

# Nervous System

## **Neurology**

- The medical specialty that studies the anatomy and physiology of the nervous system and uses diagnostic tests, medical, surgical procedures, and drugs to treat nervous system diseases.

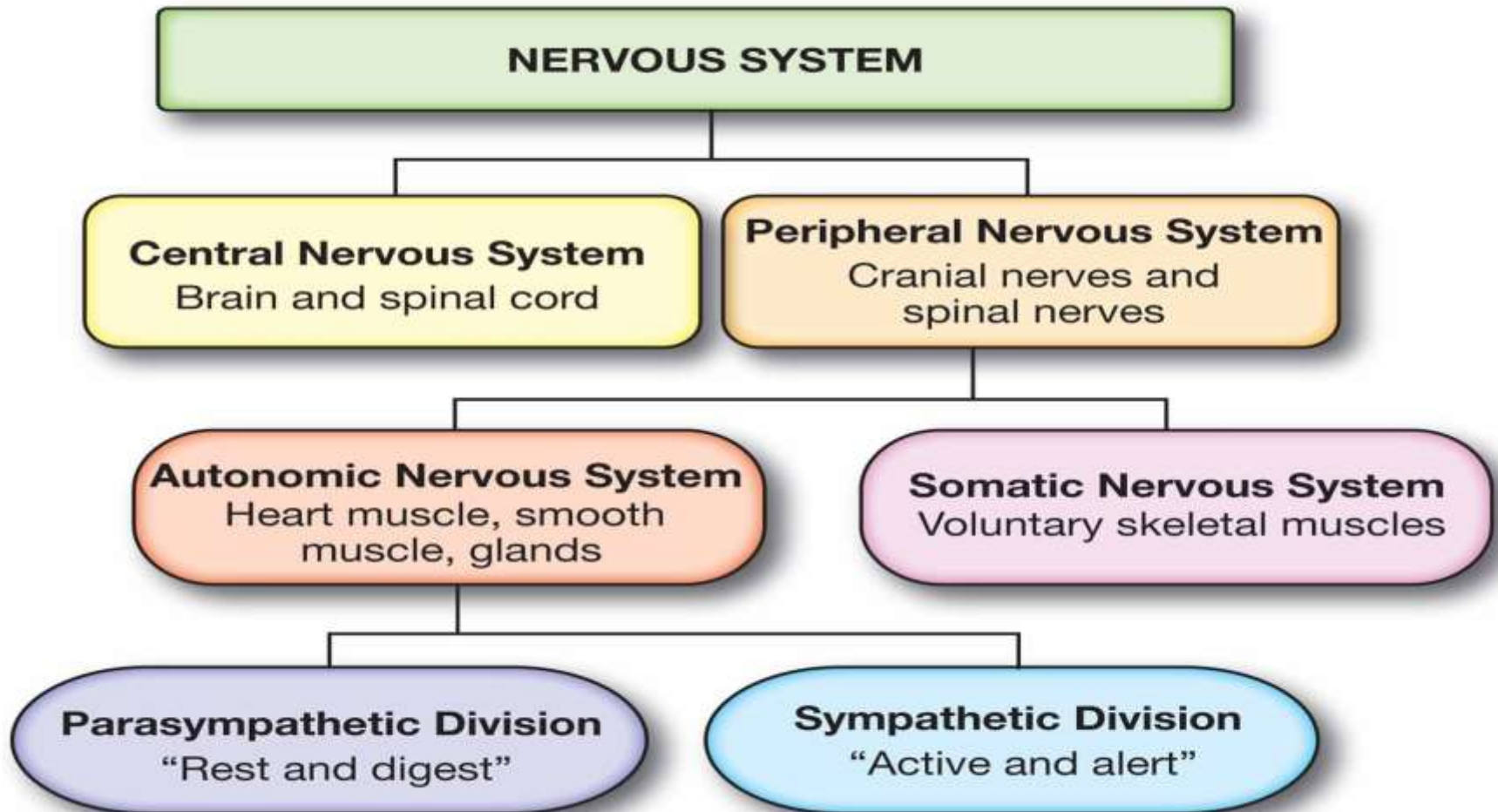
## **Functions of nervous system**

- Coordinates and controls body function by receiving information from both external and internal sensory receptors, then, using that information to adjust activity of muscles and glands to match needs of body
- Receives sensory input
- Makes decisions
- Orders body responses

## **Organs of nervous system**

- Brain
- Spinal cord
- Nerves

- Nervous system is divided into:
  - Central nervous system (CNS) which is consisted of:
    - Brain
    - Spinal cord
  - Peripheral nervous system (PNS) which is consisted of:
    - Cranial nerves
    - Spinal nerves

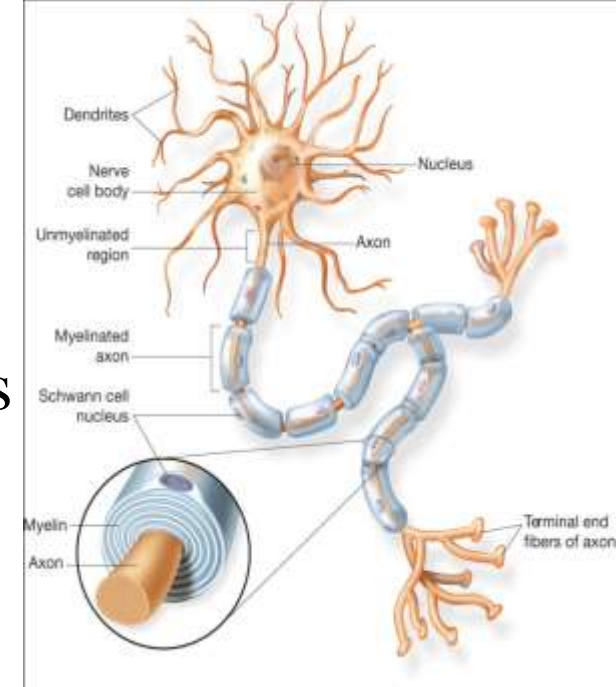


# Nervous tissues

- Composed of two types of cells
  - Neurons
  - Neuroglial cells

## Neurons

- Capable of conducting electrical impulses
- Neurons have three basic parts:
  - Dendrites: highly branched projections receiving impulses
  - Nerve cell body: contains nucleus & organelles
  - Axon: conducts electrical impulse to destination
- Synapse
  - Point where a neuronal axon meets dendrite of a neuron
- Synaptic cleft
  - Gap between two neurons in a synapse
- Neurotransmitter
  - Chemical released by axon to crosses gap to stimulate dendrite of second neuron



## **Neuroglial cells**

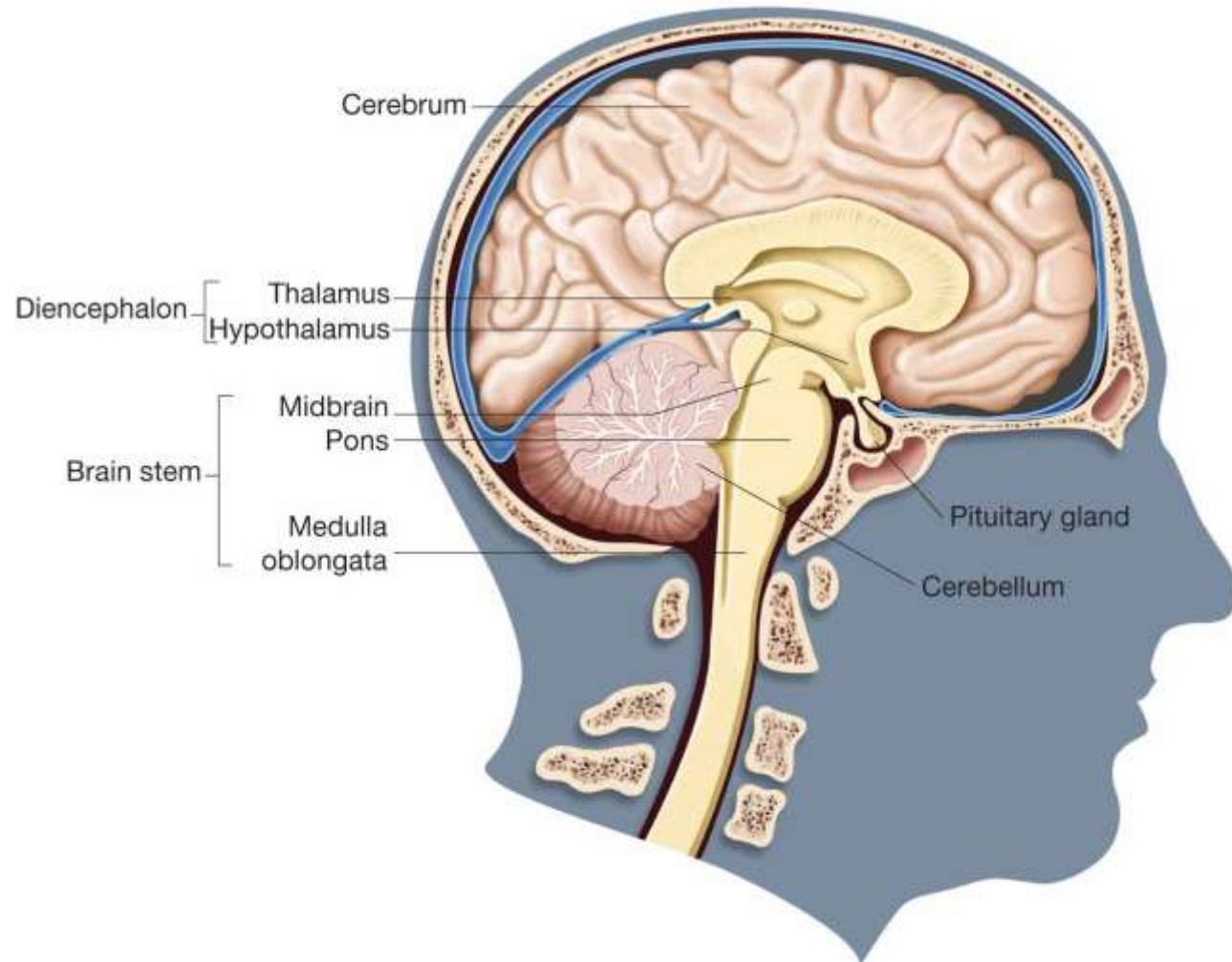
- Variety of cells, each has different support function for neurons but do not conduct electrical impulses
- Some neuroglial cells produce myelin that acts as insulation for many axons

## **Central nervous system** (brain and spinal cord)

- Function:
  - Receives impulses from all over body to process them
  - Responds with action
- Bundles of nerve fibers interconnecting different parts of CNS are called tracts
- Consists of both gray and white matter
- Gray matter: comprised of unsheathed cell bodies and dendrites
- White matter: myelinated nerve fibers

# Brain:

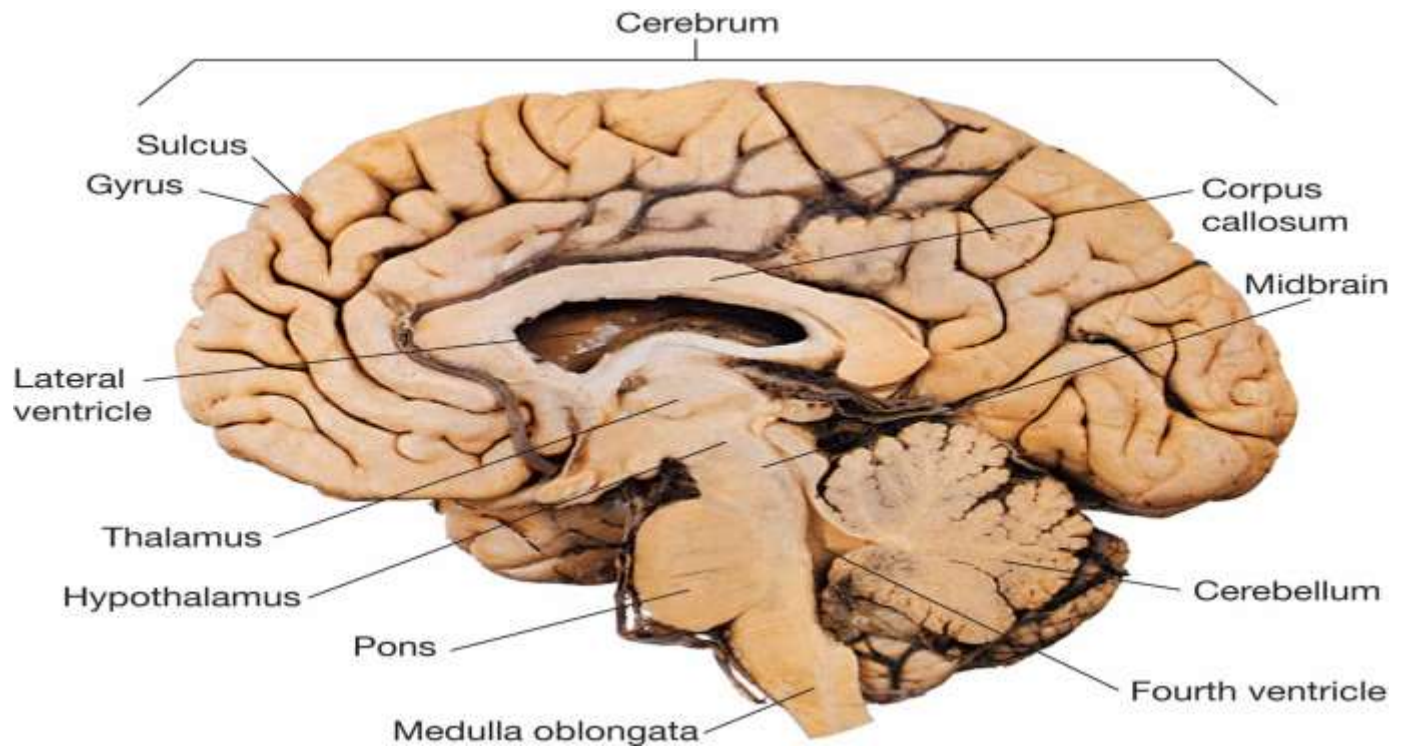
- One of the largest organs in body
- Coordinates most body activities
- It is consisted of four sections
  - Cerebrum
  - Cerebellum
  - Diencephalon
  - Brain stem



# Cerebrum: largest and upper portion

## - Functions:

- 1- Thoughts
  - 2- Judgment
  - 3- Memory
  - 4- Association skills
  - 5- Ability to discriminate between items
- Cerebral cortex: outer layer of cerebrum, composed of folds of gray matter
  - Gyri: elevated portions of the cerebrum
  - Sulci: fissures between gyri



# Lobes of cerebrum

- Subdivided into left and right halves (cerebral hemispheres)
- Right hemisphere
  - Recognizes faces, patterns, three-dimensional structures
  - Analyzes the emotional content of words but not the actual words
- Left hemisphere
  - Performs mathematical and problem-solving
  - Coordinates the recall of memories
  - Contains the speech center and is important in language skills
- Each hemisphere has four lobes:
  - A- Frontal lobe: most anterior lobe
    - Controls motor function, personality, and speech
  - B- Parietal lobe: most superior portion
    - Receives & interprets nerve impulses and language



C- Occipital lobe: most posterior which controls vision

D- Temporal lobe

- Left and right lateral portion
- Controls hearing and smell

## **Diencephalon**

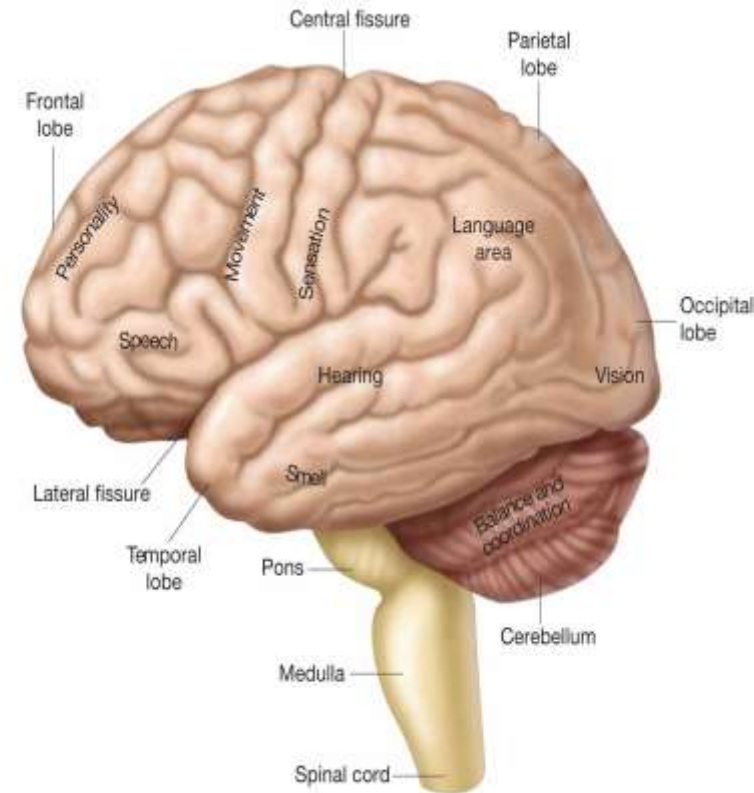
- Located below cerebrum
- Contains:

1- Thalamus

- Center for relaying impulses from eyes, ears, and skin to cerebrum
- Controls perception of pain

2- Hypothalamus

- Controls body temperature, appetite, sleep and sexual desire
- Controls autonomic nervous system, cardiovascular system, gastrointestinal system, and release of hormones from pituitary gland



## **Cerebellum**

- Second largest portion of brain
- Located beneath posterior part of cerebrum
- Aids in:
  - Coordinating voluntary body movements
  - Maintaining balance and equilibrium

**Brain Stem** has three components:

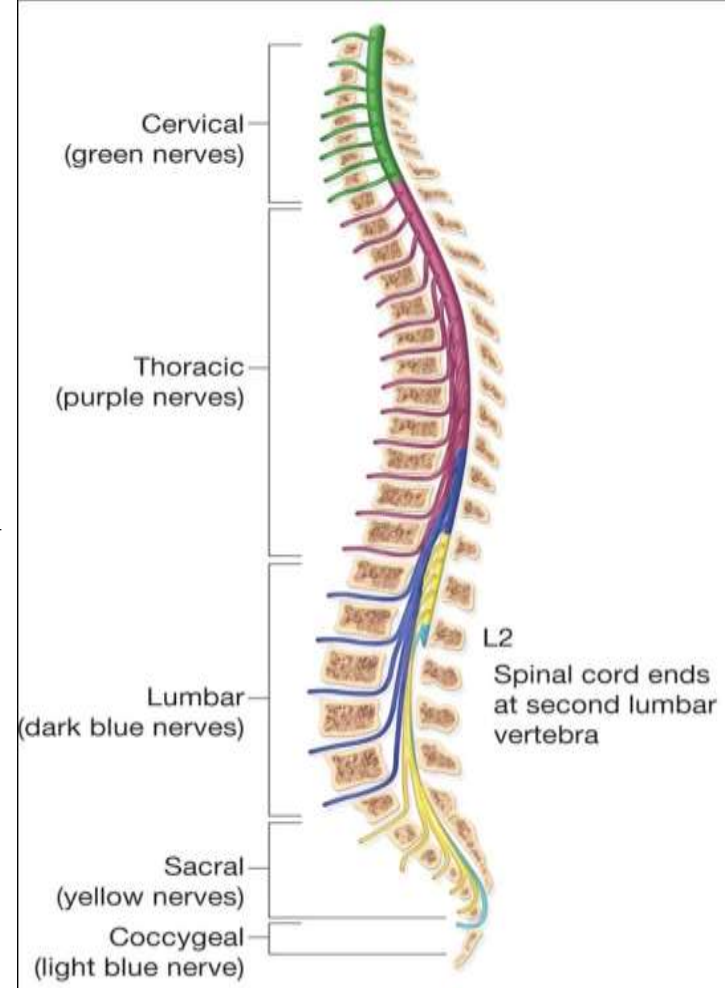
- Midbrain: a pathway for impulses between brain and spinal cord
- Pons: means bridge that connects cerebellum to rest of brain
- Medulla oblongata: most inferior portion of brain that connects it to spinal cord

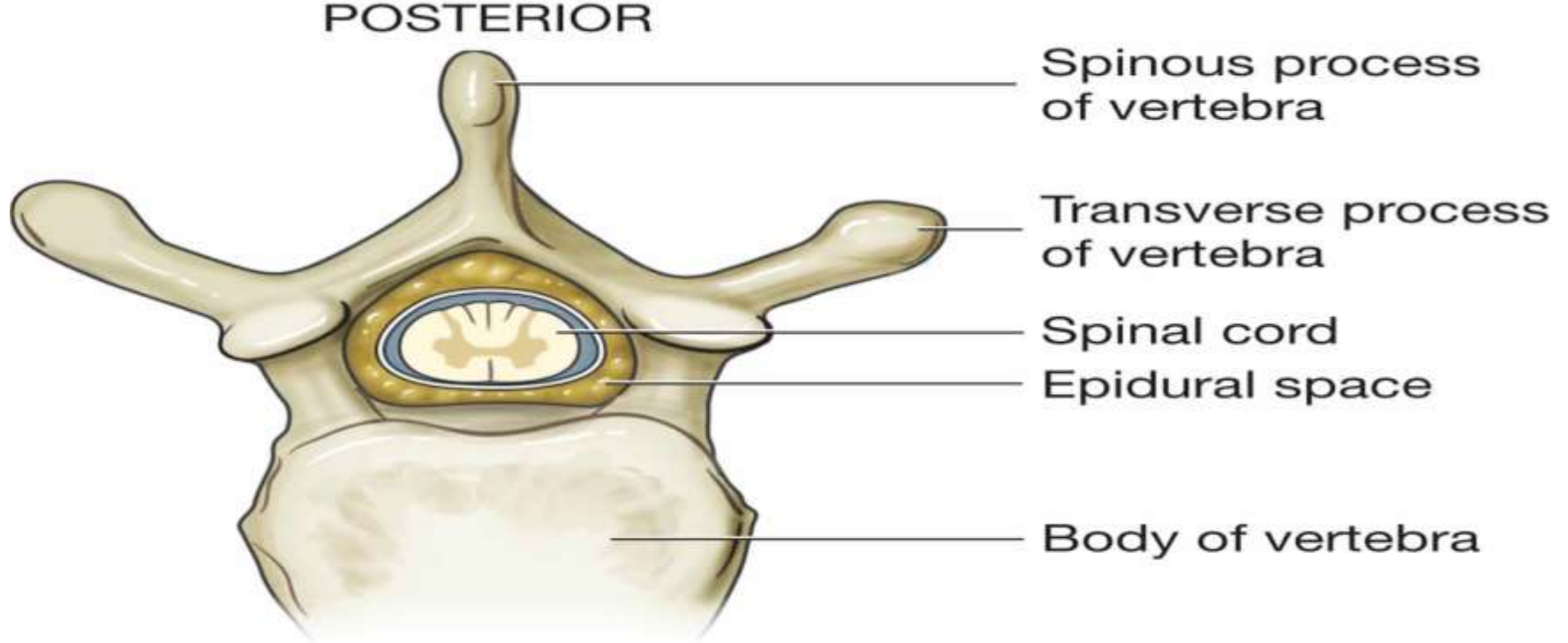
**Brain ventricles** (interconnected)

- Cavities containing cerebrospinal fluid (CSF) (watery, clear fluid)
  - CSF provides shock protection for CNS
- Locations:
  - One in each cerebral hemisphere
  - One in thalamus
  - One in front of cerebellum

# Spinal cord

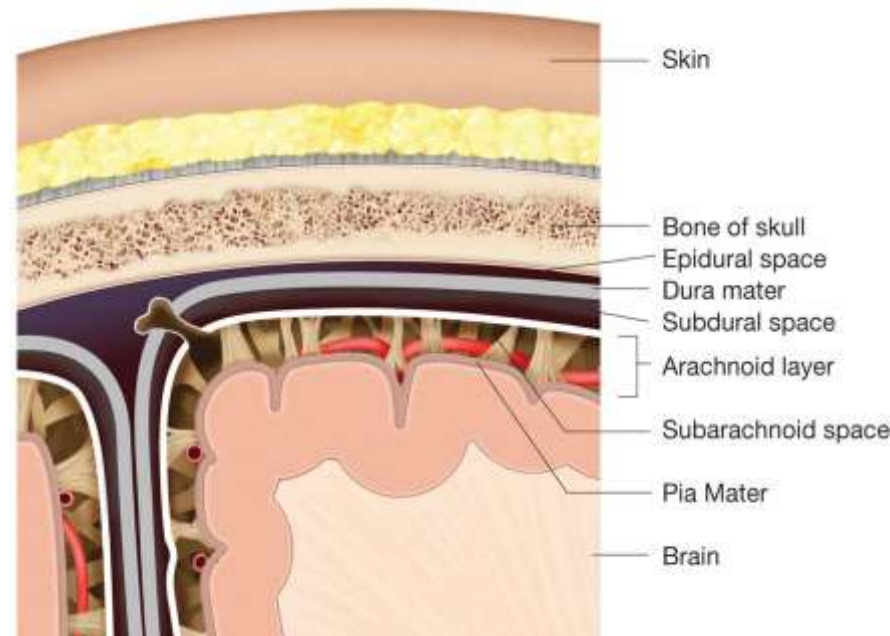
- Extends from medulla oblongata to second lumbar vertebra
- Within vertebral column
  - 33 vertebrae of back bone
  - Line up to form continuous canal
  - Called spinal cavity or vertebral canal
- Protected by CSF
  - Flows through central canal down through spinal cord
- Outer portion of spinal cord contains two types of tracts
  - 1- Ascending tracts carry sensory information up to brain
  - 2- Descending tracts carry motor commands down from brain to peripheral nerve





## Meninges

- Protective membrane sacs
- Encases entire CNS
- Consists of three layers:
  - Dura mater (tough mother)
  - Arachnoid layer (spider-like)
  - Pia mater (soft mother)



## Peripheral nervous system (PNS)

- Consists of:
  - 12 pairs of cranial nerves
  - 31 pairs of spinal nerves
- Cranial nerves: arise from brain
- Spinal nerves
  - Split off from spinal cord at regular intervals
  - One pair (left and right) exit between each pair of vertebrae

## Nerves

- A nerve:
  - Is a bundle of axon fibers located outside CNS
  - Carries messages between CNS and various parts of body
- Nerve root
  - Point where nerve is attached to CNS
- Names of most nerves reflect:
  - Organ the nerve serves
  - Portion of body the nerve is traveling through

# Cranial nerves

I	Olfactory	sense of smell
II	Optic	sense of sight
III	Oculomotor	controls eye muscles and pupil of eye
IV	Trochlear	controls oblique muscles of eye
V	Trigeminal	facial sensation and controls muscles for chewing
VI	Abducens	controls eyeball muscles to turn eye to side
VII	Facial	controls facial muscles for expression, salivation, and taste on 2/3 of tongue
VIII	Vestibulocochlear	sense of equilibrium and hearing
IX	Glossopharyngeal	sensation from pharynx and taste on 1/3 of tongue
X	Vagus	supplies most organs in abdomen and thorax
XI	Accessory	controls neck and shoulder muscles
XII	Hypoglossal	controls tongue muscles

## **Neurons**

- Each nerve can carry information both to and from CNS
- But any individual neuron can carry information in only one direction
- Either an:
  - 1- Afferent neurons (sensory neurons) from sensory receptor to CNS
  - 2- Efferent neurons (motor neurons) from CNS to muscles or glands

## **Divisions of PNS** (each division serves different area of body)

- Nerves of PNS are subdivided into two divisions
  - Autonomic nervous system (ANS)
  - Somatic nerves

## **Autonomic nervous system (ANS)**

- Controls involuntary or unconscious bodily functions
- It may increase or decrease the activity of:
  - Smooth muscle found in viscera and blood vessels
  - Cardiac muscle of heart
  - Glands

ANS divided into 2 branches:

### Sympathetic branch

- Stimulates body in times of stress and crisis
- Increases heart rate, dilates airways, increases blood pressure, inhibits digestion, and stimulates production of adrenaline

### Parasympathetic branch

- Serves as counterbalance for sympathetic nerves
- Causes ↓ heart rate, ↓ blood pressure, and stimulates digestion

### Somatic Nerves

- Involved with conscious and voluntary activities of body
- Serve skin and skeletal muscles
  - Carry information from sensory receptors of skin
    - Such as touch, temperature, pressure, and pain
  - Carry motor commands to skeletal muscles



## Nervous System Combining Forms

cephal/o	head	cerebell/o	cerebellum
cerebr/o	cerebrum	encephal/o	brain
gli/o	glue	medull/o	medulla
mening/o	meninges	meningi/o	meninges
myel/o	spinal cord	neur/o	nerve
phas/o	speech	poli/o	gray matter
pont/o	pons	radicul/o	nerve root
thalam/o	thalamus	thec/o	sheath (meninges)
ventricul/o	ventricle		

## Nervous System Suffixes

–algnesia	pain, sensitivity	–esthesia	feeling, sensation
–paresis	weakness	–phasia	speech
–plegia	paralysis	–taxia	Muscle coordination

## **Word Building with cephal/o, cerebell/o and cerebr/o**

–algia	cephalalgia	head pain
–ar	cerebellar	pertaining to cerebellum
–itis	cerebellitis	inflammation of cerebellum
–al	cerebral	pertaining to cerebrum
spin/o –al	cerebrospinal	pertaining to cerebrum and spine

## **Word Building with encephal/o, meningi/o and mening/o**

electr/o –gram	electroencephalogram	record of brain electricity
–itis	encephalitis	brain inflammation
–oma	meningioma	meninges tumor
–eal	meningeal	pertaining to meninges
–itis	meningitis	meninges inflammation

## Word Building with neur/o

–al	neural	pertaining to nerve
–algia	neuralgia	nerve pain
–ectomy	neurectomy	removal of nerve
–ologist	neurologist	nerve specialist
–oma	neuroma	nerve tumor
–pathy	neuropathy	nerve disease
–plasty	neuroplasty	surgical repair of nerve
poly–    –itis	polyneuritis	inflammation of many nerves
–rrhaphy	neurorrhaphy	suture a nerve

## Word Building with myel/o and pont/o

–gram	myelogram	spinal cord record
–itis	myelitis	inflammation of spinal cord
–ine	pontine	pertaining to pons

## Word Building with radicul/o, thalam/o and thec/o

–itis	radiculitis	nerve root inflammation
–pathy	radiculopathy	nerve root disease
–ic	thalamic	pertaining to thalamus
intra– –al	intrathecal	pertaining to inside meninges

# Nervous System Vocabulary

anesthesiology	the use of anesthesia for surgical procedures, resuscitation, and pain management
neurosurgery	treating nervous system disease by surgical means
aura	sensations occurring prior to epileptic seizure or migraine; such as seeing colors
conscious	awake and aware of surroundings
unconscious	unaware of surroundings; unable to respond to stimuli
coma	state of profound unconsciousness
convulsion	alternating between strong involuntary muscle contractions and relaxations
seizure	sudden, uncontrollable onset of symptoms; such as in epileptic seizure
focal seizure	seizure in only one limb or body part
carpal Tunnel syndrome	Pinching or compression of median nerve within the carpal tunnel

paresthesia	abnormal sensations such as burning or tingling
tremor	involuntary repetitive alternating movements
delirium	confusion, disorientation, and agitation
dementia	impaired intellectual function
encephalitis	Inflammation of the brain or spinal cord tissues
meningitis	Serious bacterial infection of meninges
syncope	fainting or temporary loss of consciousness
quadriplegia	paralysis of the trunk, legs, and pelvic organs with partial or total paralysis in the upper extremities caused by severe injury to the spinal cord between the 5th and 7th cervical vertebrae
Palsy	loss of ability to control movements

hemiparesis	weakness on one side of body
paralysis	temporary or permanent loss of voluntary movement
hemiplegia	paralysis on one side of body
paraplegia	paralysis of lower portion of body
lethargy	abnormal inactivity or lack of response to normal stimuli
cerebral concussion	brief interruption of brain function, usually with loss of consciousness lasting for a few seconds
headache (cephalgia)	Acute or chronic pain anywhere within the cranial cavity varying in intensity from mild to severe

# Brain Pathology

Alzheimer's disease	disorder characterized by progressive dementia, disorientation, apathy, and loss of memory
astrocytoma	malignant tumor originating in astrocytes, a neuroglial cell
brain tumor	intracranial mass; may be malignant or benign; dangerous because occupies space
cerebral aneurysm	ballooning of cerebral artery; may cause stroke
cerebral contusion	bruising of brain from impact; symptoms last longer than 24 hrs; include unconsciousness, dizziness, vomiting, unequal pupils
aphasia	class of language disorder ranges from having difficulty remembering words to being completely unable to speak
vertigo	where there is a feeling of motion when one is stationary

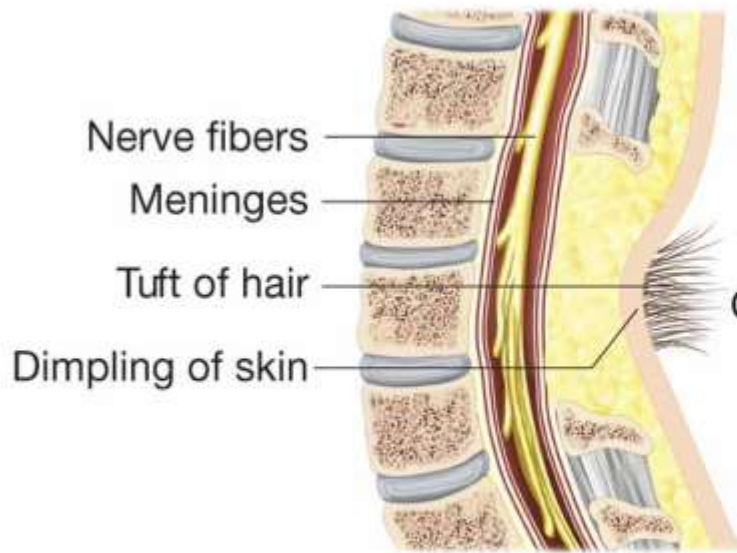


peripheral neuritis	inflammation of one or more peripheral nerves
skull fracture	broken segment of the skull bone thrust into the brain as a result of a direct force, usually a blunt object
multiple sclerosis	degenerative inflammatory disease of the central nervous system attacking the myelin sheath in the spinal cord and brain
cerebrovascular accident (CVA)	infarct due to loss of blood supply to brain; may be due to hemorrhage, thrombus, embolus, or compression; commonly called a stroke
transient ischemic attack (TIA)	temporary interference with blood supply to brain; may lead to a CVA
migraine	specific type of headache with severe pain, light sensitivity, dizziness, and nausea
epilepsy	seizures and loss of consciousness caused by uncontrolled electrical activity of brain

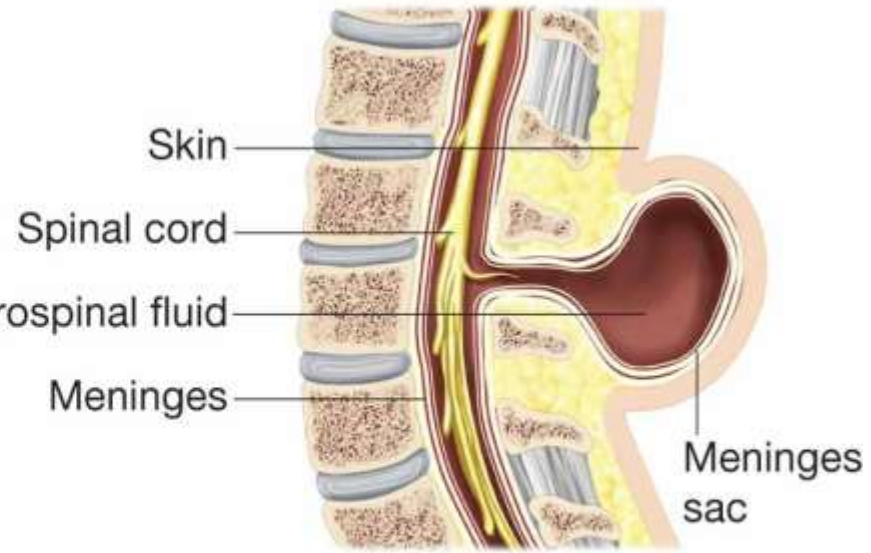
absence seizure	epileptic seizure characterized by loss of awareness and absence of activity; formerly called petit mal
anencephaly	Brain fails to form during fetal development, baby is usually stillborn or dies shortly after birth
hydrocephalus	accumulation of CSF within brain ventricles
Parkinson's disease	chronic disorder of brain with tremors, weakness, muscle rigidity, and shuffling gait
Reye syndrome	acute encephalopathy and organ damage; follows viral infection and associated with taking aspirin
cerebral palsy (CP)	brain damage results from defect, trauma, or oxygen deprivation at time of birth

# Spinal Cord Pathology

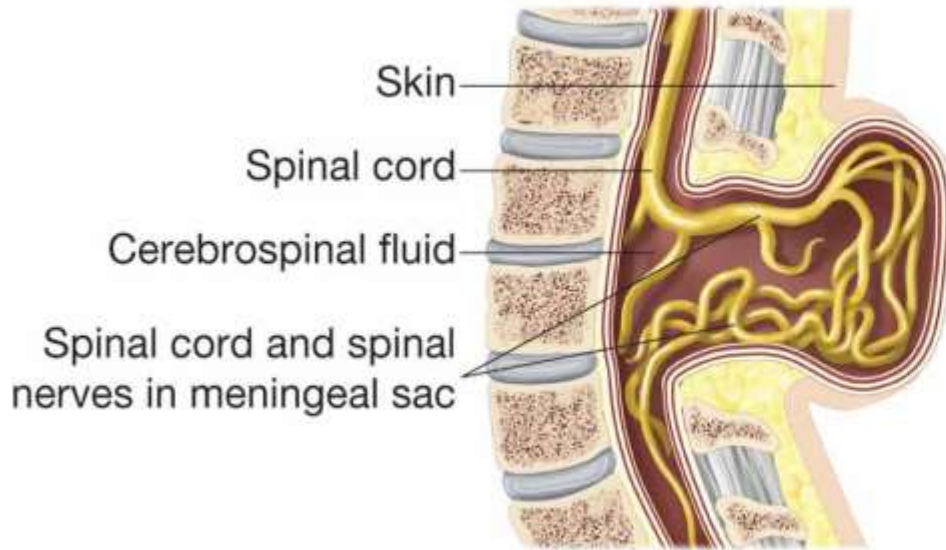
poliomyelitis	viral infection affecting spinal cord; paralysis may be mild and temporary or severe and permanent
spinal cord injury (SCI)	damage to spinal cord due to trauma; may be bruised and recover or severed and permanent
spina bifida	congenital defect where lamina of vertebra do not meet or close to form spinal canal, defect covered only by the meninges
myelomeningocele	protrusion of meninges and spinal cord through opening left by spina bifida defect
meningocele	protrusion of meninges sac through opening left by spina bifida defect



**A. Spina bifida**



**B. Meningocele**



**C. Myelomeningocele**

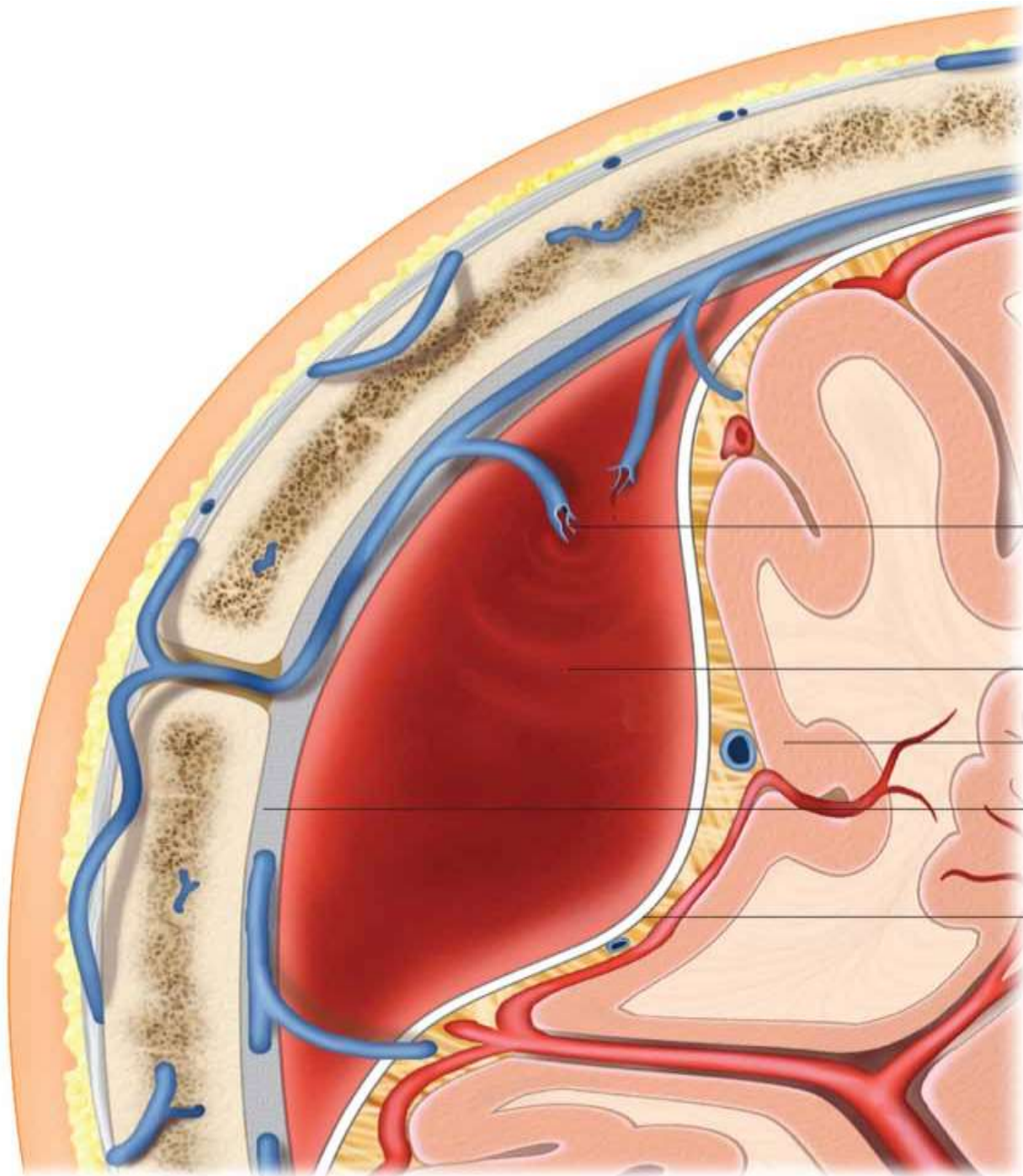
## Nerve Pathology

Bell's palsy	one-sided facial paralysis due to inflammation of facial nerve caused by virus
Guillain-Barré syndrome	temporary loss of myelin sheath; may be autoimmune; starts in legs and progresses up nervous system
myasthenia gravis	muscular weakness and fatigue due to insufficient neurotransmitter at synapses
shingles	eruption of painful blisters on body along a nerve path; caused by <i>Herpes zoster</i> virus

## Meninges Pathology

epidural hematoma	mass of blood in space outside dura mater
subdural hematoma	mass of blood forming inside subdural space; due to torn meningeal blood vessel; space occupying lesion





Torn cerebral vein

Subdural hematoma

Compressed brain tissue

Dura mater

Arachnoid layer

## Clinical Laboratory Tests

cerebrospinal fluid analysis	examination of CSF; may detect infections and blood in the fluid
Lumbar puncture	Insertion of a needle and syringe into the lumbar area of the spine, used to withdraw a sample of cerebrospinal fluid (CSF) for analysis

## Diagnostic Imaging

brain scan	image of brain after injection of radioactive isotopes into bloodstream
cerebral angiography	X-ray of cerebral blood vessels after injection of radiopaque dye
echoencephalography	ultrasound image of brain
Computed tomography	The use of a computer to generate three-dimensional images, effective in diagnosis of brain and spinal cord disorders as tumors

Myelography	X-ray of spinal cord after injection of radiopaque dye
positron emission tomography (PET)	use of positive radionuclides to construct an image of the brain; image reveals metabolic activity of brain areas
Babinski's reflex	reflex test that reveals nervous system lesions; performed by stroking sole of foot
electroencephalography	records the electrical activity of brain
electromyography	Recording of electrical signals from the muscle at rest and during contraction, used to evaluate the muscle health and its response to electrical stimuli
Romberg test	Examination used to evaluate cerebellar function and balance
nerve conduction velocity	measures speed at which an impulse travels along a nerve; reveals nerve damage



magnetic resonance imaging	noninvasive scanning procedure that provides visualization of fluid, soft tissue, and bony structures without the use of radiation
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## **Surgical Treatments**

cerebrospinal fluid shunt	shunt carries CSF from ventricle to abdominal cavity; treats hydrocephalus
laminectomy	removes part of vertebra; relieves pressure on spinal nerve
cryosurgery	exposure of abnormal tissue to super freezing, used to treat tumors and pain and control bleeding
Thalamotomy	Destruction of a very small area of the thalamus, used to control tremors in Parkinson disease
craniotomy	surgical procedure to create an opening in the skull to gain access to the brain
tractotomy	surgical cut of nerve tract; treats severe chronic pain

trephination	Production of a circular opening into the skull using a special device called a <i>trephine</i> , used to reveal brain tissue or relieve intracranial pressure
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## Nervous System Pharmacology

analgesic	treats minor to moderate pain, non-narcotic
anesthetic	produces loss of sensation or consciousness
anticonvulsant	reduces nerve excitability to prevent seizures
dopaminergic drugs	treats Parkinson's disease
hypnotic	promotes sleep
narcotic analgesic	treats severe pain
sedative	calming or relaxing effect