons

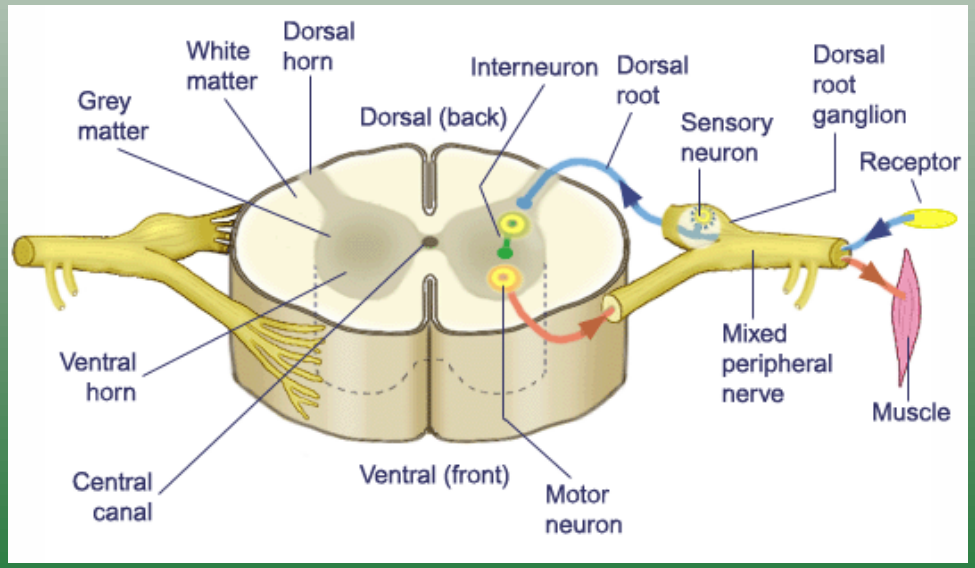
The Spinal Cord (Cont.)

- White matter
  - Afferent (sensory) and efferent (motor) fibers
  - Organized into tracts
  - Each tract has a unique position in the white matter.
  - Name of tract based on source and destination.
  - Ascending tracts
    - Spinal cord to brain
  - Descending tracts
    - Brain to spinal cord



Spinal Nerves





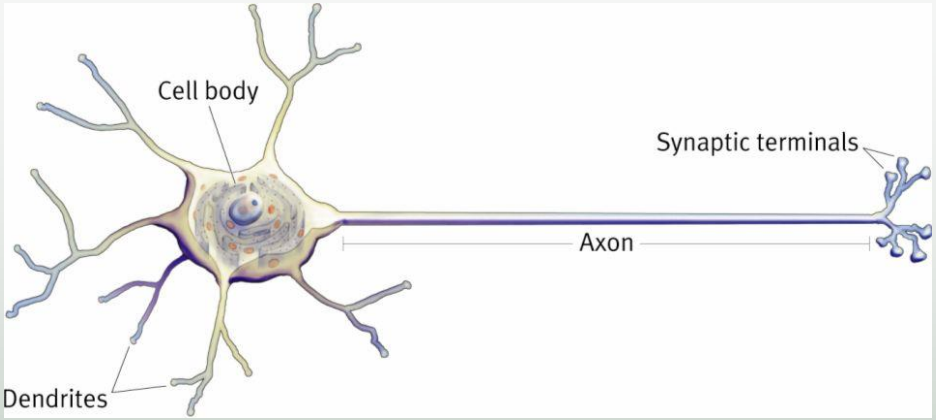
- 31 pairs
- Named by location in the vertebral column where they emerge
- Each nerve connected to spinal cord by roots
- Dorsal (posterior) root
  - Sensory (afferent) fibers
- Ventral (anterior) root
  - Motor (efferent) fibers

Reflexes

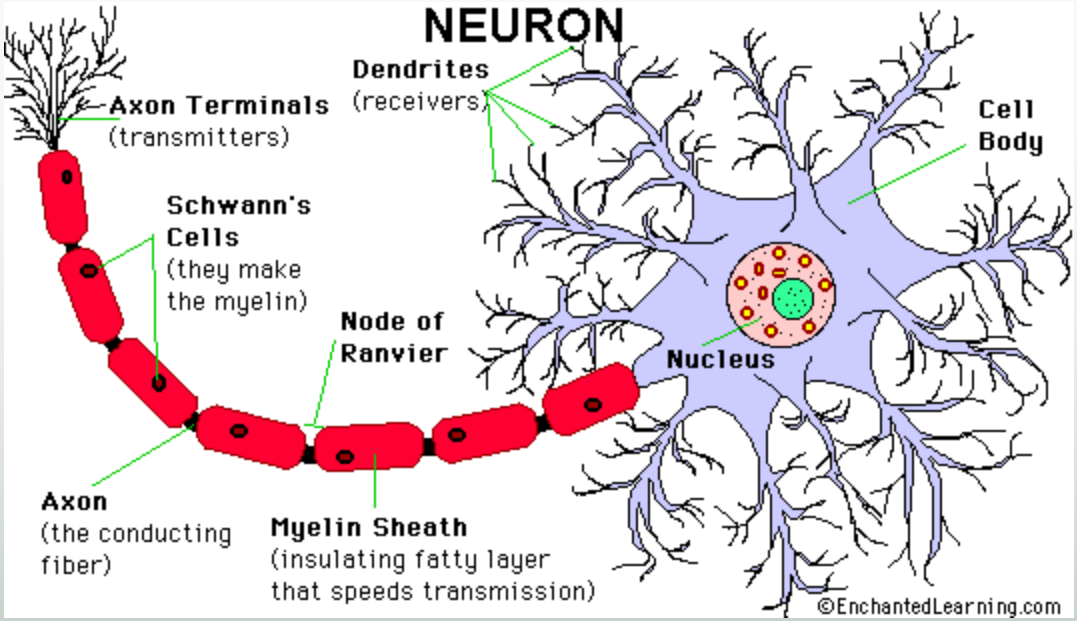
- Automatic, rapid, involuntary responses to a stimulus
- Sensory stimulus
  - From receptor—conducted along afferent fiber
- Synapse
  - In the spinal cord or for cranial reflexes in the brain
- Efferent impulse to elicit the response
- Connecting and interneurons
  - Transmit sensory information to the brain

Neurons and Conduction of Impulses

Neurons



- Highly specialized, nonmitotic cells
- Conduct impulses throughout central nervous system (CNS) and peripheral nervous system (PNS)
- Require glucose and oxygen for metabolism
- Cell body and processes
  - **Axons**
    - **Conduct impulses away from cell body**
  - **Dendrites**
    - **Receptor site**
    - **Conducts impulses toward cell body**

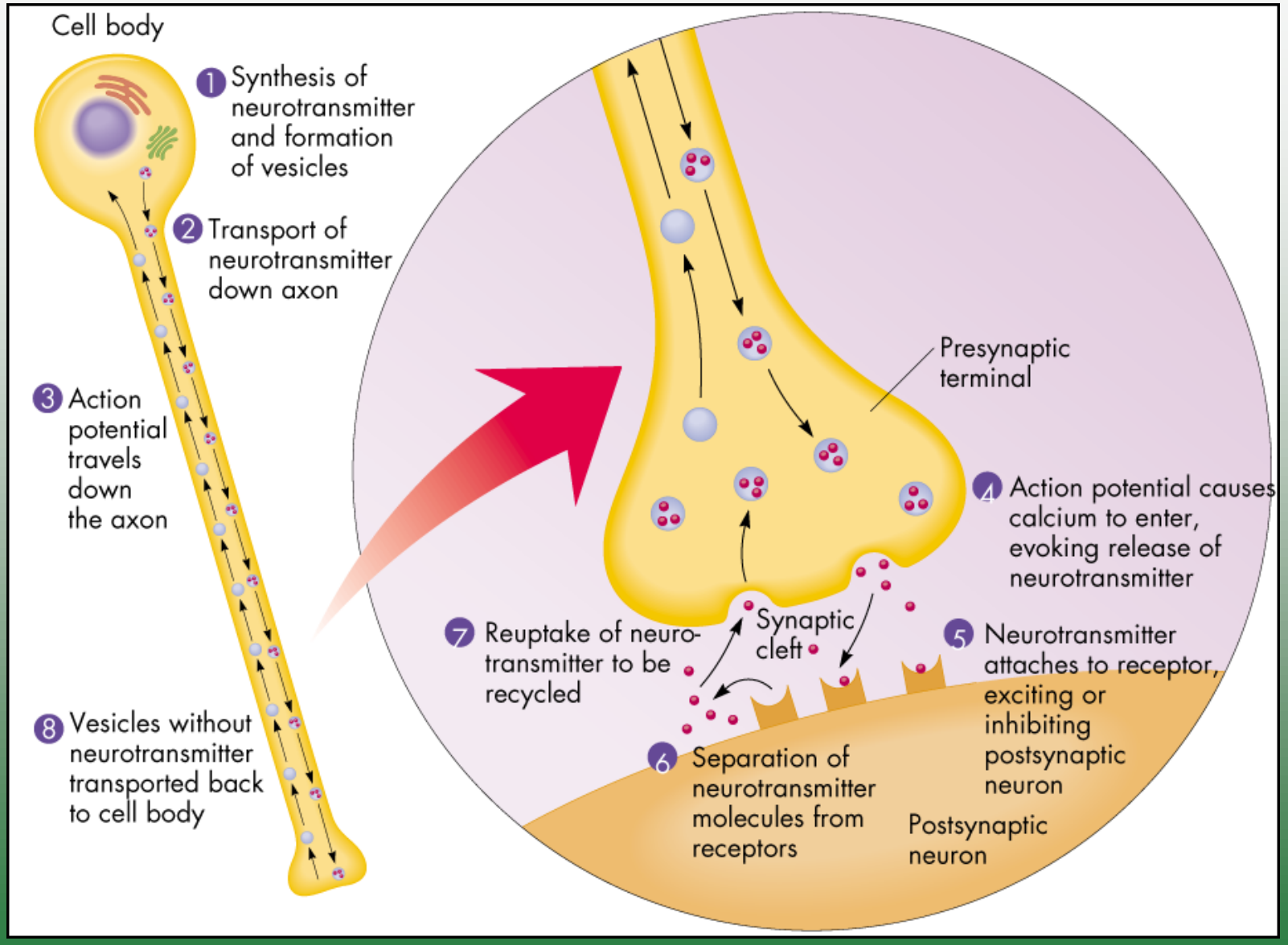


- Nerve fibers may be covered by a myelin sheath.
  - Insulates fiber
  - Speeds up rate of conduction
  - Formed by Schwann cells in the PNS
  - Formed by oligodendrocytes in the CNS
  - Gaps between myelin sheath—nodes of Ranvier
  - Axon collaterals may emerge.

Neurons

- Glial cells (neuroglia)—supportive cells
  - Astroglia
    - Contribute to the blood-brain barrier
  - Oligodendroglia
    - Provides myelin for axons in the CNS
  - Microglia
    - Phagocytotic
  - Ependymal cells
    - Line brain ventricles and neural tube cavity
    - Form part of the choroid plexus

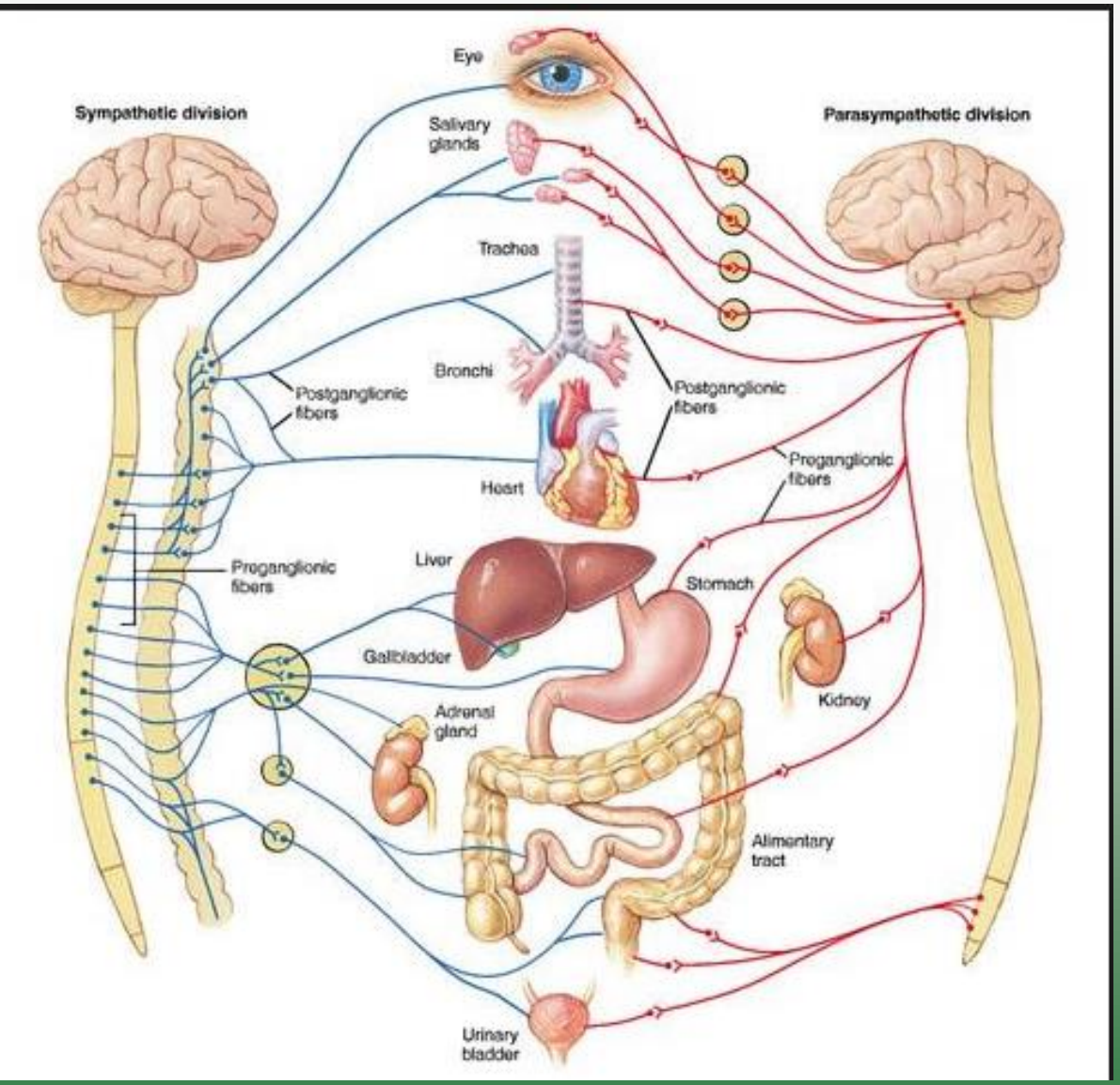
Transmision of nerve signals at synapse



Examples of Neurotransmitters

- Acetylcholine (excitatory)
  - At neuromuscular junction
  - In ANS and brain
- Norepinephrine and epinephrine (excitatory)
  - Brain
  - Sympathetic nervous system (SNS)
- Dopamine, serotonin (excitatory)
  - Brain
- Gamma-aminobutyric acid (GABA) (inhibitory)
  - Brain
- Glycine (inhibitory)
  - Spinal cord

Autonomic Nervous System



- Sympathetic and parasympathetic
  - Motor and sensory innervation
  - Involuntary

Both have presynaptic neurons in the brain and spinal cord.

These send nerves that terminate in a ganglion (collection of nerve cell bodies, discrete structure).

Sympathetic ganglia are in a chain adjacent to the vertebrae.

Parasympathetic ganglia are more distant from the spine and are adjacent to or within the organ being serviced.

Sympathetic Nervous System

- Fight-or-flight response
  - Increases general level of activity in the body
- Preganglionic fibers arise from thoracic and first two lumbar segments.
- Ganglia located in chains or trunks
- Neurotransmitters
  - Preganglionic—acetylcholine
  - Postganglionic—norepinephrine
- Receptors
  - Alpha and beta receptors

Parasympathetic Nervous System

- Originates in the brainstem and sacral spinal nerves
- Dominates digestive system
- Aids recovery after sympathetic activity
- Ganglia scattered and close to target organ
- Neurotransmitter
  - Acetylcholine—both presynaptic and postsynaptic
- Receptors
  - Nicotinic and muscarinic

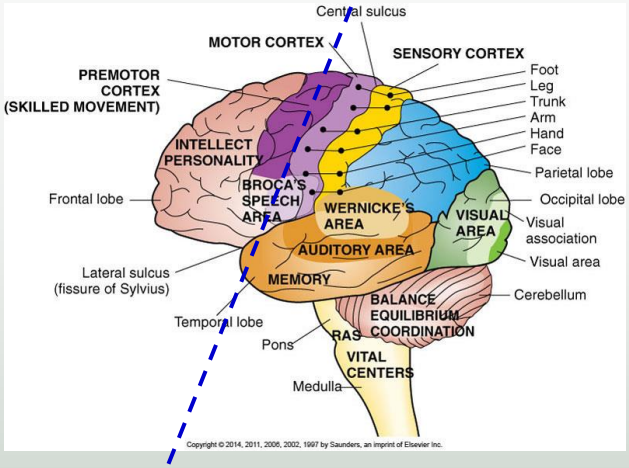
Effect of Stimulation of the Autonomic Nervous System

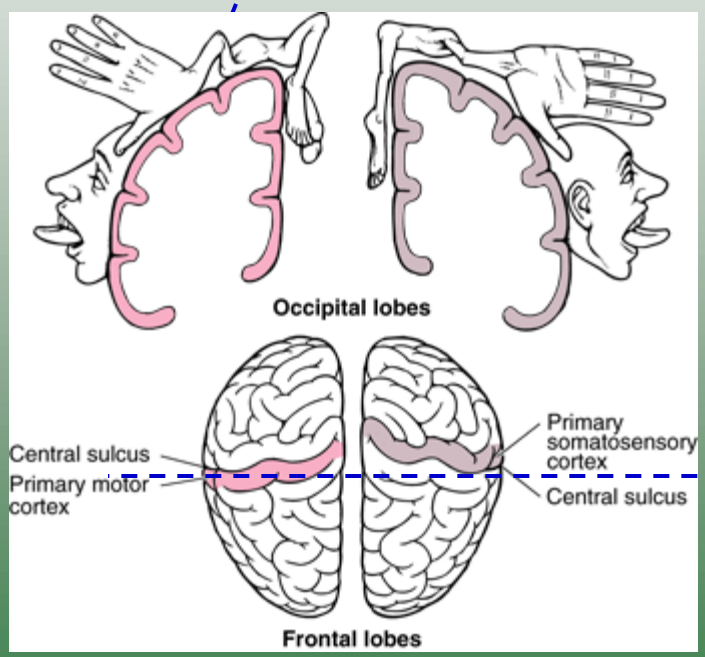
TABLE 14-4 Effect of Stimulation of the Autonomic Nervous System

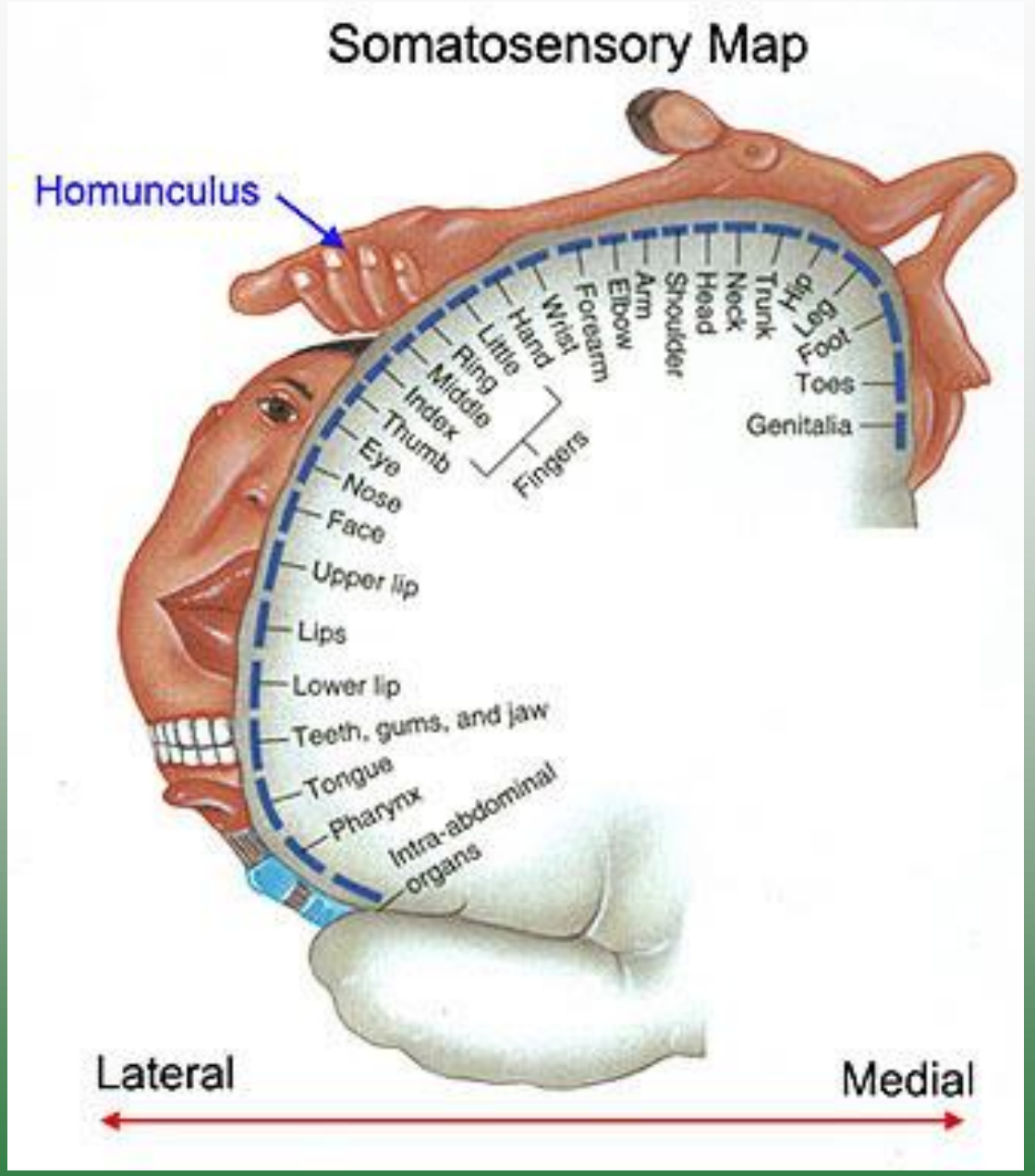
Area	SNS Receptor	Sympathetic	Parasympathetic
Cardiovascular System			
Heart blood vessels	β-1 (beta-1)	Increases rate and force of contractions	Decreases rate and contractility
Skin, mucosa, viscera	α-1 (alpha-1)	Vasoconstriction	No innervation
Skeletal muscle	β-2	Vasodilation	No innervation
Adrenal medulla		Secretion of epinephrine and norepinephrine	No innervation
Respiratory system	β-2	Bronchodilation (smooth muscle)	Bronchoconstriction
Eye	α-1	Pupil dilation (radial muscle)	Pupil constriction (sphincter or circular muscle)
Sweat glands	α-1	Increased secretion	
Digestive system	α-2		
Secretions		Decreased	Increased
Peristalsis		Decreased	Increased
Sphincters	α-1	Constricts	Relaxes
Urinary system			
Sphincters of bladder	α-1	Constricts	Relaxes
Renin	β-1	Increased secretion	
Male genitalia	α-1	Ejaculation	Erection

SNS, sympathetic nervous system.

General Effects of Neurologic Dysfunction







Homunculus

Homunculus is a drawing of the body parts serviced by the sensory and motor strips of the brain drawn onto a picture of the brain (frontal sections) that makes several points:

1. Some body parts (hands and face) get an disproportionate amount of attention vs their true size.
2. The homunculus shows how focal lesions in the brain result in focal deficits.
3. The anatomy is crossed. Cells on the right drive body parts on the left.

Supratentorial and Infratentorial Lesions

- Supratentorial lesions
  - Occur in the cerebral hemispheres above the tentorium cerebelli
    - Lead to specific dysfunction in a discrete area
- Infratentorial lesions
  - Located in the brainstem or below the tentorium
  - May affect many motor and sensory fibers
    - Results in widespread impairment
  - Respiratory and circulatory function may be impaired.
  - Level of consciousness may be impaired.

Left and Right Hemispheres

- Damage to left hemisphere
  - Loss of logical thinking ability, analytical skills, other intellectual abilities, communication skills
- Damage to right hemisphere
  - Impairs appreciation of music and art
  - Causes behavioral problems
  - Spatial orientation and recognition of relationships may be deficient
  - Self-care deficits common

Glasgow Coma Scale

TABLE 14-5 Glasgow Coma Scale and Use in Assessment

Criteria	Maximum	Example—0700Hours	Example—0900Hours	Example—1100Hours
Eye opening				
Spontaneous	4			
Response to speech	3	×	×	
Response to pain	2			
None	1			×
Motor response				
Obeys commands	6	×		
Localizes pain	5		×	
Normal flexion (to pain)	4			
Abnormal flexion (decorticate)	3			
Abnormal extension (decerebrate)	2			
None (flaccid)	2			×
Verbal response				
Oriented to time and place	5			
Confused	4	×		
Inappropriate words	3		×	
Incomprehensible	2			
None	1			×
Score	15 (good, normal)	13	11	4

Level of Consciousness (Cont.)

- Vegetative state
  - Loss of awareness and mental capabilities
    - Result of diffuse brain damage
    - Brainstem function continues.
    - Appearance of a sleep-wake cycle
    - Person unresponsive to external stimuli
- Locked-in syndrome
  - Individual is aware and capable of thinking but is paralyzed and cannot communicate

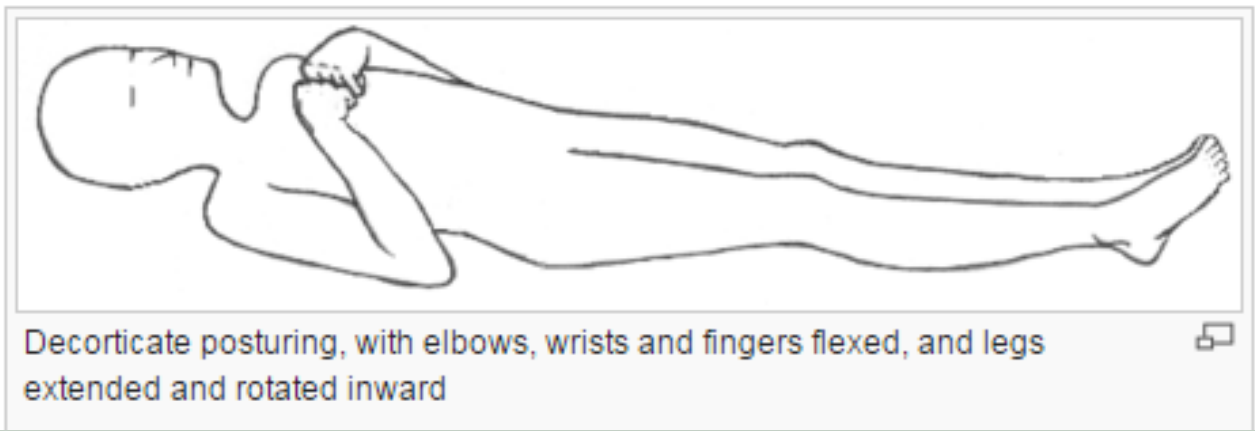
Level of Consciousness (Cont.)

- Criteria for brain death
  - Cessation of brain function
    - Including function of the cortex and the brainstem
    - Flat or inactive electroencephalogram (EEG)
  - Absence of brainstem reflexes or responses
  - Absence of spontaneous respirations when ventilator assistance is withdrawn
  - Establishment of the certainty of irreversible brain damage by confirmation of cause of the dysfunction
  - Evaluation twice by different physicians

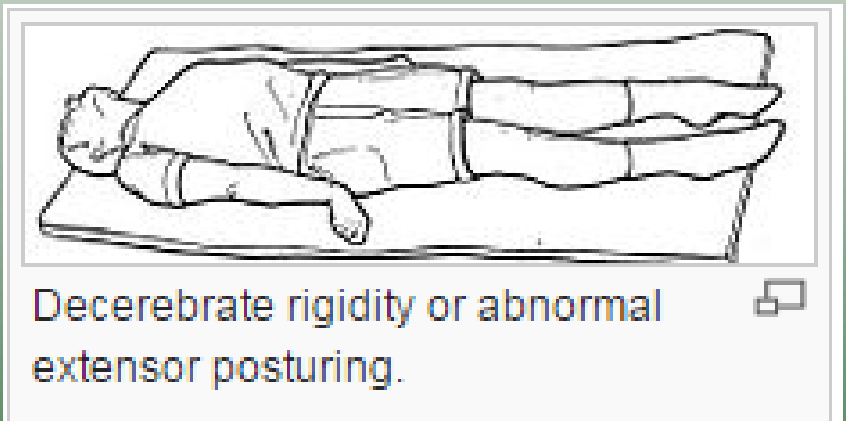
Motor Dysfunction

- Damage to **upper motor neurons** (in brain)
  - Interference with voluntary movements
  - **Weakness or paralysis on the contralateral side** of the body
- Damage to **lower motor neurons** (in spinal cord)
  - **Weakness or paralysis on the same side of the body**
  - At and below the level of spinal cord damage
- Decorticate and decerebrate posturing
  - Severe brain damage

Decorticate and Decerebrate Posturing



Decorticate posturing, with elbows, wrists and fingers flexed, and legs extended and rotated inward

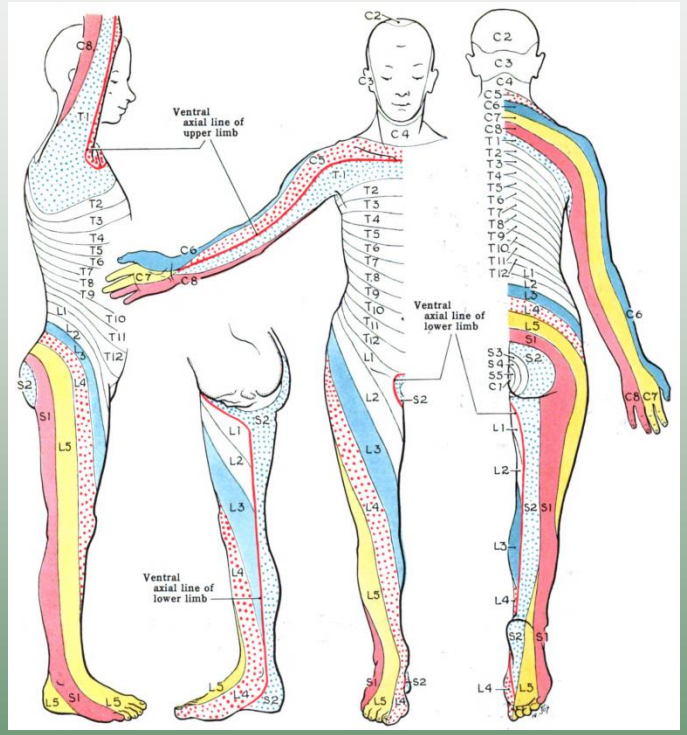


Decerebrate rigidity or abnormal extensor posturing.

Decorticate: Lesion in the cortex that results in flexor posturing.

Decerebrate: Global cerebral loss from brain stem lesion that produces extensor posturing.

Sensory Deficits



- Somatosensory cortex in the parietal lobe receives and localizes basic sensory input
  - **Mapped by dermatomes**
    - **Assists in evaluation of spinal core lesions**
  - Involves touch, pain, temperature, position
  - Involves special senses of vision, hearing, taste, smell

Language Disorders

- Aphasia
  - Inability to comprehend or express language
  - Receptive—damage to Wernicke's area (they speak, but it makes no sense to them or others).
  - Expressive—damage to Broca's area (they know what they want to say but can not get it out).
  - Mixed, global—damage to both areas or to the fibers and tracts between them
- Dysarthria
  - Motor dysfunction affecting muscles used in speech

Language Disorders (Cont.)

- Dysarthria
  - Words cannot be articulated clearly
  - Motor dysfunction—usually results from cranial nerve damage or muscle impairment
- Agraphia
  - Impaired writing ability
- Alexia
  - Impaired reading ability
- Agnosia
  - Loss of recognition or association

Seizures

- Seizures or convulsions
  - Caused by spontaneous, excessive discharge of neurons in the brain
  - Causes
    - Inflammation
    - Hypoxia
    - Bleeding in the brain
  - Focal
    - Related to the particular site of the irritation
  - May become generalized
  - Often manifested by involuntary repetitive movements or abnormal sensations (aura)

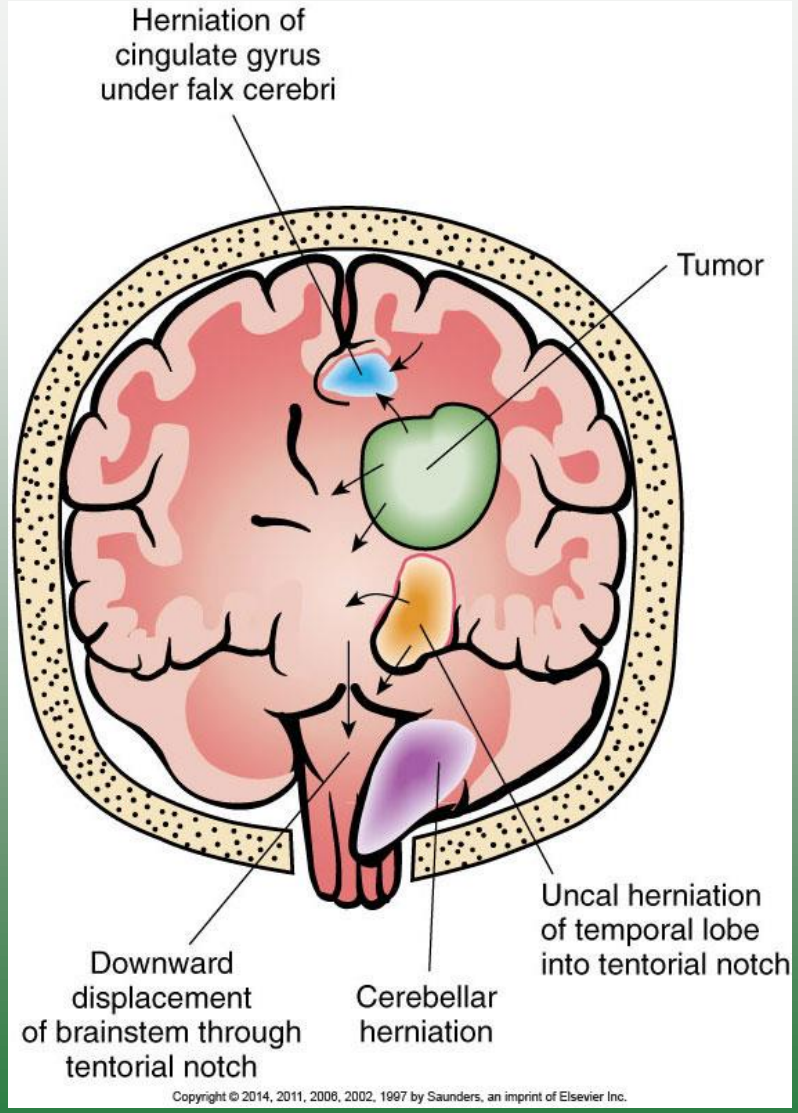
Seizures (Cont.)

- Generalized
  - Absence seizures (petit mal) – mild generalized seizures.
  - Tonic-clonic – severe generalized seizures.
  - Myoclonic
- Partial
  - Simple partial
  - Complex partial (psychomotor)
- Continuous seizures (status epilepticus)
  - Increased metabolism of glucose and oxygen
  - May be life-threatening

Increased Intracranial Pressure

- Brain is encased in rigid, nonexpendable skull.
- Fluids, blood, and CSF are not compressible.
- Increase in fluid or additional mass causes increase in pressure in the brain
  - Ischemia and eventual infarction of brain tissue
- Increased ICP is common in many neurological problems.
  - Brain hemorrhage, trauma, cerebral edema, infection, tumors, abnormal circulation of CSF

Increased Intracranial Pressure and Possible Herniations

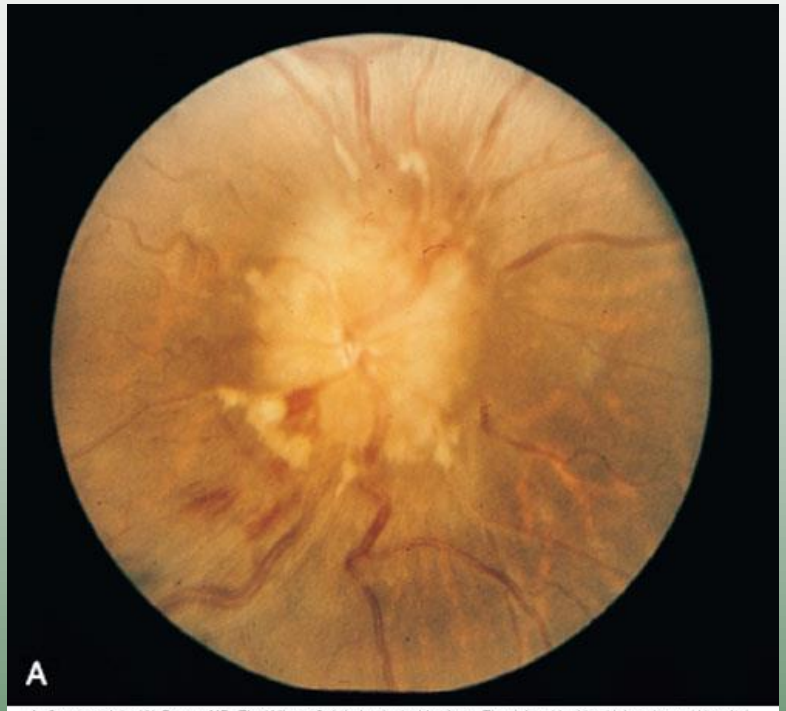


Increased Intracranial Pressure (Cont.)

- Early signs—if cause is not removed
  - Decreasing level of consciousness or decreased responsiveness (lethargy)
  - Decreased pupillary responses
  - Severe headache
    - From stretching of dura and walls of large blood vessels
  - Vomiting
    - Often projectile, not associated with food intake
    - Result of pressure stimulating the emetic center in the medulla
  - Papilledema
    - Caused by increased ICP and swelling of the optic disc

Papilledema

Normal



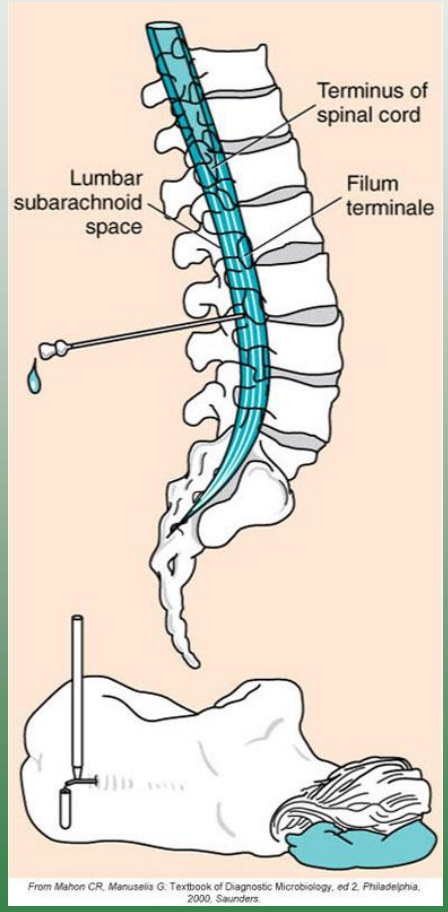
A, Courtesy John W. Payne, MD, The Wilmer Ophthalmological Institute, The Johns Hopkins University and Hospital, Baltimore, MD, from Seidel HM, Ball JW, Dains JE, et al: *Mosby's Guide to Physical Examination*, ed 5, St. Louis, 2003, Mosby; B, From Cotran RS, Kumar V, Collins T: *Robbins Pathologic Basis of Disease*, ed 6, Philadelphia, 1999, Saunders.

Papilledema

Diagnostic Tests

- Computed tomography (CT) scans
- Magnetic resonance imaging (MRI)
- Cerebral angiography
- Doppler ultrasound
- Electroencephalography
- Radionuclide may be used to track perfusion in CNS
- Lumbar puncture used to check pressure and analyze CSF

Lumbar Puncture



From Mahon CR, Manuselis G: Textbook of Diagnostic Microbiology, ed 2. Philadelphia, 2000, Saunders.

Measures CSF pressure.

Allows collection of CSF for testing and culture.

Provides portal for injection of medication.

Specific Acute Neurologic Problems

Brain Tumors

- Benign and malignant tumors occur.
- Danger is related to location and type.
  - Well demarcated benign tumors at edge of brain are easily removed.
  - Malignant tumor at the edge may not have defined margins, hard to know if you got it all out.
  - Tumor of any kind deep in brain (or in brain stem) may not be operable.
  - Tumors can cause hemorrhage and swelling producing fatal edema.

Transient Ischemic Attacks (TIAs)

- May occur singly or in a series
- Result from temporary localized reduction of blood flow in the brain
  - Partial occlusion of an artery
  - Atherosclerosis
  - Small embolus
  - Vascular spasm
  - Local loss of autoregulation

Transient Ischemic Attacks (TIAs) (Cont.)

- Signs and symptoms
  - Difficult to diagnose after the attack
  - Directly related to location of ischemia
  - Intermittent short episodes of **impaired function**
    - e.g., muscle weakness in arm or leg
  - **Visual disturbances**
  - **Numbness and paresthesia in face**
  - **Transient aphasia or confusion** may develop.
    - Repeated attacks may be a warning sign for obstruction related to atherosclerosis.

Cerebrovascular Accidents (CVAs)

- A CVA (stroke) is an infarction of brain tissue that results from lack of blood.
  - Occlusion of a cerebral blood vessel
  - Rupture of cerebral vessel
- 5 minutes of ischemia causes irreversible nerve cell damage.
  - Central area of necrosis develops
  - All function lost
  - Surrounded by an area of inflammation. this zone will regain function following healing.

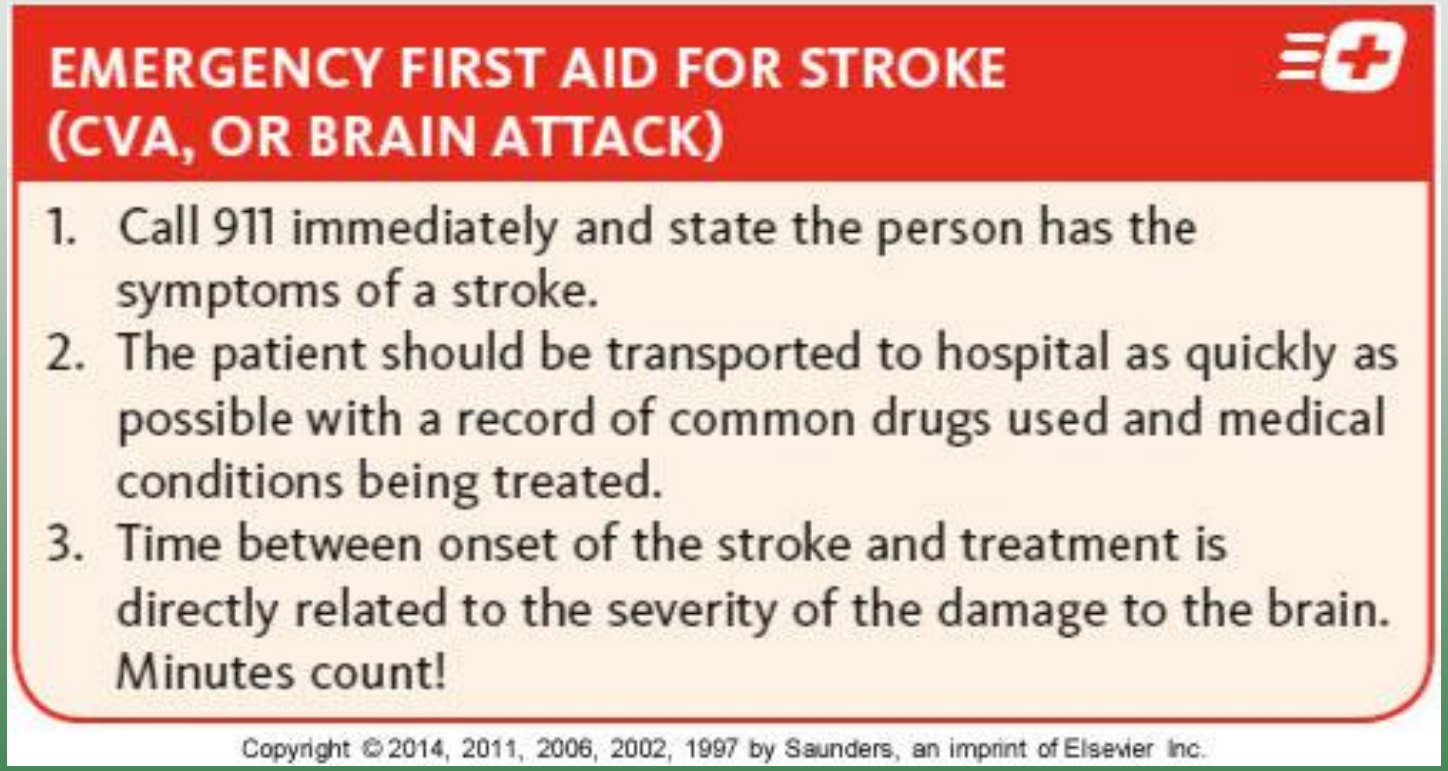
Types of CVAs

- Occlusion of an artery by an atheroma
  - Often develop in large arteries
- Sudden obstruction caused by an embolus
  - Lodging in a cerebral artery
- Intracerebral hemorrhage
  - Caused by rupture of a cerebral artery in patient with severe hypertension
    - Effects are evident in both hemispheres.
    - Complicated by secondary effects of bleeding

Types of CVAs (Cont.)

- Signs and symptoms
  - Depend on the location of obstruction
  - Size of artery involved
    - Presence of collateral circulation may diminish size of affected area
  - Lack of voluntary movement or sensation on opposite side of the body.
  - Initially flaccid paralysis
  - Spastic paralysis develops weeks later
  - NIH Stroke Scale (NIHSS)
    - Developed by the National Institutes of Health (NIH)
    - Designed to assist with rapid diagnosis in an emergency situation

Emergency First Aid for Stroke



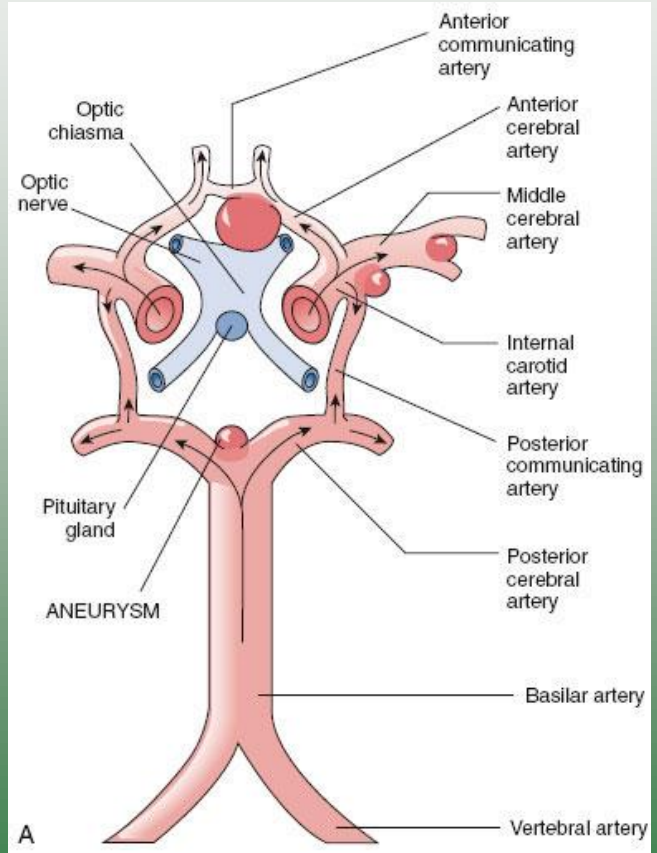
Types of CVAs (Cont.)

- Treatment
  - Clot-busting agents
  - Surgical intervention
  - Glucocorticoids
  - Supportive treatment
  - Occupational and physical therapists; speech-language pathologists
  - Treat underlying problem to prevent recurrences.
  - Rehabilitation begins immediately.

Cerebral Aneurysms

- Localized weakness in the wall of an artery
- Cerebral aneurysms frequently multiple.
  - Usually at the points of bifurcation on the circle of Willis
    - Berry aneurysms
  - Often aggravated by hypertension
  - Initially small and asymptomatic
  - Slow bleed causes vascular type headache.
  - Rupture leads to sudden fatal increase in ICP and death.

Cerebral Aneurysms (Cont.)



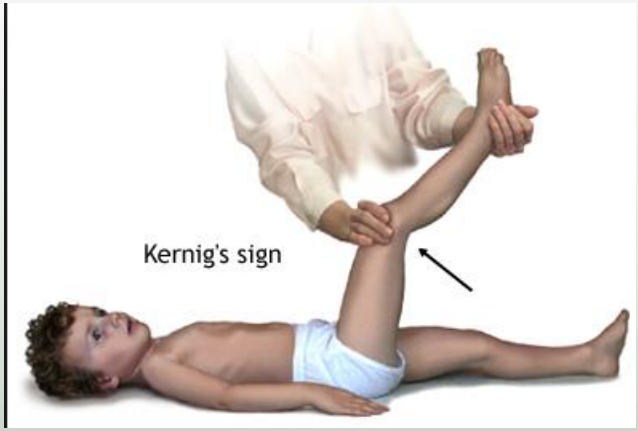
From Kumar V, Abbas AK, Fausto M: *Robbins and Cotran Pathologic Basis of Disease*, ed 7, Philadelphia, 2005, Saunders.

Infections

- Different age groups are susceptible to infection by different causative organisms.
  - May be secondary to other infections
- Children and young adults
  - *Neisseria meningitidis* or meningococci
- Neonates
  - *Escherichia coli* most common causative organism
- Young children
  - Most often caused by *Haemophilus influenzae*
- Older adults
  - *Streptococcus pneumoniae*—major cause

Infections

- Signs and symptoms
  - Sudden onset is common.
  - Severe headache
  - Back pain
  - Photophobia
  - Nuchal rigidity
  - Kernig sign
  - Brudzinski sign
  - Vomiting, irritability, lethargy, fever, chills with leukocytosis
  - Progression to stupor or seizures



Infections (Cont.)

- Diagnostic tests
  - Examination of CSF (obtained by lumbar puncture)
  - Identification of causative organism
- Treatment
  - Aggressive antimicrobial therapy
  - Specific treatment measures for ICP and seizures
  - Glucocorticoids
    - Reduction of cerebral inflammation and edema
  - Vaccines are available for some types of meningitis.

Encephalitis

- Infection of the parenchymal or connective tissue in the brain and spinal cord
  - Necrosis and inflammation develop in brain tissue.
    - Result in some permanent damage
- Infection may include meninges.
- Usually of viral origin
  - May be caused by other organisms
- Early signs
  - Severe headache, stiff neck, lethargy, vomiting, seizures, fever

Encephalitis (Cont.)

- Western equine encephalitis
- St. Louis encephalitis
- West Nile fever

Transmitted by mosquitos

- Herpes simplex encephalitis
- Neuroborreliosis (Lyme disease)
  - Caused by *Borrelia burgdorferi,* Transmitted by ticks

Other Infections

- Rabies
  - Viral—transmitted by Bite of rabid animal
- Poliomyelitis (infantile paralysis)
- Tetanus (“Lock Jaw”)
  - Caused by *Clostridium tetani*
  - Exotoxin enters nervous system
    - Tonic muscle spasms, Jaw stiffness, Difficulty swallowing
    - Stiff neck, Headache and skeletal muscle spasm
    - Respiratory failure

Infection-Related Syndromes

- Reye's syndrome
  - Cause not fully determined
  - **Linked to viral infection in children treated with aspirin**
  - **Pathological changes in brain and liver**
  - Brain
    - Function severely impaired by **cerebral edema**
  - Liver
    - Enlarged, **fatty changes** develop in tissue
    - Can result in acute failure
  - Manifestations vary in severity.
  - No immediate cure

Infection-Related Syndromes

- Guillain-Barre syndrome
  - Postinfection polyneuritis, acute idiopathic polyneuropathy, acute infectious polyradiculoneuritis
  - Inflammatory condition of the PNS
  - Exact cause unknown
  - Progressive muscle weakness, lack of reflex response, ascending flaccid paralysis, pain, general muscle aching
  - Can be life threatening

Head Injuries

- May involve skull fractures
- Hemorrhage and edema
- Direct injury to brain tissue
- Injury may be mild.
  - Bruising of the tissue
- Can be severe and life-threatening
  - Destruction of brain tissue
  - Massive swelling of the brain

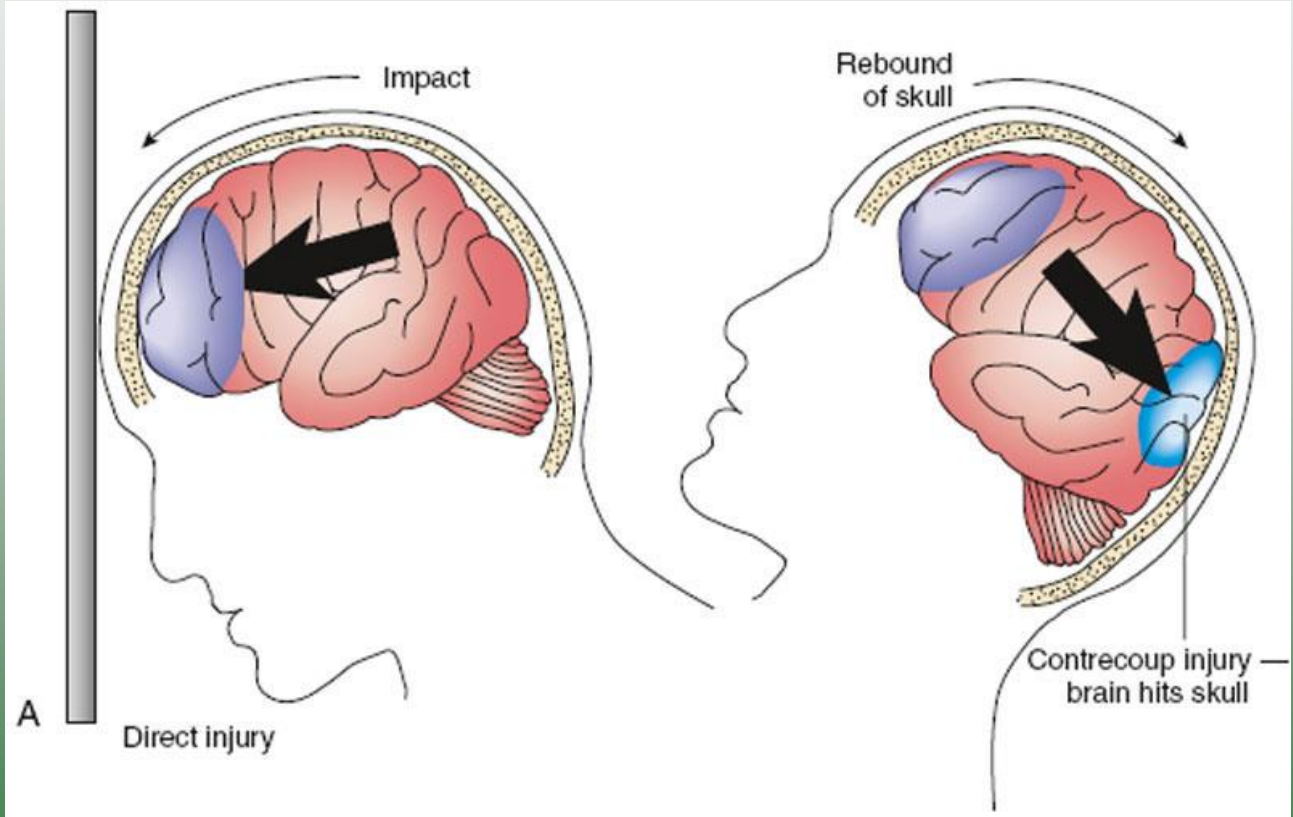
Types of Head Injuries

- Concussion (minimal brain trauma)
  - Reversible interference with brain function
    - Causes sudden excessive movement of the brain
  - Result of mild blow to the head or whiplash-type injury
  - Amnesia and headaches may follow.
    - Recovery usually within 24 hours, without permanent damage
- Contusion
  - Bruising of brain tissue, rupture of small blood vessels, and edema
  - Blunt blow to the head, possible residual damage

Types of Head Injuries (Cont.)

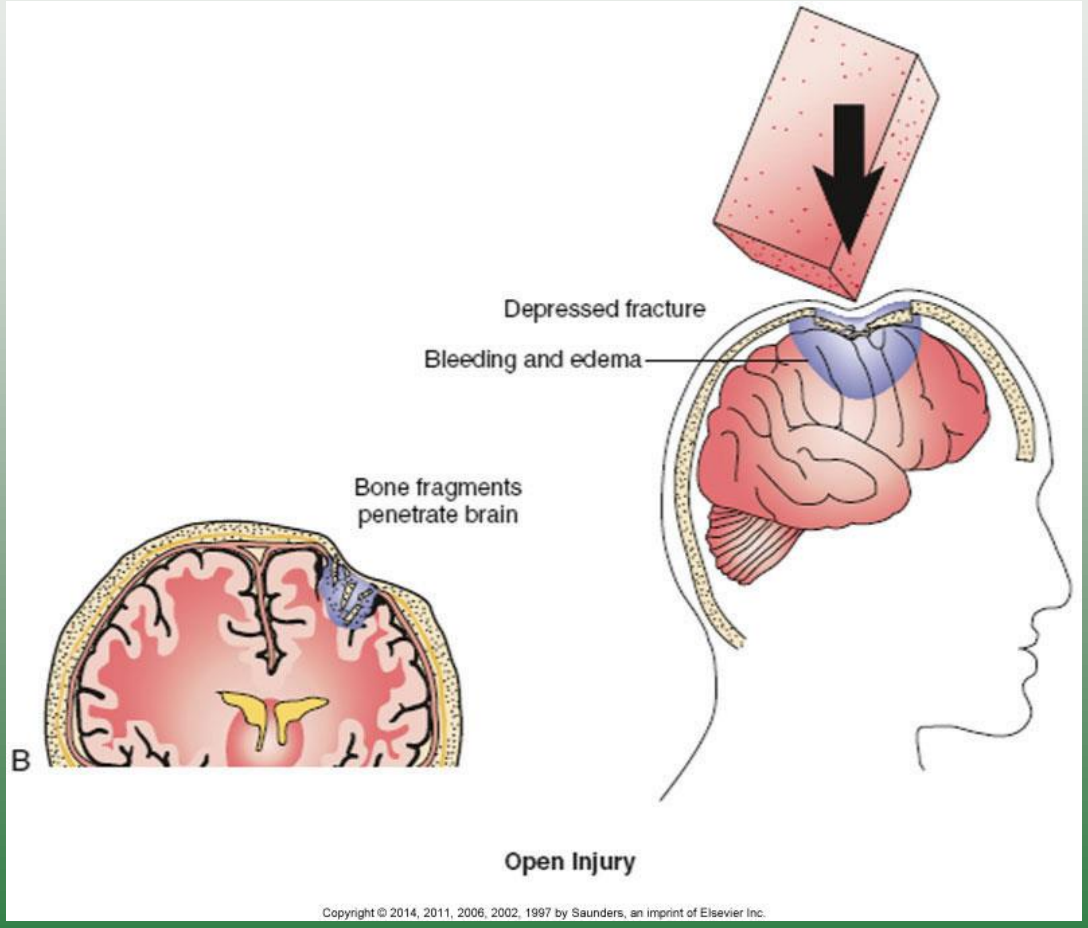
- Closed head injury
  - Skull is not fractured in injury.
  - Brain tissue is injured and blood vessels may be ruptured.
  - Extensive damage may occur when head is rotated.
- Open head injuries
  - Involve fractures or penetration of the brain

Closed Head Injury



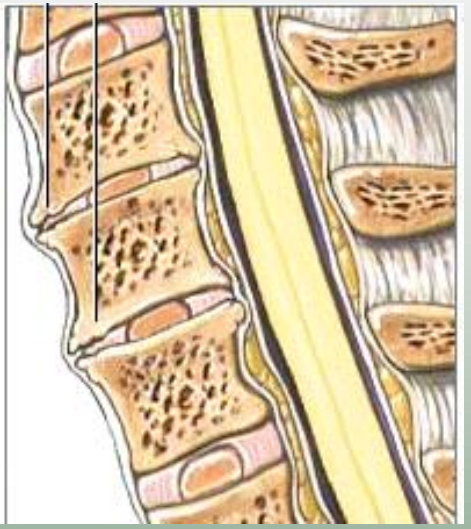
Closed Injury — Direct and Contrecoup Injury

Open Head Injury



END OF PART ONE

Spinal Cord Injury



- Results from fracture, dislocation of vertebrae
  - Compresses, stretches, or tears spinal cord
- Cervical spine injuries
  - May result from hyperextension or hyperflexion of neck with possible fracture
- Dislocation of vertebra
  - May crush or compress spinal cord
- Compression
  - Causes injury to spinal cord when great force is applied to top of the skull or to the feet

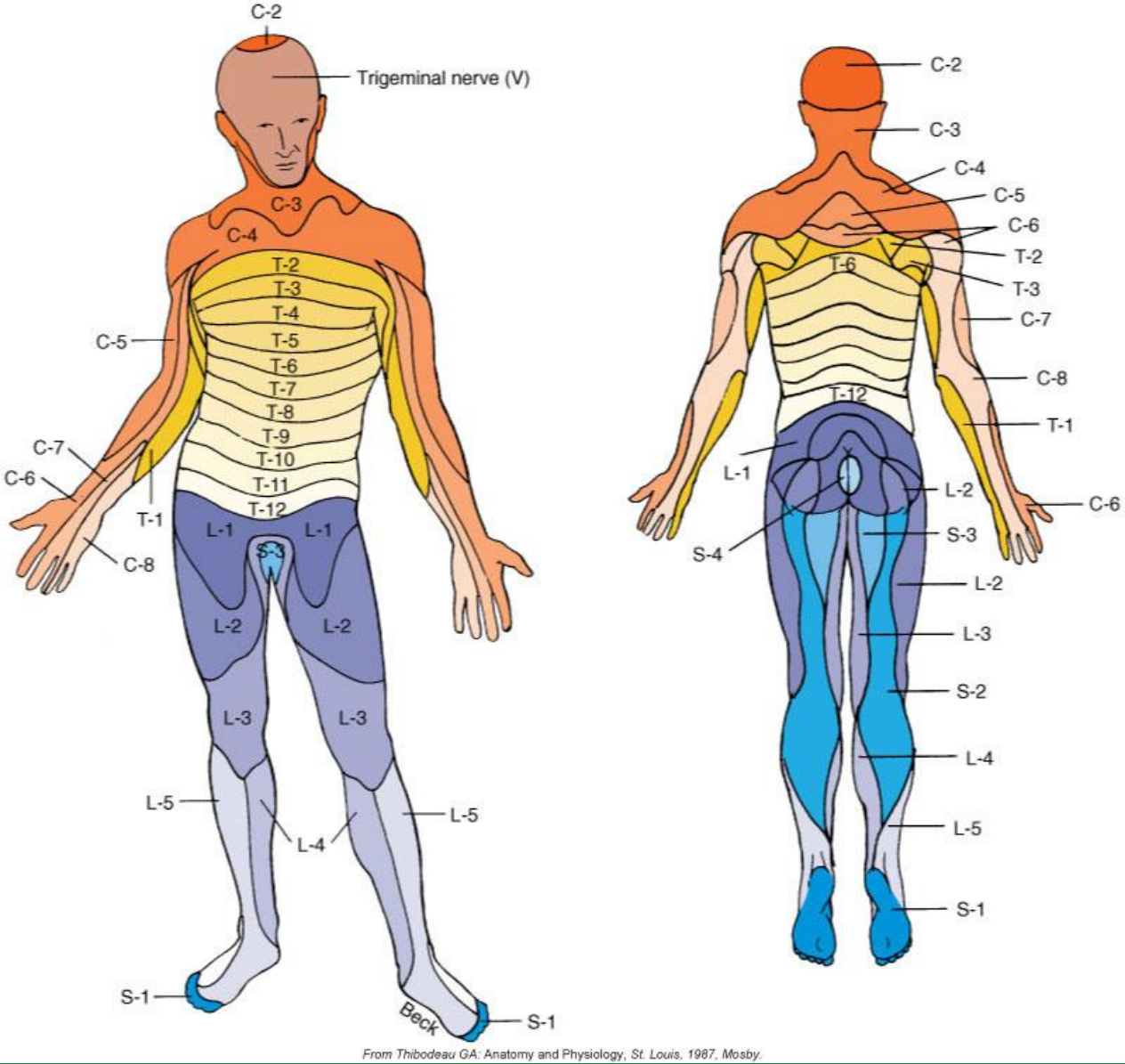
Spinal Cord Injury

- Damage may be temporary or permanent.
  - Axonal regrowth may occur.
- Laceration of nerve tissue by bone fragments
  - Usually permanent loss of conduction in affected tracts
- Complete transsection or crushing of cord
  - Irreversible loss of all sensory and motor function at and below the level of injury
- Partial transection or crushing
  - May allow recovery of some function

Spinal Cord Injury (Cont.)

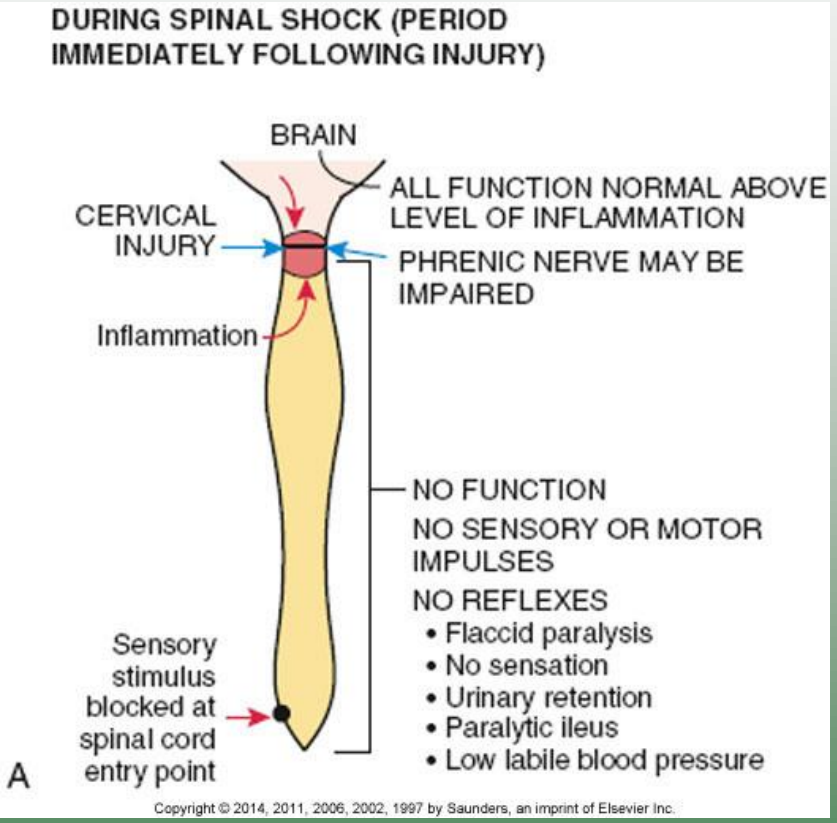
- Bruising
  - Reversible damage
- Prolonged ischemia and necrosis
  - Lead to permanent damage
- Release of norepinephrine, serotonin, histamine
  - Released by damaged tissue—vasoconstriction
- Assessment using dermatome map
  - Assessment of movement and sensory responses
    - Can determine the degree of damage or recovery

Dermatomes



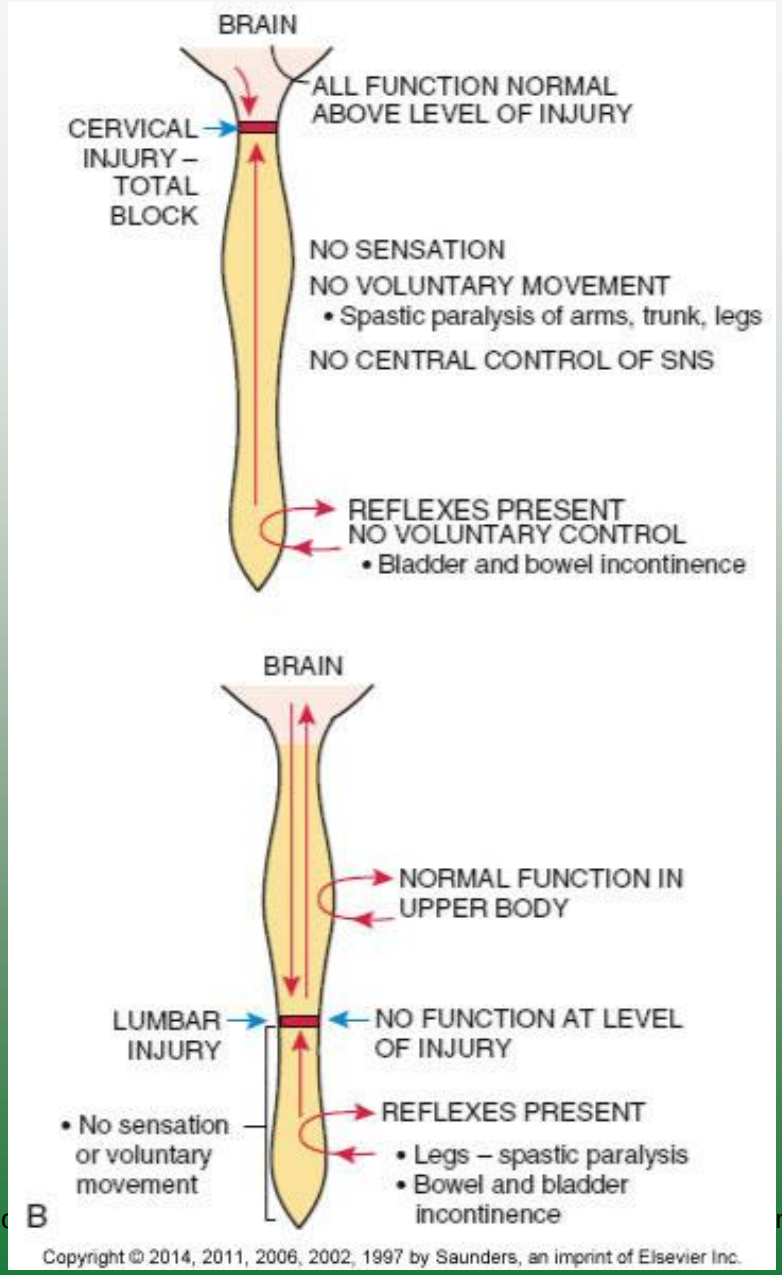
From Thibodeau GA: Anatomy and Physiology, St. Louis, 1987, Mosby.

Spinal Cord Injury (Cont.)



- Spinal shock
  - Initial period after injury—ANS reflexes absent
  - Reflex activity resumes below level of injury.
  - No communication with higher levels of brain
  - Control of reflexes below the level of damage is lost.

Effects of Spinal Cord Damage



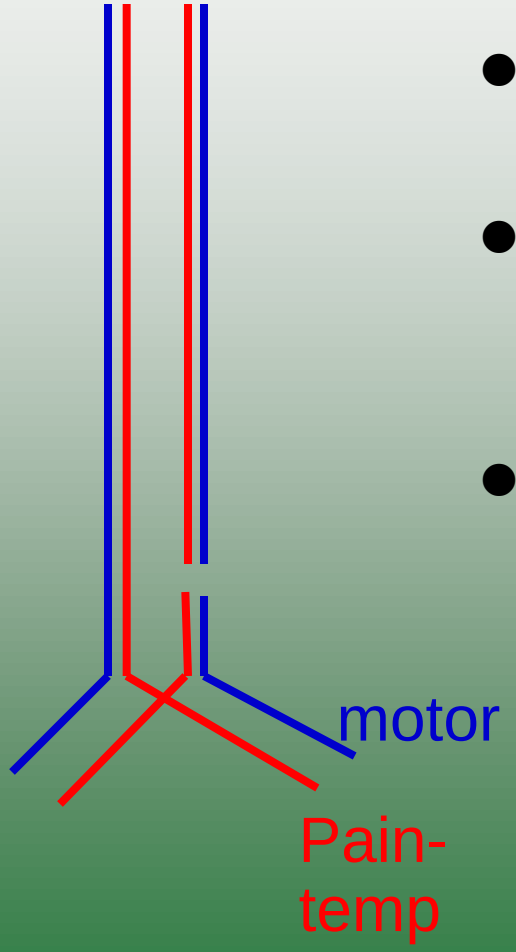
Spinal Cord Injury (Cont.)

- Two stages in post-traumatic period
  - Spinal shock
  - Recovery and recognition of extent of functional loss
- Spinal shock
  - Initially, all neurological activity ceases below and slightly above the level of injury.
  - No reflexes present
  - Condition may persist for days or weeks
    - Flaccid paralysis
    - Sensory loss at and below injured area
    - Absence of all reflexes
    - Loss of central control of autonomic function

Spinal Cord Injury (Cont.)

- Recovery
  - Gradual return of reflex activity below level of injury
  - No impulses through specific area of damage
  - Hyperreflexia may develop.
  - Gradually, extent of damage will be revealed.
  - Voluntary motor activity and sensory impulses are blocked at and below the level of damage.
  - Many injuries are incomplete, and permanent damage varies among individuals.

Spinal Cord Injury (Cont.)



- Tetraplegia (quadriplegia)
  - Paralysis of all four extremities
- Paraplegia
  - Paralysis of the lower part of the trunk and legs
- Ipsilateral paralysis and contralateral loss of pain and temperature sensation
  - Depends on the point of decussation and location

Autonomic Dysreflexia

- Massive sympathetic reflex response that cannot be controlled from the brain
- Often initiated by infection, genital stimulation, or other stimuli
- Leads to:
  - Increased blood pressure
  - Vasoconstriction below the injury
  - Vasodilation above the injury
  - Tachycardia

Complications of Spinal Cord Injury

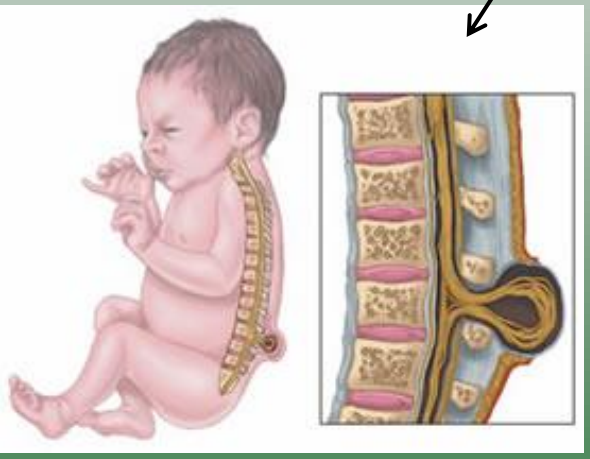
- Urinary tract infections
- Pneumonia
- Skin breakdown
- Spasm and pain
- Depression

Spinal Cord Injury (Cont.)

- Treatment
  - Treatment and rehabilitation begin at the time of injury.
  - Immobilize spine.
  - Maintain breathing and prevent shock.
  - Hospital traction or surgery
    - Relieve pressure and repair tissues
  - Glucocorticoids
    - Reduce edema and stabilize vascular system
  - Ongoing care to prevent complications related to immobility

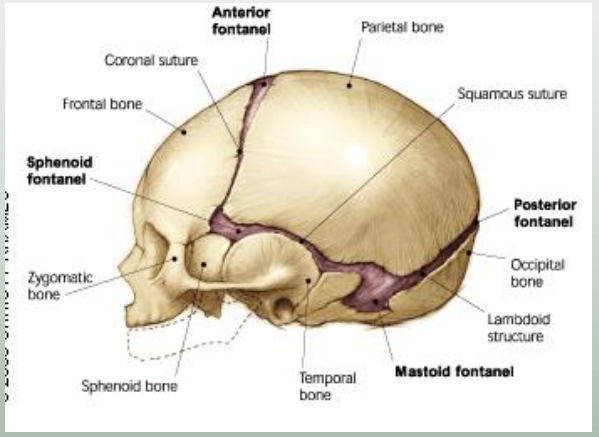
Congenital Neurologic Disorders

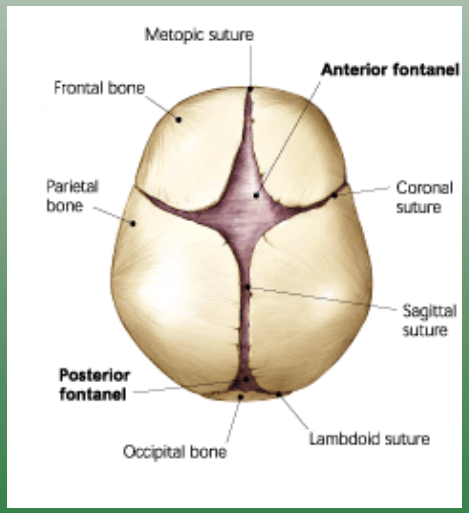
Congenital Neurological Disorders



- Hydrocephalus
  - Excess CSF accumulates within the skull
- Spina bifida
  - Group of neural tube defects of varying severity
- Cerebral palsy
  - Group of disorders with some degree of motor impairment
    - Abnormal formation of functional brain areas
    - Infection
    - Brain damage in perinatal period

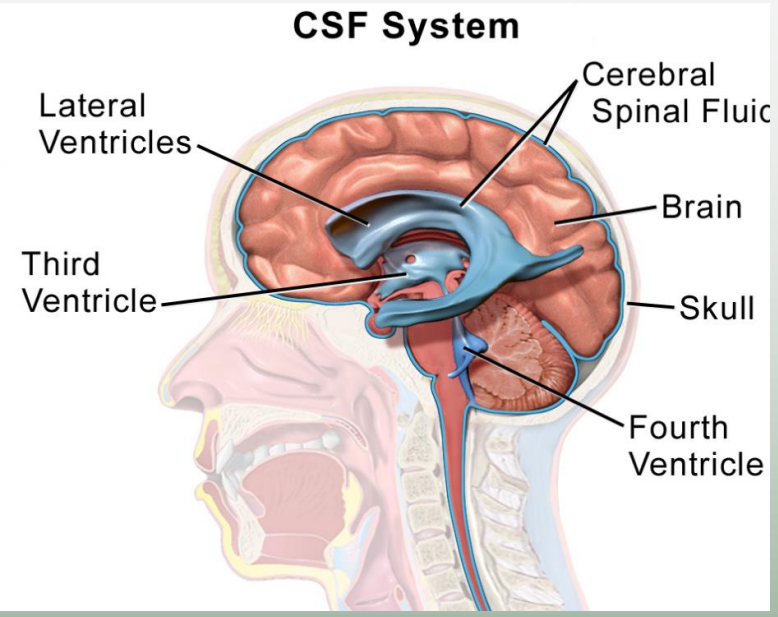
Hydrocephalus

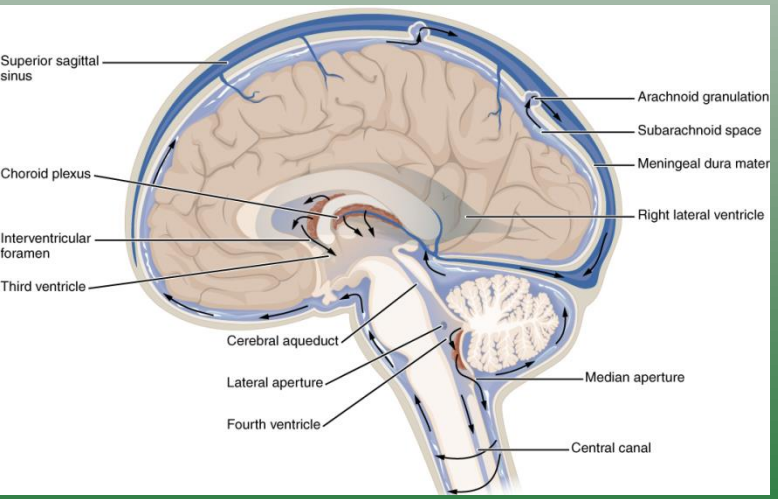




- Excess CSF accumulates in the skull.
  - Compresses brain tissue and blood vessels
  - Generally, CSF accumulates because more is produced than reabsorbed.
- If cranial sutures have not closed:
  - Infant's head enlarges beyond normal size
- Two types of hydrocephalus
  - **Noncommunicating** or obstructive hydrocephalus
  - **Communicating** hydrocephalus

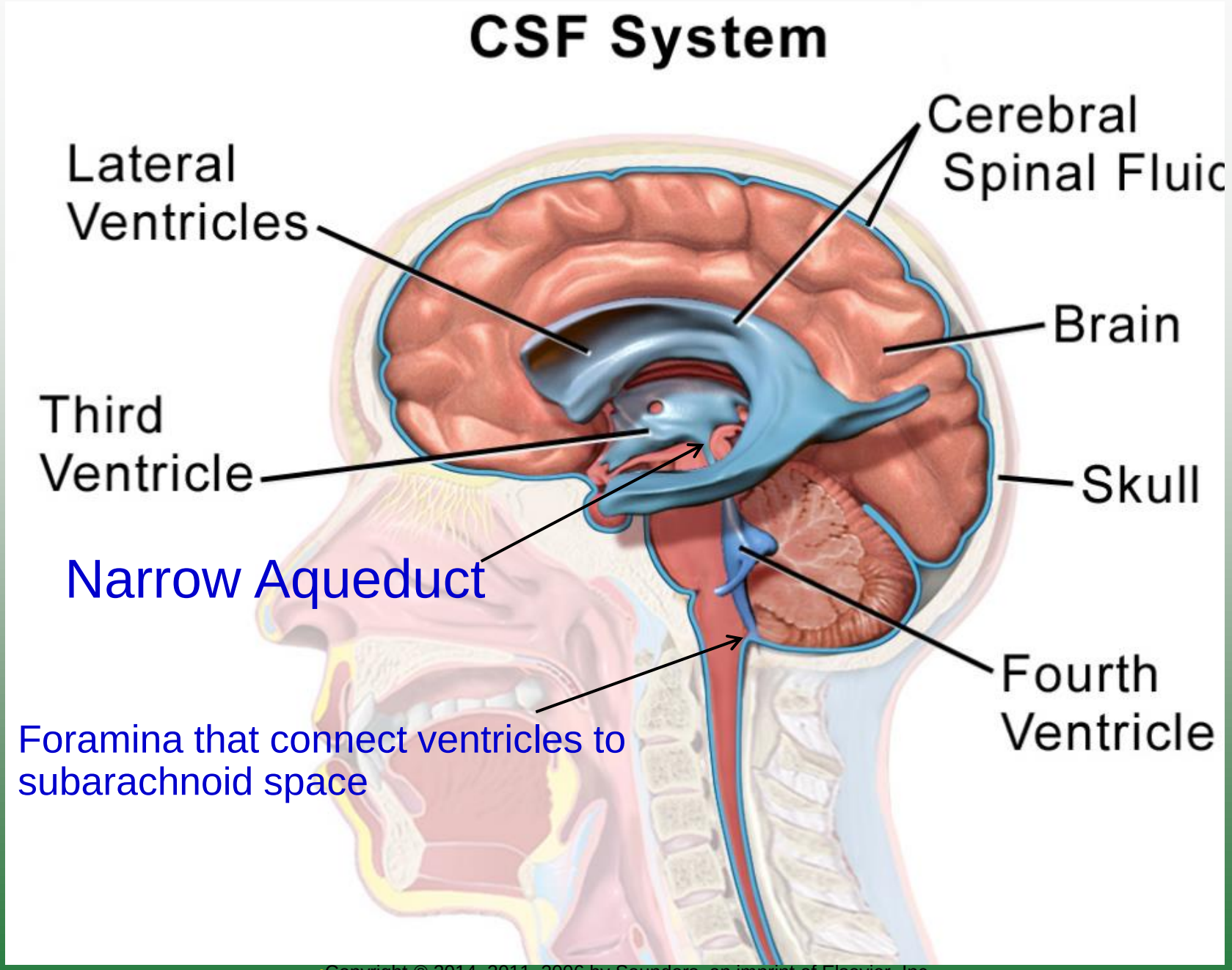
Hydrocephalus

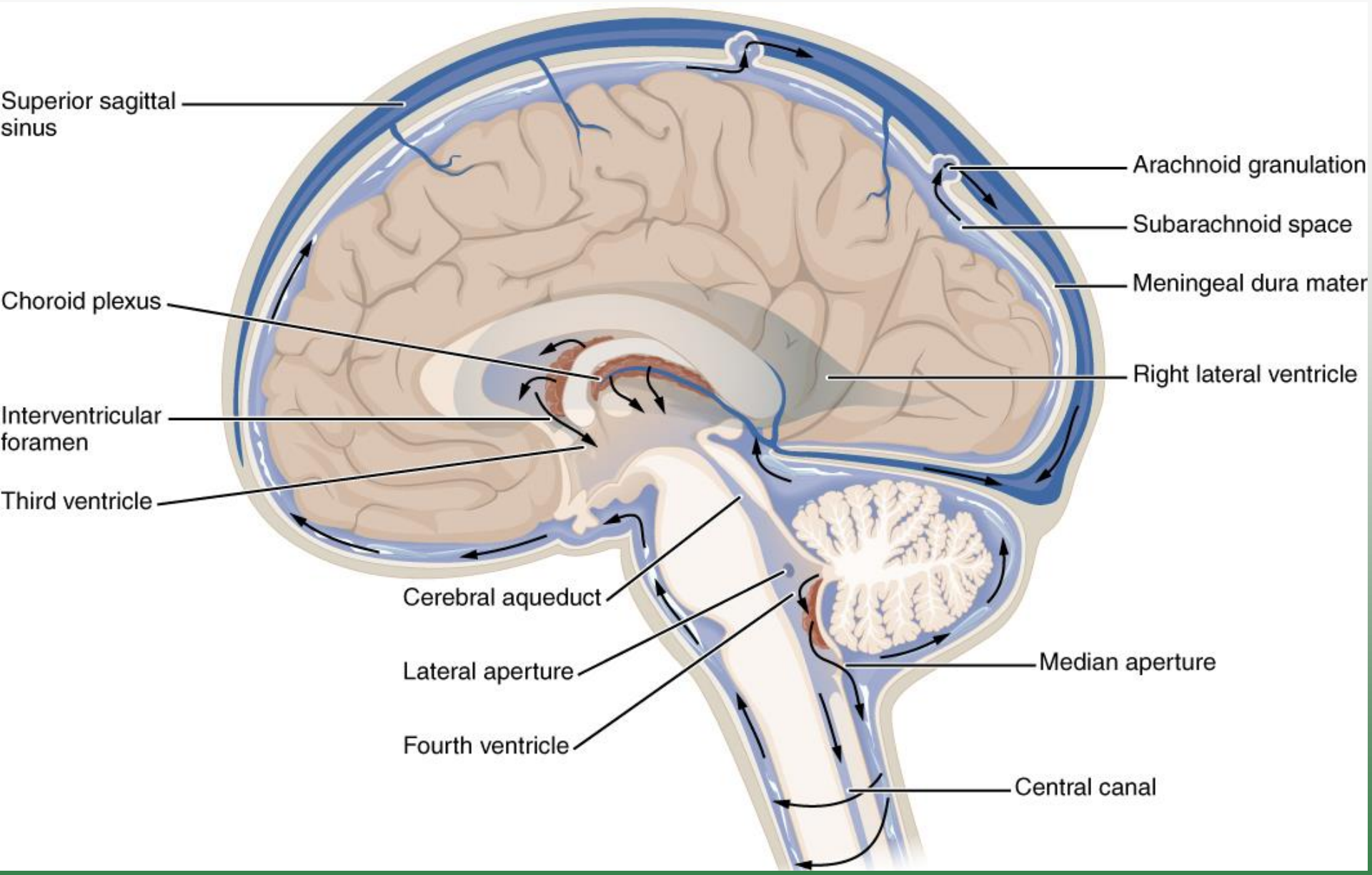




- Noncommunicating = interuption in cycling of fluid from ventricles to subarachnoid space, leads to build up in ventricles.
- *Note how narrow the cerebral aqueduct is just proximal to the forth ventricle. This is a vulnerable point that is easily obstructed. Fluid exist the ventricle system through foramina (holes) in the forth ventricle that give access to the subarachnoid space. Fluid in the subarachnoid space is reabsorbed into the blood stream with the help of arachnoid granulations (see pic this and next 2 slides).*
- Tumors, infection, & scar tissue can block the 4th ventricle, the foramina and/or the granulations.

CSF System

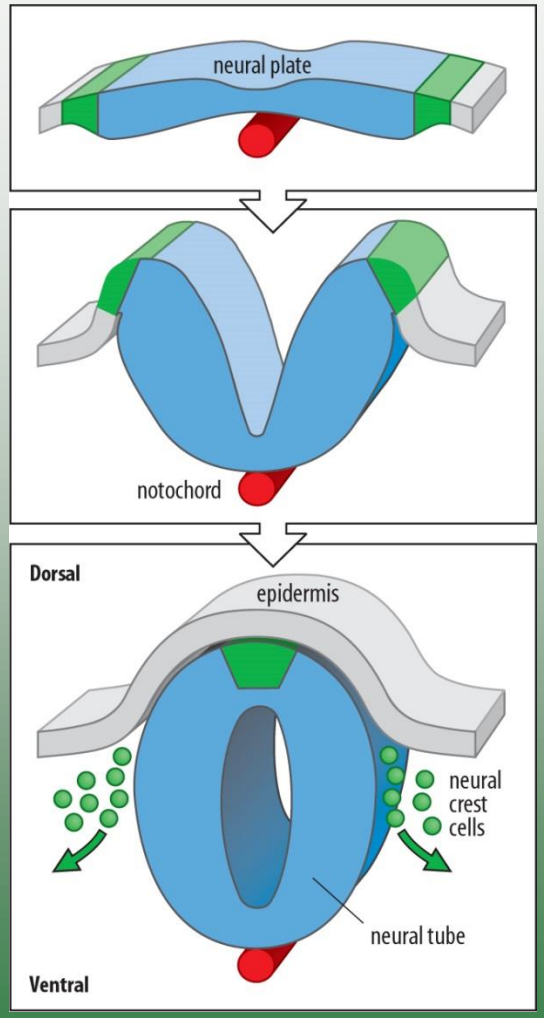




Hydrocephalus (Cont.)

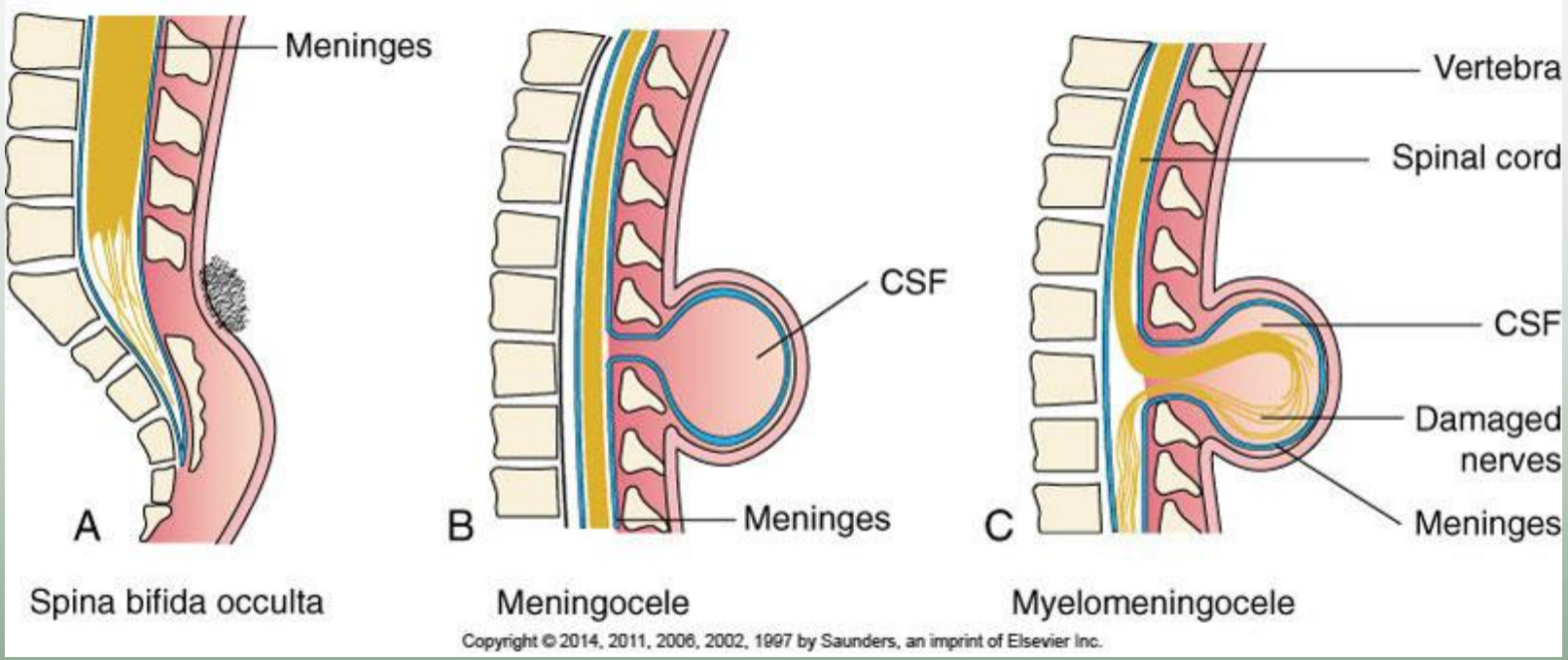
- Diagnostic tests
  - CT, MRI
    - Helps locate the obstruction or abnormal flow
    - Determines the size of the ventricles
- Treatment
  - Surgery
    - **To remove obstruction**
    - **Provides a shunt** for CSF from ventricle into the peritoneal cavity or other extracranial site
  - Shunt will have to be replaced as child grows

Spina Bifida



- Group of neural tube defects
- Common developmental abnormality
- The neural tube is the progenitor of the spinal cord. It develops from a plate that folds and makes a tube. If the fold does not fuse into a tube, development procedes with a “neural tube defect”

Spina Bifida



Spina bifida occulta: Bone defect only , skin intact, spinal cord intact.
Meningocele: Bone defect and meningeal sac covered by skin, spinal cord intact.
Myelomeningocele: Like meningocele, but spinal cord disrupted and herniates into sac.
There is also a type where there is a skin defect and exposed neural tissue.

Spina Bifida

- Appears to have multifactorial basis
  - Combination of genetic and environmental factors
    - Radiation, gestational diabetes, deficits of folic acid
  - High familial incidence
- Diagnostic tests
  - **Alpha-fetoprotein (AFP) level elevated in maternal blood**
    - Leaked from the defect
    - Specimen obtained at 16 to 18 weeks of gestation (amniocentesis)
  - **Diagnosis prenatally by ultrasound and/or amniotic fluid analysis**

Cerebral Palsy

- Group of disorders marked by motor impairment
- Caused by:
  - Genetic mutations, abnormal fetal formation of functional brain areas, infection, hypoxia or brain damage in the perinatal period
- Damage may occur before, during, or shortly after birth.
  - Brain tissue altered by malformation, mechanical trauma, hypoxia, hemorrhage, hypoglycemia, hyperbilirubinemia, infection → necrosis

Cerebral Palsy (Cont.)

- Single or multiple factors
- Hypoxia or ischemia—major brain damage
  - Can be caused by placental complications, difficult delivery, vascular occlusion, hemorrhage, aspiration, respiratory impairment in premature infant, high bilirubin levels
- Infection or metabolic abnormalities
  - Hypoglycemia in mother or child

Cerebral Palsy (Cont.)

- Patient's condition is related to the type and extent of the damage that may include:
  - Movement disorders.
  - Seizures.
  - Problems with vision and speech.
  - Paralysis
  - Cognitive functions (in some, while others that are neurologically devastated have very high cognitive function).

Chronic Degenerative Disorders

MS, Parkinson's, ALS, MG, Huntington's Dementia, Alzheimer's

Multiple Sclerosis (MS)

- **Progressive demyelination of neurons** in the brain, spinal cord, and cranial nerves
- Different types of MS
  - Variation in effects, severity, and progression
- Loss of myelin interferes with conduction of impulses in affected fibers
  - **May affect motor, sensory, and autonomic fibers**
  - Occurs in diffuse patches in the nervous system

Multiple Sclerosis (MS)

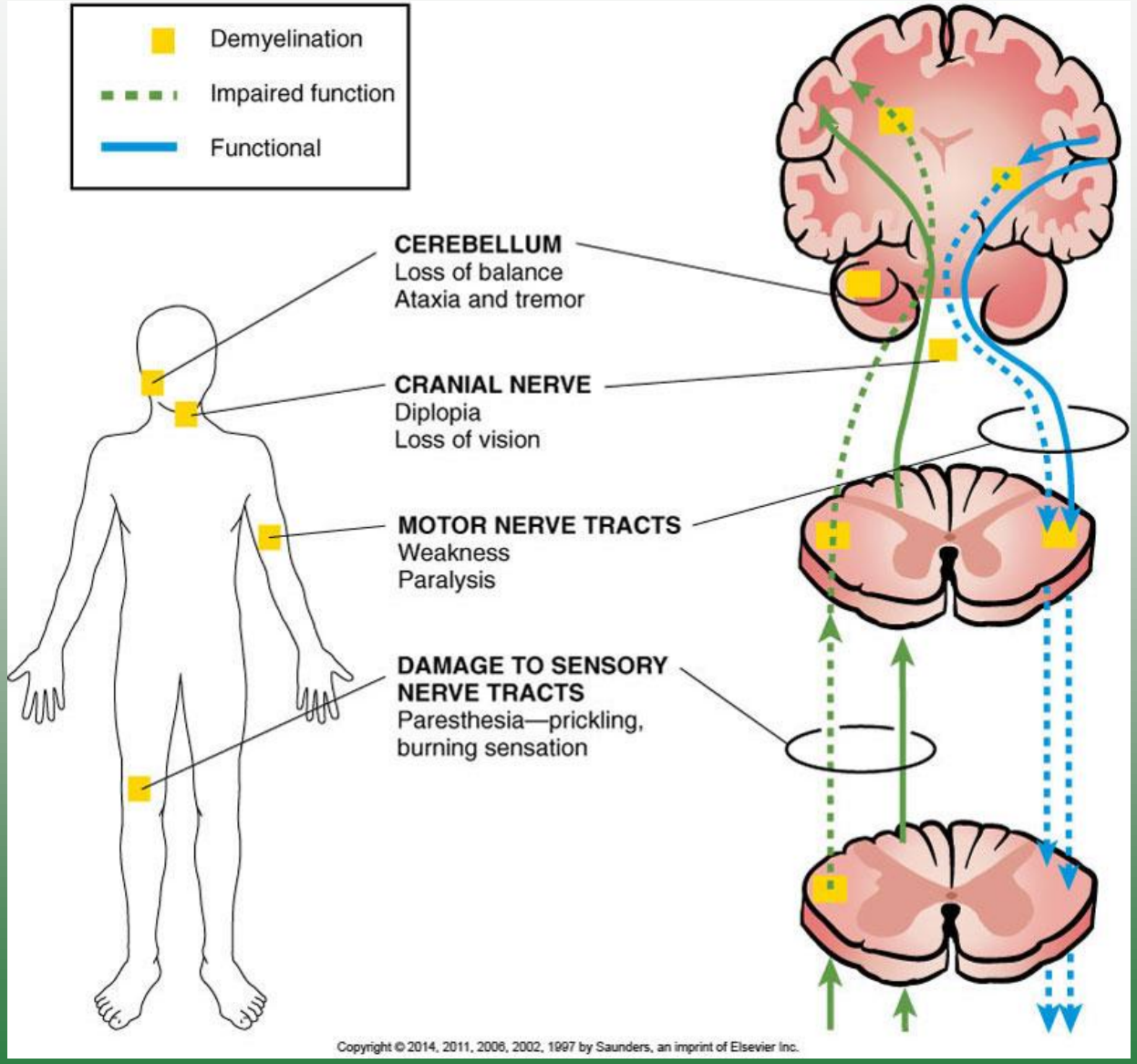
- Onset between 20 to 40 years of age.
- Cause unknown
  - May be an autoimmune disease
  - May be nutritional deficit
  - May be change in blood flow to neurons
  - May have genetic, immunological, and environmental components
- **Increased risk for close relatives of affected individuals**

*

Multiple Sclerosis (MS)

- Signs and symptoms (*some* may apply)
  - Manifestations determined by areas of demyelination
  - Blurred vision, weakness in legs
  - Diplopia (double vision), scotoma (spot in visual field)
  - Dysarthria
  - Paresthesia, areas of numbness, burning, tingling
  - Progressive weakness and paralysis extending to the upper limbs
  - Loss of coordination, bladder, bowel and sexual dysfunction, chronic fatigue

Multiple Sclerosis: Distribution of Lesions

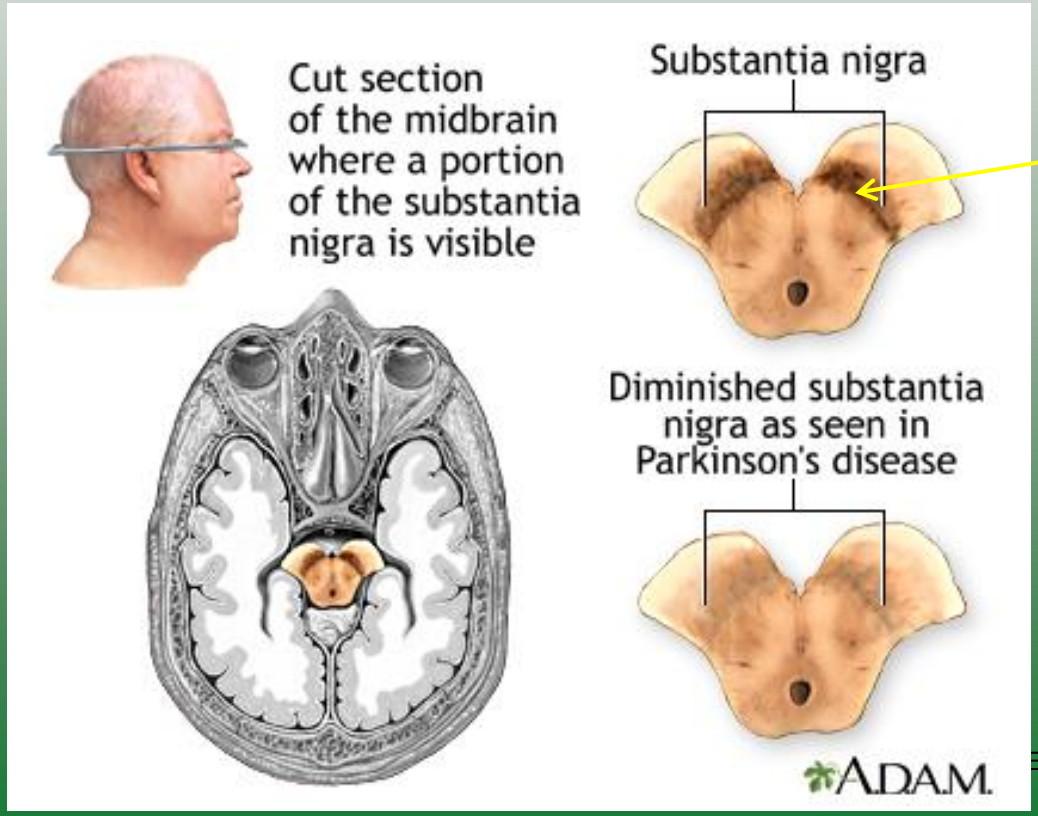


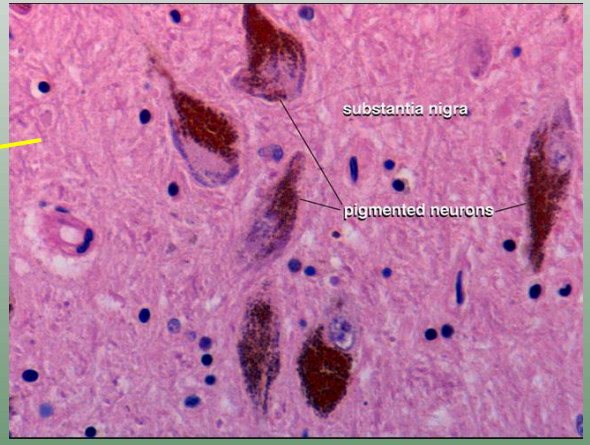
Multiple Sclerosis (MS) (Cont.)

- Diagnostic tests
  - No definitive test
  - MRI for diagnosis and monitoring
- Treatment
  - No definitive treatment approved at this time
  - Several research trials in progress
  - Therapy includes physical therapy, occupational therapy
  - Manifestations require individual attention.

Parkinson's Disease

- Progressive degenerative disorder
  - **Progressive degeneration (loss) of neurons in the "substantia niagra" (in the midbrain) that make dopamine.**





Parkinson's Disease (Cont.)

- Primary or idiopathic Parkinson's disease
  - Usually develops after age 60
- Secondary parkinsonism caused by:
  - Encephalitis
  - Trauma (e.g., sports injury)
  - Vascular disease
  - Drug-induced (e.g., phenothiazine tranquilizers)

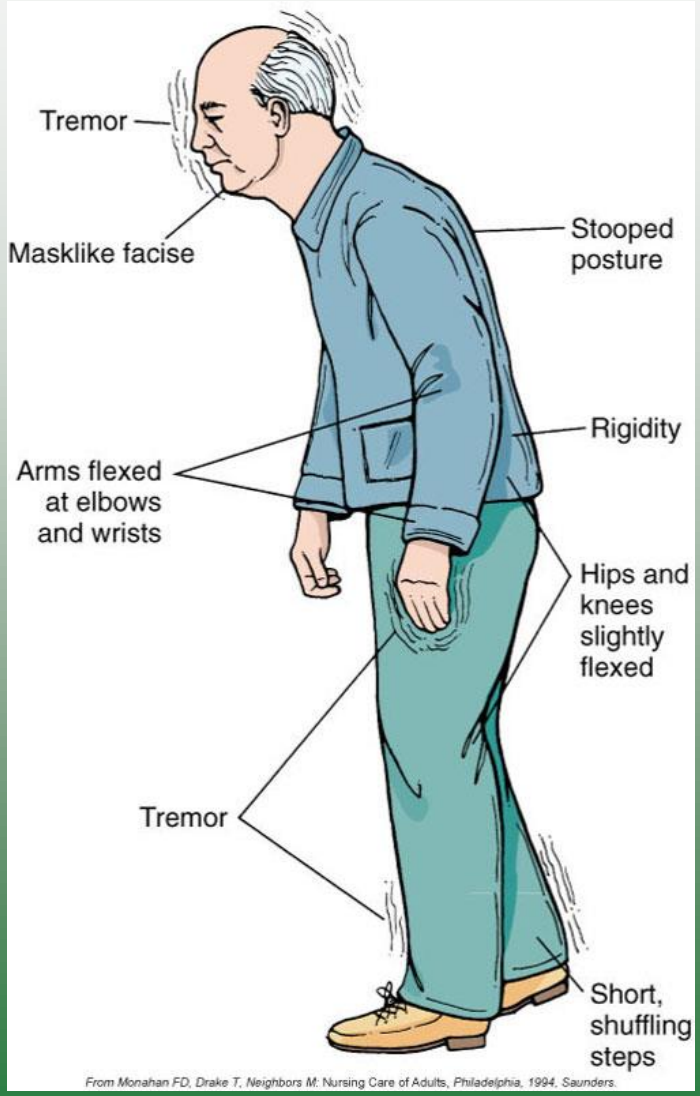
Parkinson's Disease (Cont.)

- Early signs and symptoms
  - Fatigue
  - Muscle weakness, muscle aching,
  - Decreased flexibility
  - Less spontaneous changes in facial expression
  - Tremors in the hands at rest, repetitive pill-rolling motions of hands

Parkinson's Disease (Cont.)

- Later signs and symptoms
  - Tremors affect hands, feet, face, tongue, lips
  - Increased muscle rigidity
  - Difficulty initiating movements
  - Slow movements
  - Lack of associated involuntary movements
  - Characteristic standing posture is stooped, leaning forward
  - Propulsive gait
  - Complex activities become slow and difficult.

Parkinson's Disease (Cont.)



Parkinson's Disease (Cont.)

- Treatment
  - Removal of cause, if known
  - Dopamine replacement therapy
    - Levodopa—dopamine precursor
  - Anticholinergic drugs
  - Speech and language pathologist
  - Physical therapy
  - Occupational therapy
    - Improves balance, coordination
  - Monitoring and treatment of respiratory and urinary tract infections

Amyotrophic Lateral Sclerosis (ALS)

- Also referred to as Lou Gehrig's disease
- No identified cause
  - Genes on various chromosomes have been linked to the disease.
- Progressive degenerative disease affecting **upper motor neurons in the cerebral cortex and lower motor neurons in brainstem and spinal cord**
- No indication of inflammation around the nerves
- **Cognition unimpaired**

Amyotrophic Lateral Sclerosis (ALS) (Cont.)

- Loss of upper motor neurons in cerebral cortex
  - Spastic paralysis and hyperreflexia
- Damage to lower motor neurons
  - Flaccid paralysis
  - Decreased muscle tone and reflexes
- Progressive muscle weakness and loss of fine motor coordination
  - Stumbling and falls are common.
- Death occurs because of respiratory failure.

Amyotrophic Lateral Sclerosis (ALS) (Cont.)

- Treatment
  - No specific treatment to slow degeneration
  - Stem cell therapy under investigation
  - Pharmaceutical treatment (e.g., with Riluzole [Rilutek]) to slow further damage to neurons
  - Moderate exercise and rest
  - Respiratory therapy, appropriate nutrition, speech pathology, occupational therapy, physical therapy, psychological treatment

Myasthenia Gravis

- **Autoimmune disorder**
- **Autoantibodies to acetylcholine (ACh) receptors form.**
  - Destruction of receptor site
    - Prevention of further muscle stimulation
  - Skeletal muscle weakness
  - Facial and ocular muscles usually affected first
  - **NOTE:** Dysphagia and aspiration are significant problems!

Myasthenia Gravis (Cont.)

- Diagnostic tests
  - Electromyography
  - Serum antibody test
- Signs and symptoms
  - Muscle weakness in face and eyes
  - Impaired vision, monotone speech
  - Difficult chewing and swallowing
  - Head droops, arms become weaker
  - Upper respiratory infections common

Myasthenia Gravis (Cont.)

- Treatment
  - Anticholinesterase agents
    - Temporary improvement of neuromuscular transmission
  - Glucocorticoids
    - Suppression of immune system
  - Plasmapheresis
    - Removal of antibodies from the blood
  - Thymectomy

Huntington's Disease

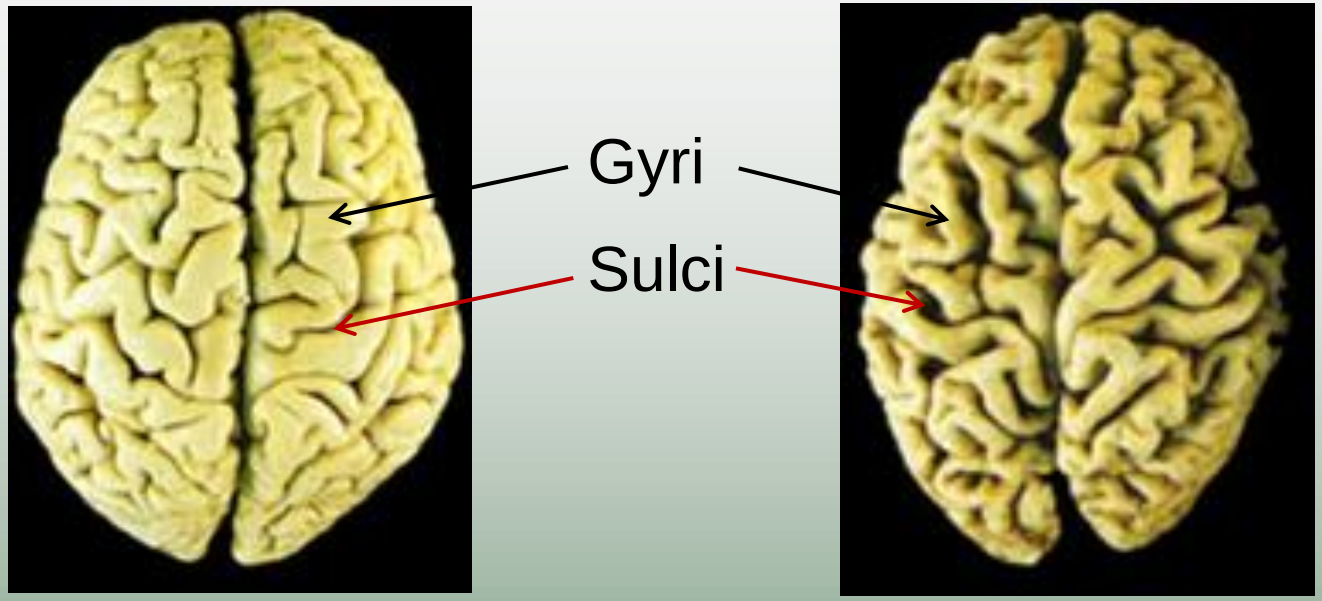
- **Inherited disease**
  - Autosomal dominant gene
    - Carried on chromosome 4
- Does not usually manifest until individual is older than 40 years
- **Progressive atrophy of brain**
  - Particularly in **basal ganglia (nuclei) and frontal cortex**
- **Depletion** of gamma-aminobutyric acid **(GABA)** in the basal nuclei

Huntington's Disease (Cont.)

- Signs and symptoms
  - Mood swings, personality changes
  - Restlessness, choreiform movements in arms and face
- Diagnostic tests
  - DNA analysis
- Treatment
  - Currently no therapy to slow progression of disease
  - Symptomatic therapy only

Dementia

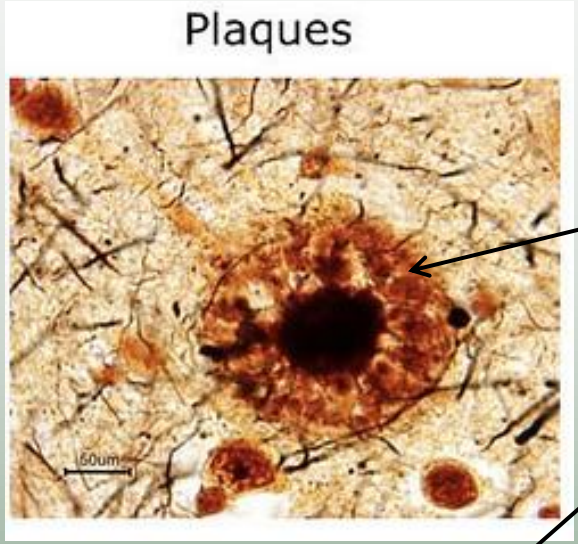
- Progressive chronic disease
  - **Cortical function is decreased.**
    - **Impaired cognitive skills**
    - **Impaired thinking, judgment, and learning**
    - **Memory loss**
    - **Confusion**
    - **Behavioral and personality changes**
- Many causes of dementia
  - Vascular disease
  - Infections
  - Genetic disorders



Normal Brain:
Gyri are full and sulci (grooves between gyri) are narrow.

Alzheimer Brain:
Gyri are narrow and sulci are wide.

Pathological Changes with Alzheimer's Disease



- Plaques
- Neurofibrillary Tangles.

Alzheimer's Disease (AD) (Cont.)

- Signs and symptoms
  - Extend over 10 to 20 years
  - Behavioral changes
    - Irritability, hostility, mood swings
  - Gradual loss of memory and lack of concentration
  - Impaired learning, poor judgment
  - Decline of cognitive function, memory, language
  - Change in food intake
  - Inability to recognize family, lack of environmental awareness, incontinence, inability to function

Alzheimer's Disease (AD) (Cont.)

- Treatment
  - No specific treatment
  - Anticholinesterase drugs
    - Some temporary improvement
  - Occupational therapy, psychologists, speech therapy
  - Team approach needed to support client and caregivers

Other Forms of Dementia

- **Vascular dementia**
  - **Caused by cerebrovascular disease**
  - Often a result of multiple small brain infarctions
  - Common in persons older than 70 years
    - Especially in those with hypertension
  - Onset insidious
    - Memory loss, apathy, inability to manage daily routines
  - Progression may be in stages.
  - Other neurologic impairment is common.

Other Forms of Dementia (Cont.)

- **Creutzfeldt-Jacob disease (CJD)**
  - Rare, rapidly progressive
  - **Caused by prion (an infectious protein) ingested or transmitted through contaminated blood**
  - May be iatrogenic
    - Invasive procedures, surgery (e.g., corneal transplantation) transfer prions
  - Most sporadic
  - Long incubation period
  - Memory loss, behavioral changes, motor dysfunction, progressive dementia

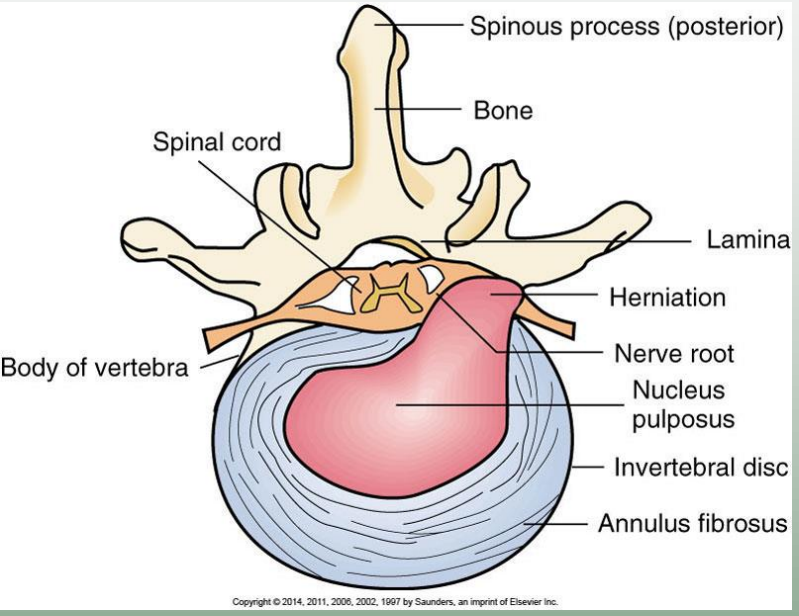
AIDS Dementia

- Common in later stages of AIDS
- Virus invades brain tissue
- May be exacerbated by other infections and tumors
- Gradual loss of memory and cognitive ability
- Impaired motor function
- Children with congenital HIV infection
  - Brain frequently affected
  - Severe developmental delay

Mental Disorders

- Classified in the *Diagnostic and Statistical Manual of Mental Disorders,* 5th edition (DSM-5)
- **Dysfunctions in the areas of behavior or personality**
- Biochemical and/or structural abnormalities may be identified.
- Genetic component possible
- Psychiatric illnesses are numerous and include:
  - Schizophrenia, delusional disorders, mood disorders, anxiety, panic disorders

Spinal Cord Problem



- Herniated intervertebral disk
  - Involves protrusion of the nucleus pulposus
  - Tear in capsule may occur suddenly or develop gradually with aging or obesity.
  - Sensory, motor, or autonomic function may be impaired.
  - Most common location—lumbosacral disks
  - Some herniations involve cervical disks.
  - If pressure is prolonged, severe permanent damage may occur.

Herniated Intervertebral Disk (Cont.)

- Diagnostic tests
  - Myelography with contrast dye
  - CT, MRI
- Treatment
  - Reduced weight-bearing, rest as needed
  - Application of heat, ice, traction
  - Drugs to relieve muscle spasm and pain
  - Physiotherapy and occupational therapy
  - Surgery in severe cases
    - Laminectomy or diskectomy, spinal fusion

END OF PART TWO