

## The Joints – joining of 2 bones divided into Structural/Functional joints

**Structural Joints (Component):** Fibrous, Cartilaginous, Synovial

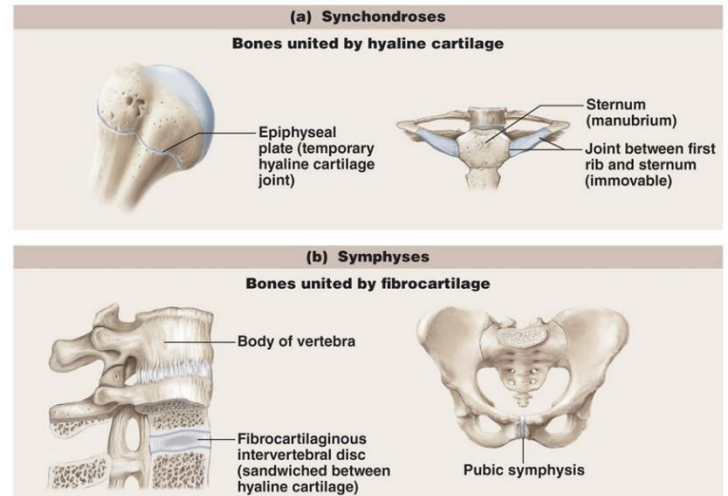
**Functional Joints (Movement):** Synarthroses, Amphiarthroses, Diarthroses

**Fibrous Joints:** Fibrous CT joint – little/no movement

1. **Sutures:** **no movement** - bones of skull, lines along two bones
2. **Syndesmoses:** **slight/no movement** - Cord/Sheet (ligament/interosseous membrane)
3. **Gomphoses:** **no movement** - teeth in bony socket

**Cartilagenous Joints:** bones joined with **cartilage**- no joint cavity

1. **Symphondroses:** **no movement**, hyaline cartilage  
eg. Area for growth – epiphyseal plates, between ribs & Sternum connection
2. **Symphysis:** **slight movement** Within bones articulates with bones using hyaline cartilage  
-Gives strength + flexibility – bones fused cartilage connection



**Synovial Joints:** most joints with **lots of movement** with..

1. **Articular cartilage:** cushions the 2 bones as a cover
2. **Joint cavity:** synovial cavity that holds the fluid
3. **Articular capsule:** double layered
4. **synovial fluid:** reduce friction for protection
5. **Reinforcing ligaments:** restrict movement of joints with attachment, giving stretch/flex

**Bursae:** act as pillow/sac including synovial fluid for reducing friction and cushioning gives extra protection still giving lots of movements

**Tendon Sheaths:** circular bursae that wraps around a tendon, gives stretched out continuous protection for relieving stress to the joint

**Bunion:** inflammation bursa by constant extra rubbing/irritation of joints

-Synovial joints requires some stability as it has lots of freedom of movements

### 3 Factors influence joint stability

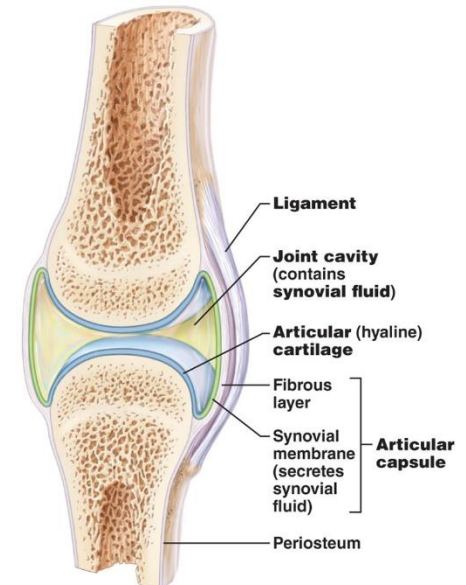
1. **Articular surfaces:** shape of the joining surface as concave/convex cavity for support/ good stability
2. **Ligaments:** giving more strength as they hold the joints tight  
-stretched ligaments stay stretched as it get stretched too much (prone to get stretched again)
3. **Muscle tone:** tendons/muscles surrounds joints giving tension and allow joints to be in place

### Common joint injuries

**Sprains:** too stretched out ligaments

**Cartilage Injuries:** no self-repair as there is no blood supply and sometimes broken pieces surgery is necessary

**Dislocations:** putting bones in wrong position/orientation + prone to get stretched again by ligament stretch



## Types of Synovial Movements

<b>Flexion:</b> decreasing angle	<b>Dorsal Flexion:</b> bottom foot stretch
<b>Extention:</b> bringing back to 180°	<b>Plantar Flexion:</b> top foot stretch
<b>Hypoextention:</b> over 180°	<b>Lateral/medial Rotation:</b> Inward/outward Rotation
<b>Gliding:</b> sliding bones eg. 8 Wrist bones	<b>Supination:</b> Parallel ulnar & Radius
<b>Abduction:</b> away from midline	<b>Pronation:</b> Crossed Radius over ulnar
<b>Adduction:</b> toward midline	<b>Inversion:</b> plantar facing medial
<b>Protraction:</b> pushing mandible forward	<b>Eversion:</b> plantar facing lateral
<b>Retraction:</b> pulling mandible backward	<b>Circumduction:</b> circular motion
<b>Elevation/Depression:</b> pulling/relaxing	<b>Opposition:</b> allow touch of tip of fingers

### Shapes of articulating surfaces for types of movements

<b>1. Plane joint:</b>	2 surfaces gliding (right/left & back/front)	eg. Intercarpal joints
<b>2. Hinge joint:</b>	Cylinder into trough (hook) for flexion & Extension	eg. Elbow
<b>3. Pivot joint:</b>	Cylinder inside a ring for circular rotation	eg. Between atlas
<b>4. Condylar joint:</b>	Concave/Convex <b>Oval surfaces</b> all plane rotation	eg. Knuckles
<b>5. Saddle joint:</b>	Limits movement by having c shape connection	eg. Metacarpal/wrist
<b>6. Ball-and-socket joint:</b>	Lots of movement by freedom to move in many direction	eg. Shoulder

**Knee joint-** flexion/extension with some rotation

Quadiceps tendon

**Patellar ligament:** ligament that holds and keeps the patella in place on top of joints

**Medial/Lateral patellar retinacula:** attachment into joint capsule

2 intracapsular ligaments

**Anterior cruciate and Posterior cruciate:** attachment to intercondylar area of the tibia, attach to femur medial condyle

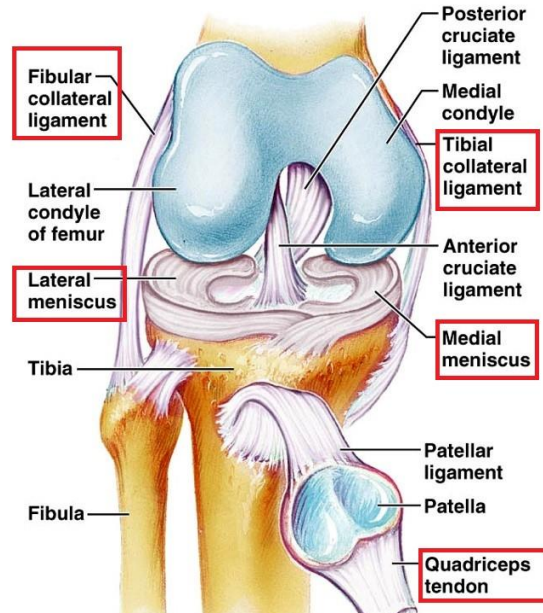
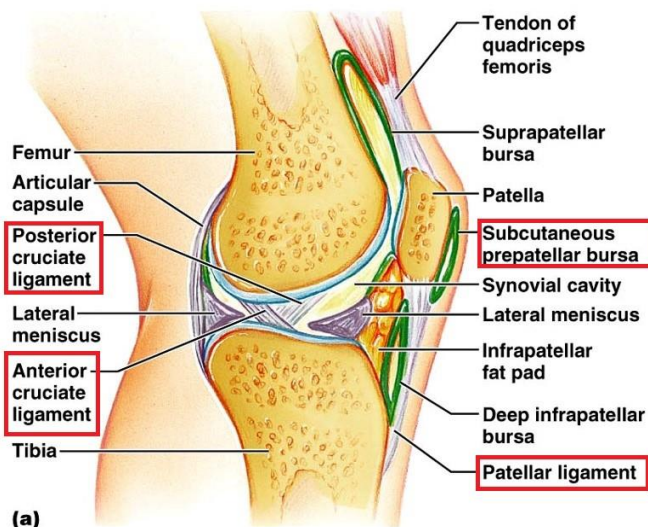
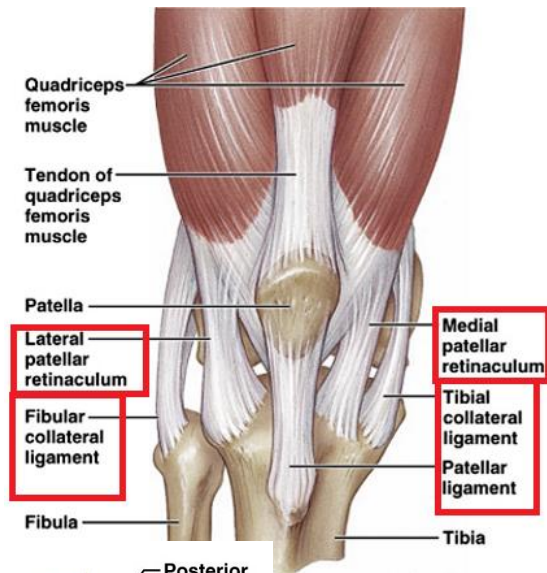
2 menisci

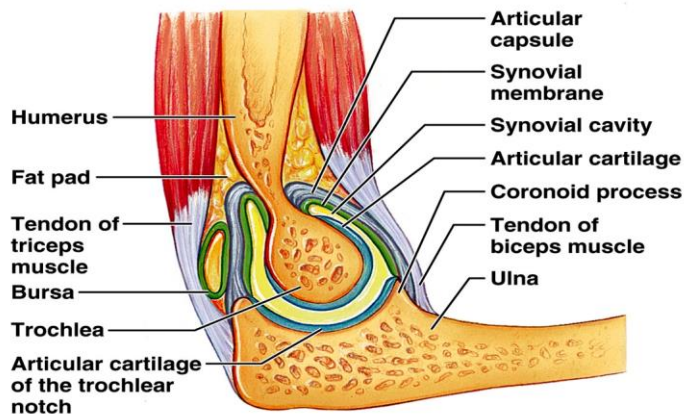
**Medial/Lateral meniscus:** attached at the fibrous capsule

2 extracapsular ligaments

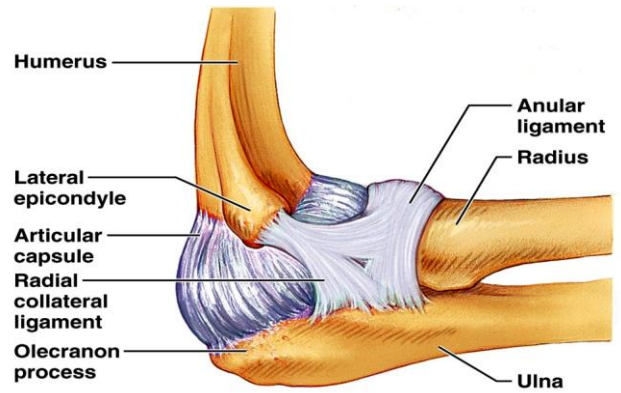
**Fibular collateral & Tibial collateral:** prevent lateral/medial rotation while knee is extended

Subcutaneous prepatellar bursa: located between the skin and the kneecap

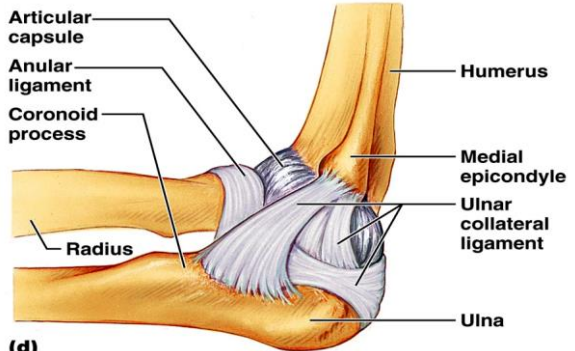




(a)



(b)



(d)

**Elbow joint** - hinge joint

Articulation of the **trochlea**: articular surface of the elbow joint

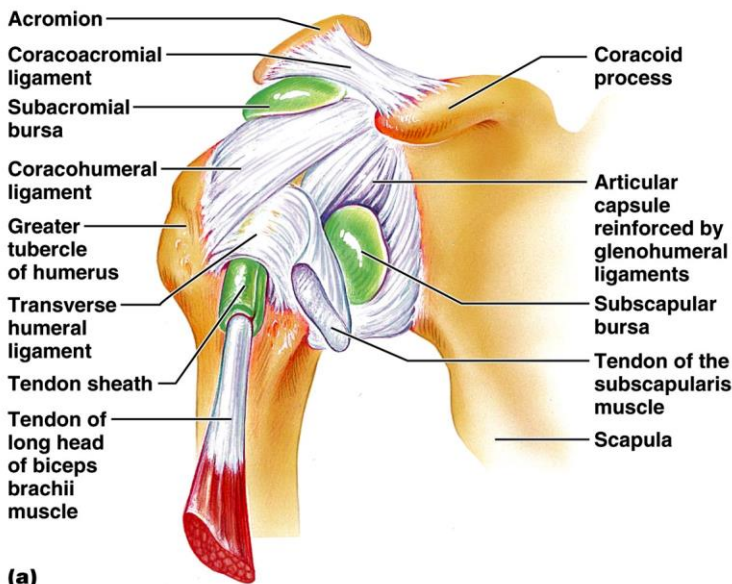
**Trochlear notch**: articulation site of ulna and trochlea

**Annular ligament**: around head of radius that allow rotation for pronation (crossing)/supination (relaxing)

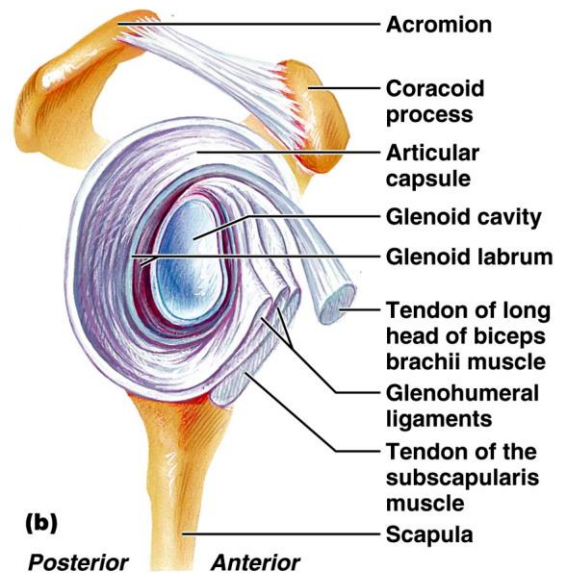
**Shoulder joint** - glenohumeral joint

**Glenoid labrum**: gives space for glenoid cavity

**Coracohumeral**: Large tendons of the rotator muscles for stabilizing the joint



(a)



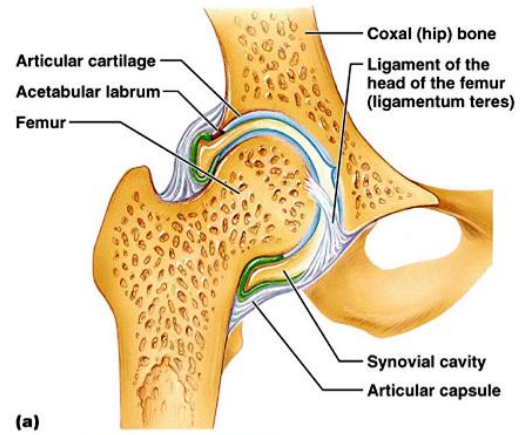
(b)

**Hip joint**- deep ball & socket joint

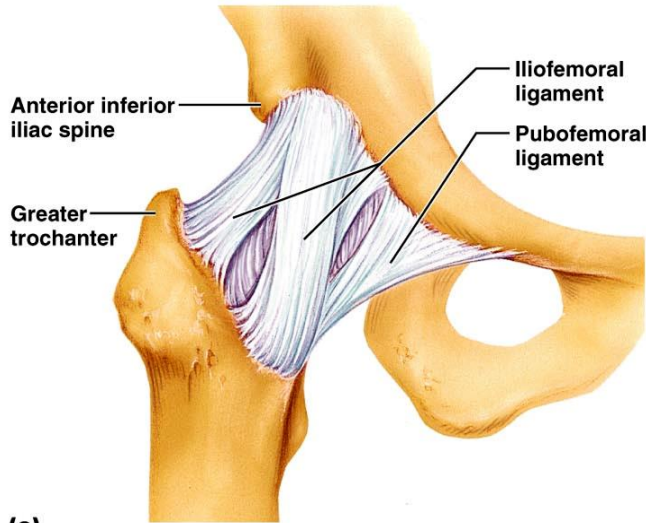
**Ligamentum teres:** tiny intracapsular ligaments that has unknown function

**Extracapsular ligaments:**

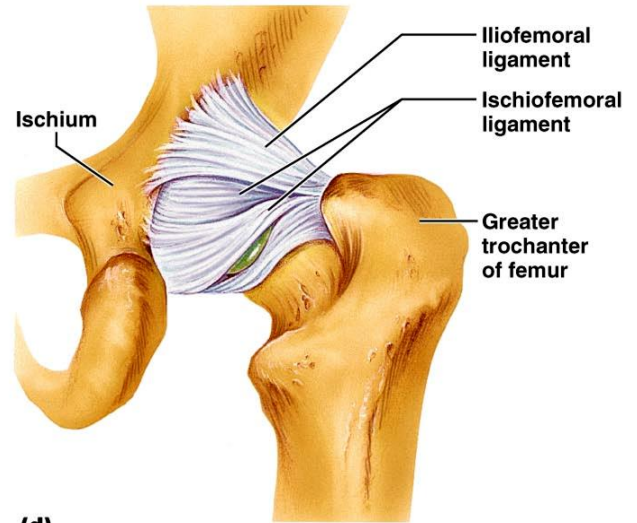
1. **Iliofemoral:** strong v-shaped ligament anteriorly
2. **Pubofemoral:** triangular thickening of the inferior part of the capsule
3. **Ischiofemoral:** spiraling posterior ligament



(a)



(c)



(d)

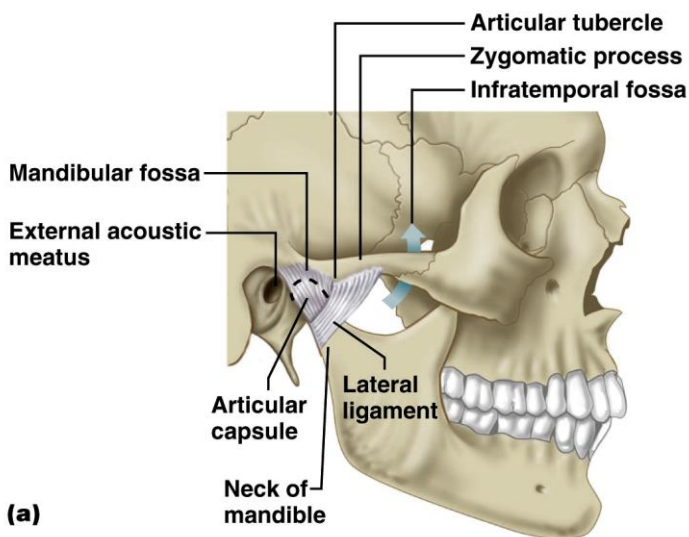
**Temporomandibular joint**

**Mandibular condyle:** top part of mandible articulates with fossa

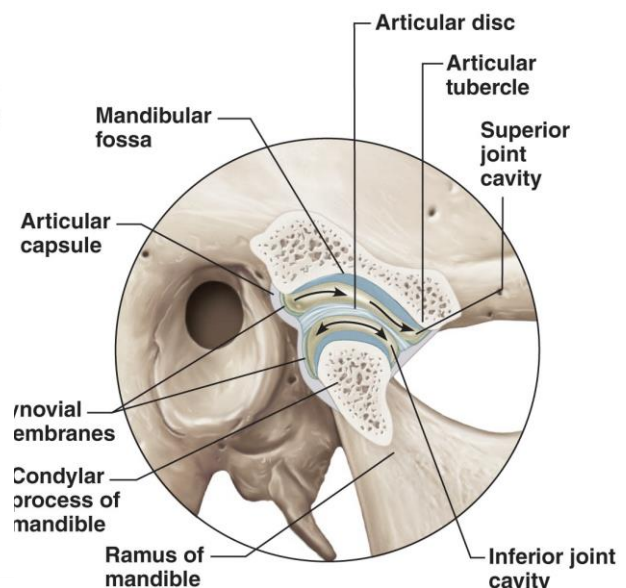
**Mandibular fossa:** depression where it articulates with mandible

**Lateral Ligament:** ligament that holds mandible

**Articular Disk:** space for superior/inferior synovial cavity – giving movement including small R&L movements



(a)



(b)

## Anatomy of the Muscular System Part 1

### Muscle Fibers

1. **Endomysium:** Fine/thin CT surrounds individual muscle cells
2. **Perimysium:** sheath surrounds fascicle bundles
3. **Epimysium:** dense CT surrounds multiples of fascicle bundles outside layer of a single muscle

**Deep fascia:** dense CT binds muscles with functional groups

### Muscle attachments

Most muscles are **Span joints** for movements

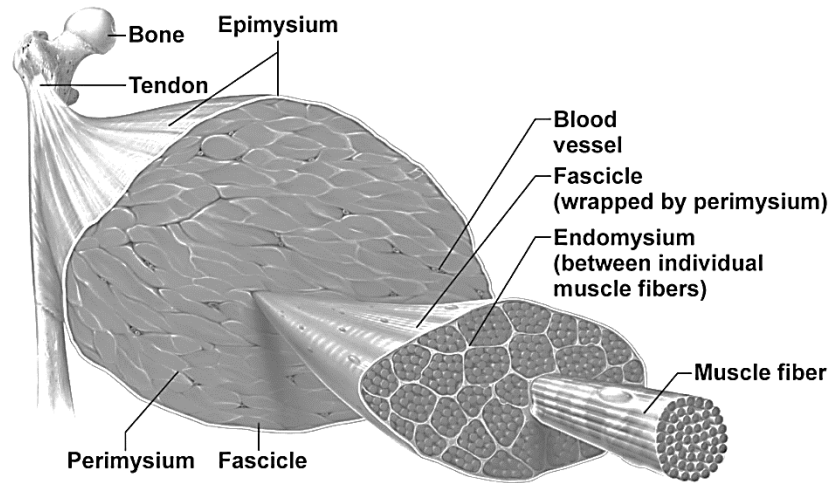
-Originating from anchoring site of bone which does not move and insertion for

-mostly indirect attachments with tendon or

### aponeurosis

### Arrangement of Fascicles

1. **Parallel: Straplike:** long curvy or **Fusiform:** flexion
2. **Pennate: Bipennate:** long up/down , **Unipennate:** really long/, **Multipennate:** allows abduction
3. **Convergent:** Triangular shaped –narrow on side-down and narrow
4. **Circular:** ring that surrounds external opening and contraction for closing the opening  
-surrounds, eyes, mouth



**Interactions of skeletal muscles-muscle can work together or in opposition**

### 4 functional groups

**Prime mover:** make specific movement for pulling of strong muscle

**Antagonist:** opposite movement giving tension-extension

**Synergists:** muscle that help the prime mover by keep making same movement, reducing unwanted movements

**Fixators:** holds the posture and allow freedom to stop any movement

**Naming Skeletal Muscles**-gives general information/cues about the muscles

1. **Locations of muscle:** bone or body region
2. **Shape of muscle:** unique shapes
3. **Relative size of muscle:** maximus(big), minimus(small), longus(long), brevis(short)
4. **Direction of muscle fibers:** rectus=parallel to midline, transverse, abdominis, oblique
5. **Number of origins:** ex. Biceps, triceps, quadriceps
6. **Location of muscle's origin and/or insertion:** origin indicated first, then insertion; sternocleidomastoid
7. **Action of the muscle:** ex. flexor, extensor, adductor, abductor

Ex. Extensor carpi radialis longus: extension (Stretch), carpal, radial, long

### Facial Expression Muscles

**Epicranium= main scalp muscle**

**Epicranium aponeurosis:** no muscle in this area- skull do not need muscle

1. **Frontalis:** forehead muscle for raising eyebrows
2. **Occipitalis:** pull the scalp backward-just anchoring

**Orbicularis oculi:** surrounds eye(rim of orbit), protecting from light/injury by blinking

**Zygomaticus:** cheek-corner of mouth-smile muscle

**Orbicularis oris:** muscle of lips

**Mentalis:** mandible chin muscle

**Masseter:** superficial to buccinators, big muscle that holds the lower jaw

**Buccinator:** deep muscle that holds the movement of mandible-allow chewing to be efficient [part of mastication]

**Platysma:** lowers mandible by pulling skin of neck

### Tongue Muscles

1. **Genioglossus:** prime mover under tongue, prevent obstruction of respiration

2. **Hyoglossus:** lowers tongue - anchoring with hyoid bone

3. **Styloglossus:** pull-in, move up tongue - anchoring with styloid process

### Other Muscles of the head

**Masseter:** prime mover of jaw closure

**Temporalis:** closes jaw at rest

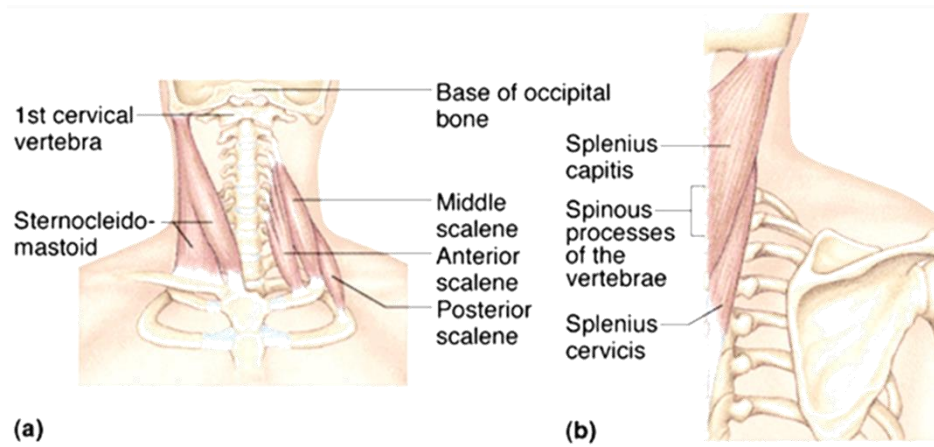
**Medial/Lateral Pterygoid:** allow side-to-side movements

### Neck muscles

**Sternocleidomastoid:** gives rotations (sides & tilts) of the head

**Scalenes:** flex/rotate the neck -cervical vertebrae to 1,2 ribs anchoring

**Splenius:** thick extended "bandage" muscle, rotation & tilts



### Vertebral Column Muscles

**Erector spinae:** prime mover of back extension 3 column muscles:

1. **Iliocostalis** 2. **Longissimus** 3. **Spinalis**

-gives resistance to bending forward/extensors for straight position

**Semispinalis:** deep muscle around thoracic region, extends vertebral to head

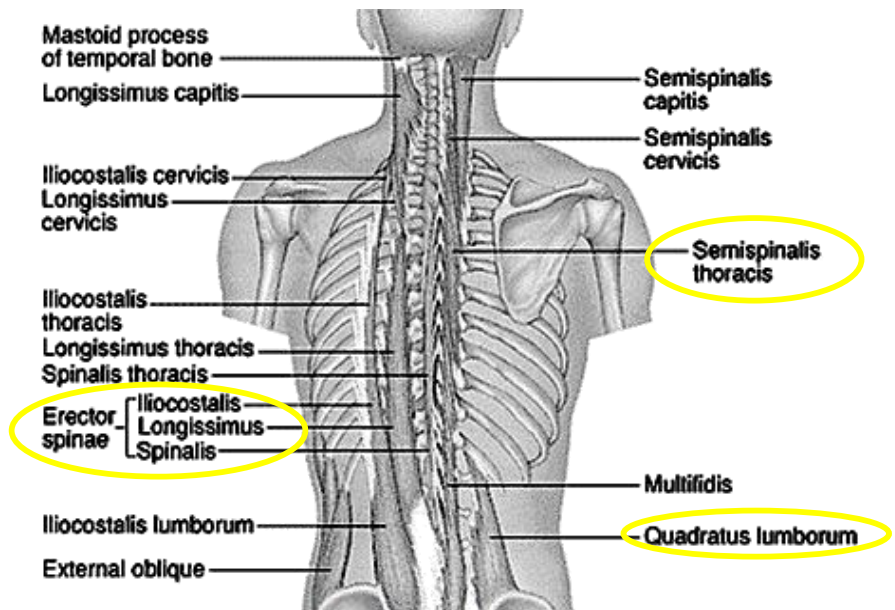
**Quadratus lumborum:** allow straight posture - iliac crest to lumbar vertebrae

### Respiration Muscles

**External Intercostals:** Gives **Inspiration** by lifting ribs

**Internal Intercostals:** Gives **expiration** by relaxing ribs

**Diaphragm:** prime mover of inspiration -no other muscles are used if they are not required



## Abdominal Wall Muscles

**Rectus abdominis:** superficial layer of rib cage to pubis- allow lumbar rotation, fix ribs

**External oblique:** largest outer layer

**Internal oblique:** deeper layer

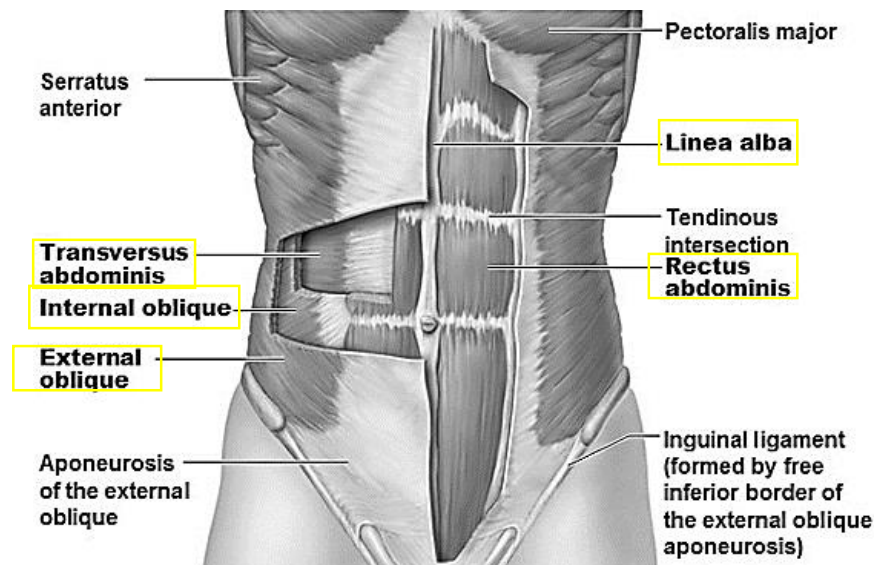
**Transversus abdominis:** deepest layer-press abdominal contents

**Linea alba:** white part of muscle

## **Muscles of the pelvic floor/perineum**

### **Pelvic diaphragm:**

1. **Levator ani** –supports pelvic viscera & forms flexible strap for the openings; resists intraabdominal pressure Elevates/adduct region
2. **Coccygeus** –supports pelvic viscera & coccyx
3. **Urogenital diaphragm** –supports pelvic viscera and constricts urethra -for women



## Anatomy of the Muscular System Part 2

**Pectoralis major:** prime mover of arm flexion –rotates arm medially, abducts arm

**Latissimus dorsi:** broad, flat back muscle; prime mover of arm extension –rotates arm at shoulder, adducts arm

**Deltoid:** thick, rounded, prime mover of arm abduction-lateral & medial rotations, flexion/extensions-some fiber

**Trapezius:** superficial, stabilizes, raises, retracts, rotates scapula

**Rhomboids:** under trapezius –aid in scapula movements

**Rotator cuff muscles:** Supraspinatus, Subscapularis, Infraspinatus, Teres minor

**\*\*Teres major is not part of rotator!!**

**Triceps brachii:** only back arm muscle  
– powerful **major forearm extensor**

**Biceps brachii:** front, flexes elbow joint + supinates forearm –weak flexor of arm at shoulder

**Brachialis:** deep inserted to biceps brachii - powerful **major forearm flexor**

**Brachioradialis:** superficial, far apart from humerus & forearm, helper in forearm flexion

**Muscles of the Forearm: Movements of the Wrist, Hand & Fingers**

**Pronator teres:** pronates forearm, weak flexor of elbow

**Flexor carpi radialis:** diagonally across forearm, **powerful flexor of wrist**, abducts hand

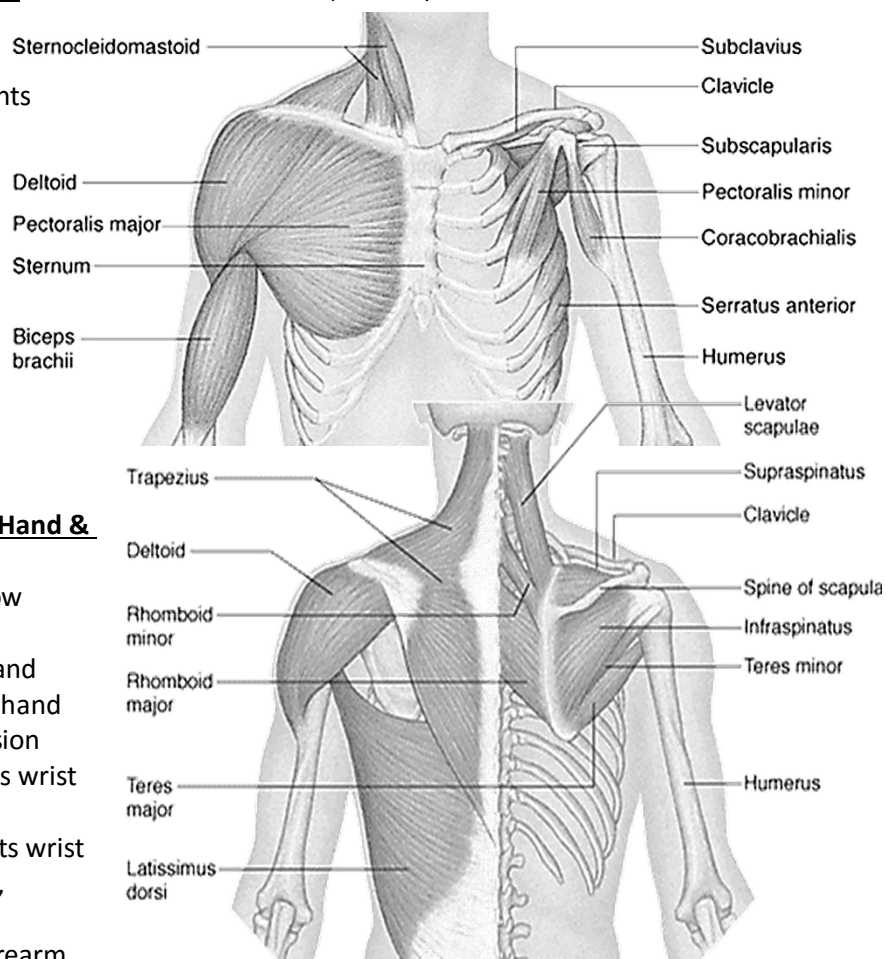
**Flexor carpi ulnaris:** **powerful flexor of wrist** adducts hand –stabilizes wrist during finger extension

**Flexor digitorum superficialis:** 2 headed deeper, flexes wrist & middle phalanges of fingers 2-5

**Extensor carpi radialis longus/brevis:** extends+abducts wrist

**Extensor digitorum:** prime mover of finger extension, extends wrist

**Supinator:** deep+help biceps brachii for supinating forearm



## Muscles of Hip, Thigh & Leg

**Iliopsoas:** 2 muscles - prime mover of hip flexion

**Sartorius:** longest muscle – flexes & laterally rotates thigh – weak knee flexor

**Adductors:** all adduct, flex, medially rotate thigh

**Pectineus:** adducts/flexes + medially rotates thigh

**Gracilis:** adducts thigh + medially rotates leg

**Tibialis anterior:** prime mover of dorsiflexion- inverts foot

**Extensor digitorum longus:** dorsiflexes foot –prime mover of toe extension

**Quadriceps femoris-** the only muscles that can extend the leg

Includes: **Vastus medialis, vastus intermedius, vastus lateralis, and rectus femoris**

**Rectus femoris:** extends knee + flexes thigh at hip

**Vastus (lateralis, medialis, intermedius):** all extend the knee

**Hamstrings:** 3 muscles includes: **Biceps femoris, Semitendinosus, Semimembranosus** –all extend thigh +flex knee

**Gluteus maximus:** largest + most superficial buttock muscle –major thigh extensor

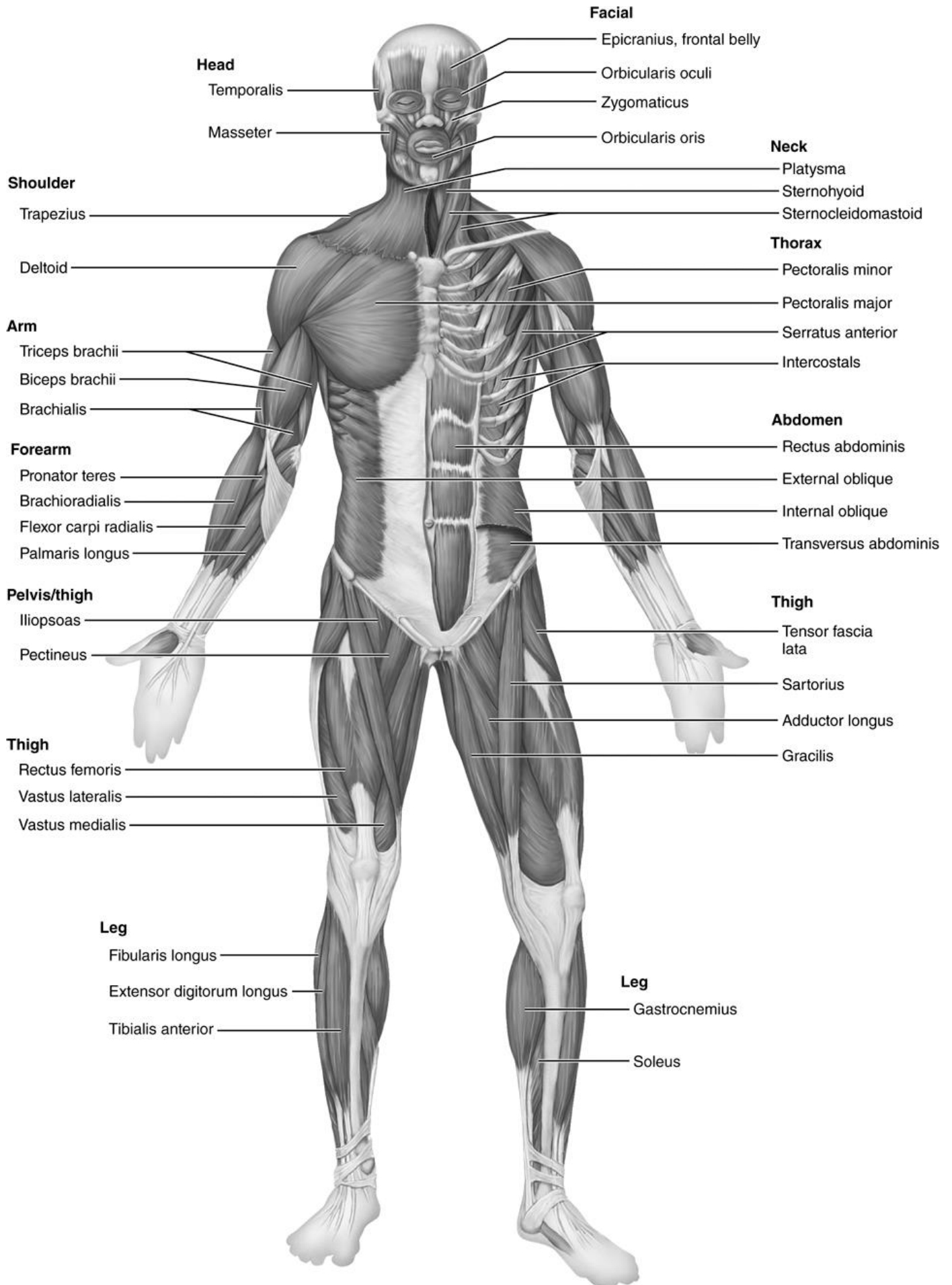
**Gluteus medius:** abducts + medially rotates thigh

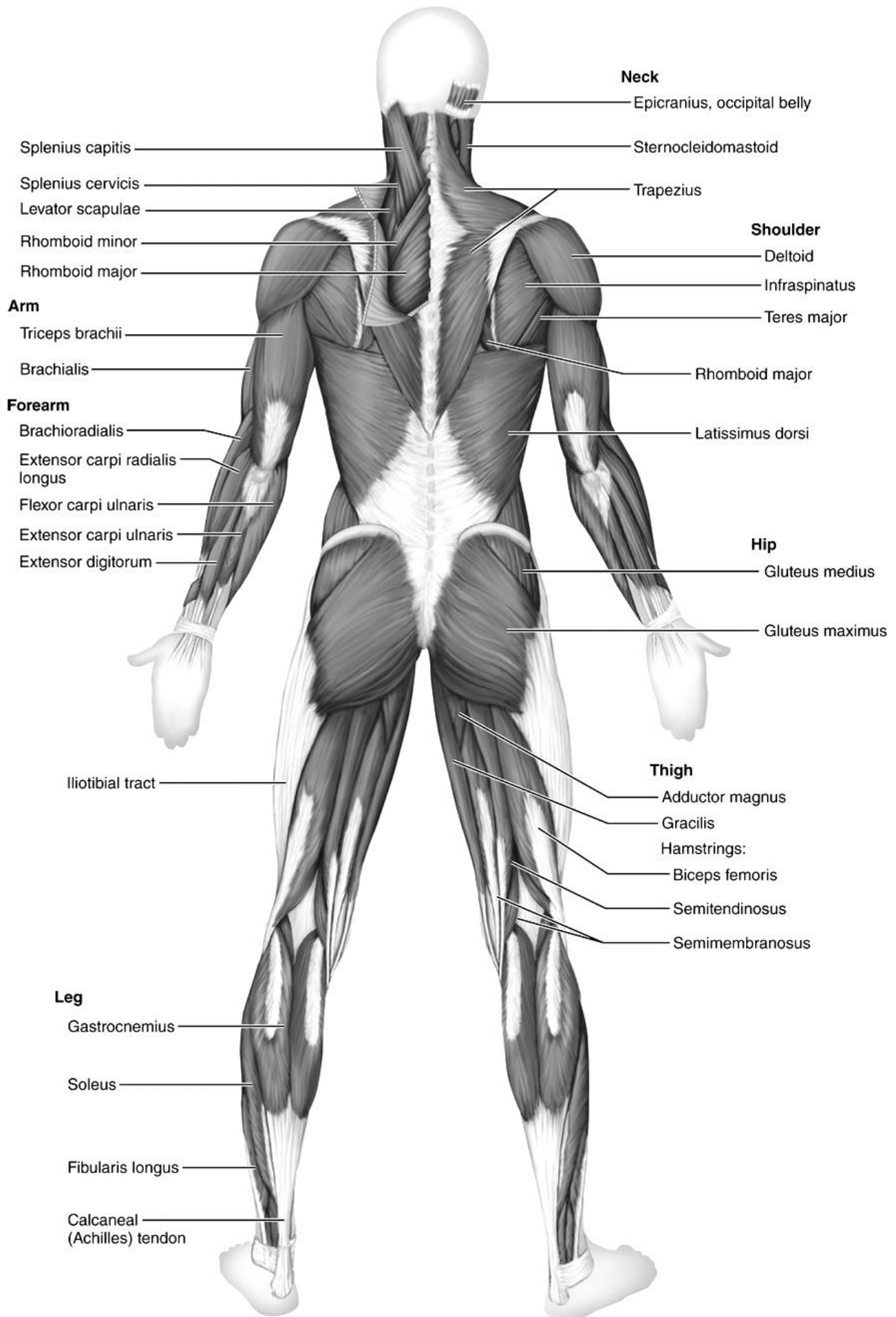
**Gastrocnemius:** plantar flexes foot when knee extend, flex knee if foot dorsiflexed

**Soleus:** deeper, plantar flexes ankle

**Fibularis (peroneus) longus:** plantar flexes + everts foot –help keep foot flat on ground

**Calcaneal:** largest tendon in body





# Anatomy of the Nervous System Part A

**Central Nervous System:** brain + spinal cord –integrating command center for our body

**Peripheral Nervous System:** cranial + spinal nerves –communication between CNS and all parts of body

**Sensory(afferent) division:** somatic & visceral fibers - receptor to CNS

**Motor(efferent) division:** motor nerve fibers – CNS to skeletal muscle

a) **Sympathetic division:** fight or flight

b) **Parasympathetic division:** conserve energy at rest

## Histology of Nervous Tissue-

2 types of cells: **neurons** and 6 types of **supporting cells**

### CNS-4 types

**Astrocytes:** star shape, most common, anchor neurons close to capillaries –nutrient exchange, sampling of antigen

**Microglia:** protective, touch neurons to monitor well-being –may turn into macrophages

**Ependymal Cells:** lines cavities of brain & spinal cord as barrier btw CSF & fluid bathing cells, cilia circulate CSF

**Oligodendrocytes:** few branches that gives myelin sheaths to CNS neurons

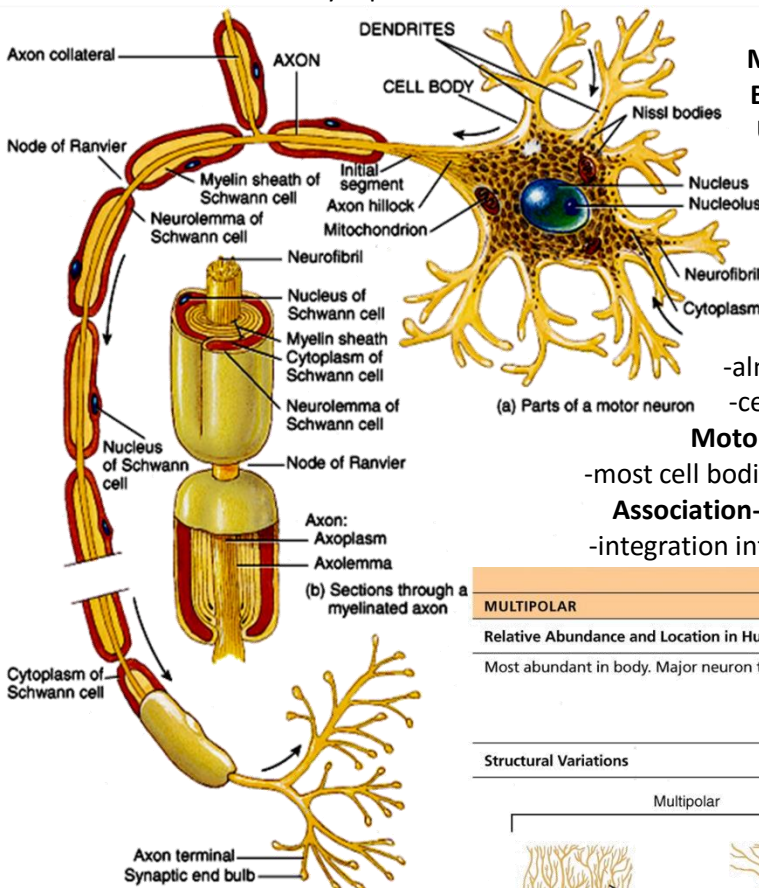
### PNS-2 types

**Satellite cells:** surround neuron cell bodies in ganglia –gives chemical environment of the neurons similar function as astrocyte

**Schwann cells:** myelin sheaths around larger neurons in PNS-important for peripheral nerve cell regeneration

**Neurons:** long lasting, High metabolic rate

**Parts include:** input dendrites, cell body, axon hillock, axons, myelin sheath, node of Ranvier, terminal branches, & axonal terminals -> synapses -



## Types of Neurons

**Multipolar:** Multi branches

**Bipolar:** 1 dendrite

**Unipolar (pseudounipolar):** extended cell body

## Functional Classification of Neurons

-the direction of nerve impulse by the CNS

-Includes: **sensory, motor & association neurons**

**Sensory-toward CNS** –primary, secondary, tertiary

-almost all **primary** sensory neurons are **unipolar**

-cell bodies outside CNS

**Motor-away from CNS** to effector organs(ex. muscle & glands)

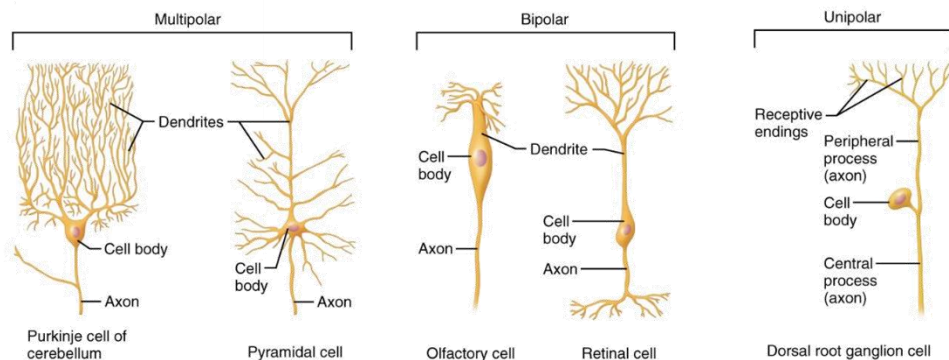
-most cell bodies stay in CNS- multipolar

**Association-between sensory & motor neurons**

-integration info – mostly in CNS 99% of neurons of the body - multipolar

NEURON TYPE		
MULTIPOLAR	BIPOLAR	UNIPOLAR (PSEUDOUNIPOLAR)
Relative Abundance and Location in Human Body		
Most abundant in body. Major neuron type in the CNS.	Rare. Found in some special sensory organs (olfactory mucosa, eye, ear).	Found mainly in the PNS. Common only in dorsal root ganglia of the spinal cord and sensory ganglia of cranial nerves.

## Structural Variations



## The Brain

-complexity of wiring of the brain is what to look for rather than size

### Subdivisions:

**Cerebral hemispheres:** the two halves that the cerebrum is divided into

**Diencephalon:** includes thalamus, hypothalamus, epithalamus

- central core of the forebrain, surrounded by cerebral hemispheres -consists of mostly gray matter

**Brain stem:** includes midbrain, pons, medulla

**Cerebellum:** maintains balance & equilibrium, executes voluntary movement, smoothing oscillations of movements, adjusting motor commands for changes in gravity/orientation, corrects for errors in motor commands, generates normal muscle tone, motor learning, cognitive functions

### Arrangement of gray & white matter

**Spinal cord** has central cavity surrounded by gray matter –unmyelinated & white matter –myelinated

**Brain** –same parts with additional regions of gray matter

-cerebral hemispheres & cerebellum have outer “bark” of gray matter

**Ventricles of the Brain:** continuous with one another and with central canal of spinal cord - filled with CSF & lined by ependymal cells

- Paired **lateral ventricles** separated by narrow **septum pellucidum**

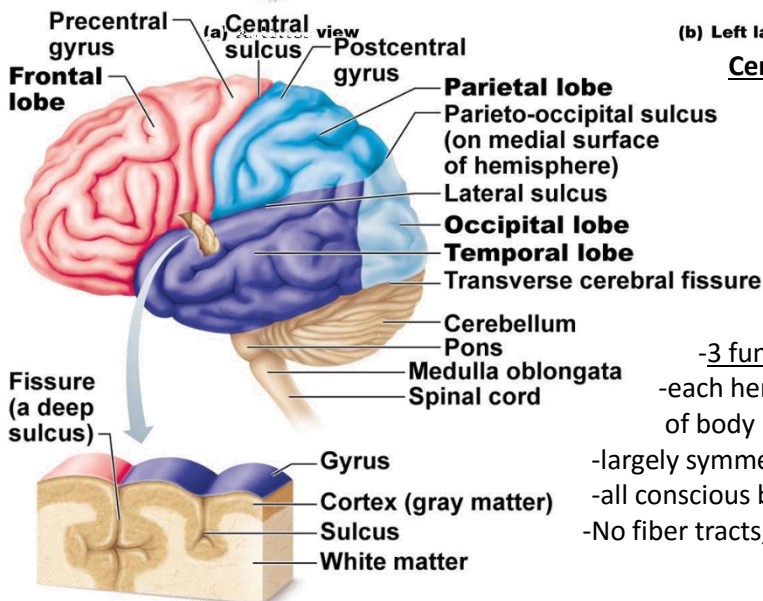
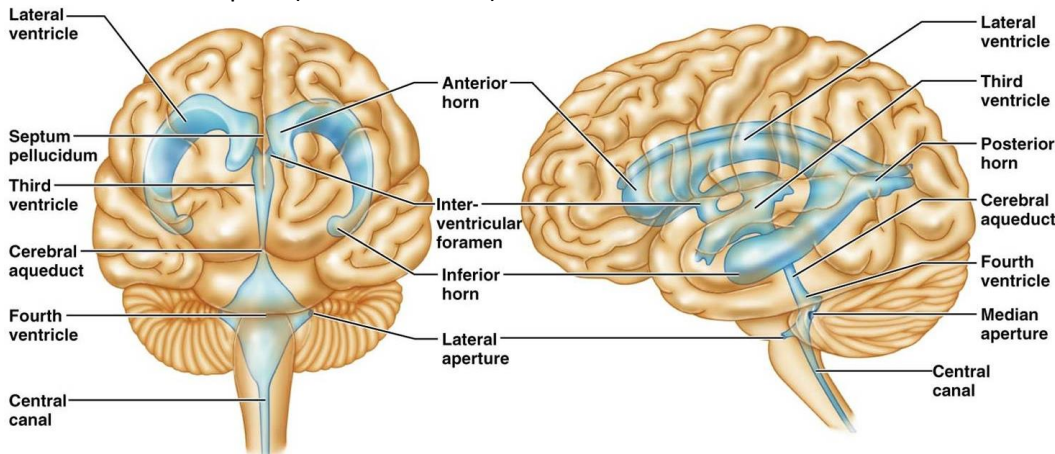
- Each communicates with narrow **3rd ventricle** in diencephalon by

**interventricular foramen**

-3<sup>rd</sup> ventricle continuous with 4th ventricle (dorsal to pons) by **cerebral aqueduct**

- 4th ventricle continuous with central canal

- 3 **apertures** (paired lateral apertures & median aperture) connect ventricles to subarachnoid space (surrounds brain)



(b) Left lateral view

**Cerebral cortex:** gateway for cerebral cortex

-Gives **Conscious behavior** by allowing to perceive, communicate, remember, understand, appreciate, initiate voluntary movements

-Includes cell bodies, dendrites & unmyelinated axons

-**Brodman** areas: numbered according to subtle differences in thickness, structure of contained neurons

- have overlapping domains; more diffusely organized

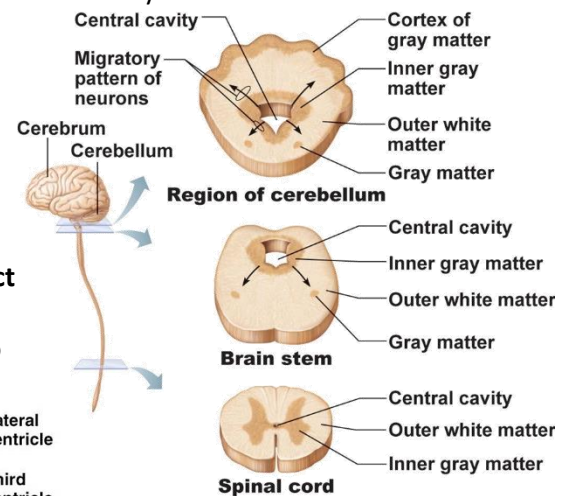
-3 functional areas: **motor, sensory & association**

-each hemisphere handles sensory & motor functions of opposite side of body

-largely symmetrical, but not 100% equal in function (lateralization)

-all conscious behavior involves entire cortex in some way –never act alone

-No fiber tracts, only cell bodies, dendrites, unmyelinated axons



### The Cerebral Hemispheres

-superior ~ **83%** of brain mass

-**gyri** separated by **sulci**

-**Lobes** frontal, parietal, occipital, temporal, insular central sulcus: precentral/postcentral gyrus parieto-occipital sulcus, lateral sulcus

## Motor Areas

**1. Primary motor cortex:** precentral gyrus of frontal lobe of each hemisphere  
-**pyramidal cells** allow control of skeletal muscles -axons project to spinal cord

**Somatotopy:** entire body represented as spatially in primary motor cortex of each hemisphere

\*face + fingers/hand require most precise motor control

-most motor nerve supplies are **contralateral**-side of the body opposite

**Stroke:** damage to area of right hemisphere paralyzes body muscles on left – only voluntary movement lost; reflex contraction still possible

**2. Premotor cortex:** front of precentral gyrus

-helps plan movements by selecting and sequencing basic motor movements into more complex tasks

-coordinates movement of several muscle groups simultaneously/sequentially by activating motor cortex

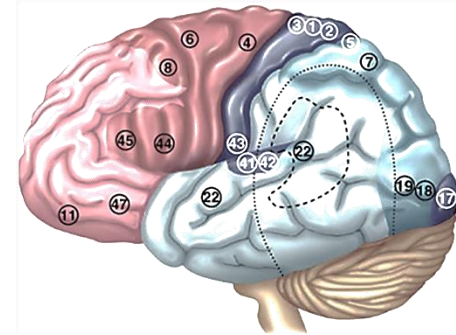
-can control voluntary actions that depend on sensory feedback –continuous feedback

\*damage to the area of premotor cortex regulating keyboarding –loss of the precise click

**3. Broca's area:** 44-45 -thought to be only a motor speech area -present in usually the left hemisphere only

-active when we prepare to speak and plan voluntary activities other than speech

**4. Frontal eye field:** 8 -controls voluntary movements of the eyes –No visual output just movement



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## Sensory Areas

**1. Primary somatosensory cortex:** 1-3 -in postcentral gyrus of parietal lobe

-receives info from somatic sensory receptors (skin) & proprioceptors (skeletal muscle)

**Spatial discrimination:** the ability of neurons to identify the site or pattern of stimulation

**2. Somatosensory association cortex:** back of the primary somatosensory cortex –with many connections

-touch sense with no visual connection- integrate/analyze somatic inputs ex temp, pressure

- according to size, texture, relationship of parts based on prior experience

**3. Visual areas:**

**Primary visual cortex:** back tip occipital lobe - largest cortical area with map of visual space on retina (opposite sides)

**Visual association area:** surrounds primary visual cortex - interprets visual image based on prior experience

\*damage to the primary visual cortex lead to loss of visual sense, giving sight with no process- **local blindness**

\*damage to the visual association area lead to **difficulty understanding visuals**

**4. Auditory areas:**

**Primary auditory cortex:** sound evaluated according to the pitch, rhythm, loudness

**Auditory association area:** interpretation based on memory – speech, words, music, thunder, etc.

**5. Vestibular (equilibrium) cortex:** back part of insula/next to parietal cortex - awareness of balance

• **6. Olfactory cortex:** middle of the temporal lobes = **uncus** –conscious awareness of different odors

-small in humans; most of surrounding tissue now forms limbic system (emotions, memory)

**7. Gustatory cortex:** perceive taste stimuli – in front of 43 -in **insula** deep to the temporal lobe

**8. Visceral sensory area:** back of the gustatory cortex – gives conscious perception of visceral sensations

ex. stomachache , full bladder

**Visual Agnosia** – the inability to recognize/understand things that you see

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**Multimodal Association Areas:** - any cortical area that is not “primary”

**Sensory receptors -> Primary sensory cortex -> Sensory association cortex -> Multimodal association cortex**

**1. Anterior Association Area (Prefrontal Cortex):**

-intellect, complex learning (cognition) & personality-working memory

-abstract ideas, judgment, reasoning, persistence, planning, concern, conscience

-matures slowly according to the social environment feedback

-linked to limbic system; involved in mood

\*damage lead to dramatic personality change

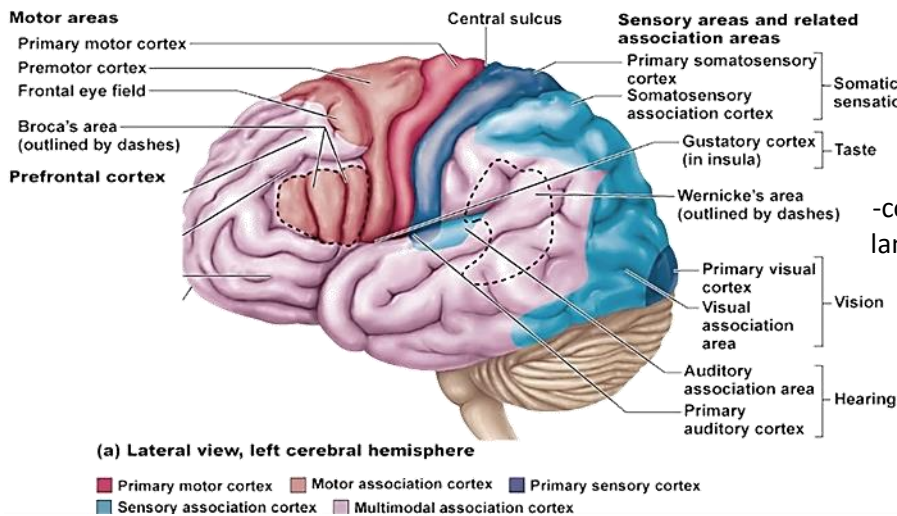
**2. Posterior Association area:** parts of temporal, parietal & occipital lobes

-input from all sensory association areas

• -> storage of complex memories linked to sensation – put info together to understand what see, feel, recognition of patterns, faces

-some parts for understanding written & spoken language(Wernicke's area)

**3. Limbic Association area:** provides emotional impact + according to memory



## Lateralization of Cortical Functioning

- each cerebral hemisphere not completely shared by other hemisphere
- cerebral dominance = dominant hemisphere for language
- commonly **left hemisphere** dominant for language, math, logic
- right hemisphere** for visual-spatial skills, intuition, emotion, appreciation of art & music
- most individuals with left cerebral dominance are right-handed

**Cerebral White Matter:** communication between cerebral areas, between cortex & lower CNS centers

**Commissural fibers:** connect between the 2 hemispheres for corresponding areas

**Corpus callosum:** largest commissural fibers

**Association fibers:** connections within a hemisphere (connect gyri, lobes)

**Projection fibers:** to or from cortex and rest of nervous system; these ones run vertically

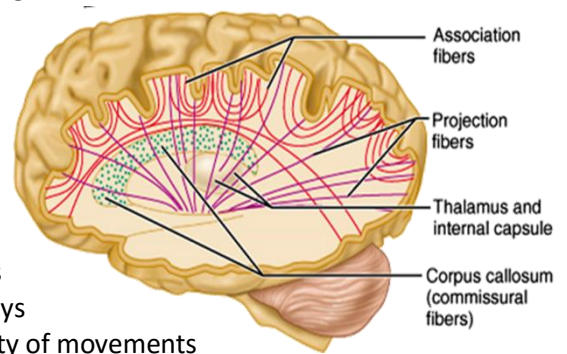
**Basal Nuclei (Basal Ganglia)**

**Caudate nucleus + [putamen & globus pallidus = lentiform nucleus]**

- inputs from entire cerebral cortex, other subcortical nuclei & each other
- project to premotor & prefrontal cortices to influence muscle movements directed by primary motor cortex – have no direct access to motor pathways
- precise roles with overlap - roles in starting, stopping, monitoring intensity of movements executed by cortex, especially if slow, sustained, stereotyped; also inhibit antagonistic and/or unnecessary actions
- \*disorders can result in:

Too much movement (e.g. **Huntington's disease**)-**mutant huntingtin protein accumulation** in brain -> degeneration of the basal nuclei and eventually of the cortex –loss of control

Too little movement (**Parkinson's disease**)- degeneration of **dopamine**-releasing neurons of substantia nigra (midbrain)  
 -make Basal Nuclei->substantia nigra to become overactive ->constant unwanted movement at rest; muscles become rigid leading to difficulty walking, loss of facial expression, difficulty writing



## The Diencephalon

Thalamus, hypothalamus, epithalamus –cover 3<sup>rd</sup> ventricle

**Thalamus:** 2-sided masses of gray matter held together by midline commissure called the **intermediate mass**

-have many different nuclei, named for their position in thalamus – afferent impulses from all senses & all parts of body converge on thalamus -

-sorting & editing of information –gives grouping of impulses to send to appropriate region of cortex- natural awareness of sensation

-gives input for emotions & viscera from hypothalamus

-important for mediating sensation, motor activities, cortical arousal, learning, memory = “**gateway to cerebral cortex**”

**Hypothalamus:**

**Autonomic control centre:** centres for bp, heart, GI, respiration, etc

**Centre for emotional response & behaviour:** heart of limbic system

**Body temperature regulation**

**Regulation of food intake:** hunger, satiety

**Regulation of water balance & thirst:** release of ADH; thirst centre

**Regulation of sleep-awake cycles:** suprachiasmatic nucleus

**Control of endocrine system:** releasing factors plus 2 nuclei (supraoptic & paraventricular) produce ADH & oxytocin

\***Hypothalamic disturbances:** cause disorders in body homeostasis

**Epithalamus:** most dorsal part of diencephalon & forms roof of 3rd ventricle

Pineal gland (melatonin) extends from its dorsal border

**Choroid plexus:** part of epithalamus - CSF forms the structure

**The Brain Stem:** midbrain, pons, medulla oblongata

- rigidly programmed, automatic behaviours necessary to survival
- pathway between higher & lower neural centres
- associated with (most of the nerves) 10 pairs of cranial nerves

**Midbrain:** 2 cerebral peduncles that contain large pyramidal (corticospinal) motor tracts

Hollow cerebral aqueduct runs through midbrain

Periaqueductal gray matter involved in pain suppression

**Corpora quadrigemina:** superior colliculi: visual reflex centres; inferior colliculi: part of auditory relay (sudden shock reflex)

**Substantia nigra:** band-like nucleus; high melanin content

**Red nucleus:** rich vascular supply, iron pigment in neuron cell bodies; relay nuclei for descending pathways influencing limb flexion -also some nuclei associated with reticular formation

**Pons:** dorsally, forms part of anterior wall of 4th ventricle

-primarily conduction tracts

- some run longitudinally; others oriented transversely to communicate with cerebellum

**cranial nerves V** (trigeminal), **VI** (abducens) & **VII** facial; other pons nuclei are part of **reticular formation** and others are involved in respiration)

**Medulla oblongata:** from pons to spinal cord

-pyramids, decussation for each hemisphere to control the voluntary movements of muscles on the opposite side of the body

-inferior **olivary nuclei:** relay sensory info re muscles & joints to cerebellum

cranial nerves **XII** (hypoglossal), **IX** (glossopharyngeal), **X** (vagus), **XI** (accessory) vestibulocochlear nerve fibers (**VIII**) synapse with cochlear nuclei -for maintaining equilibrium

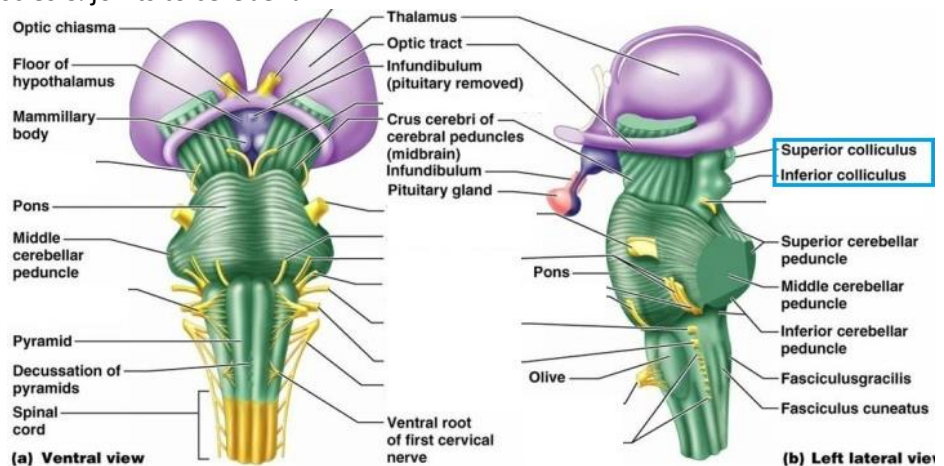
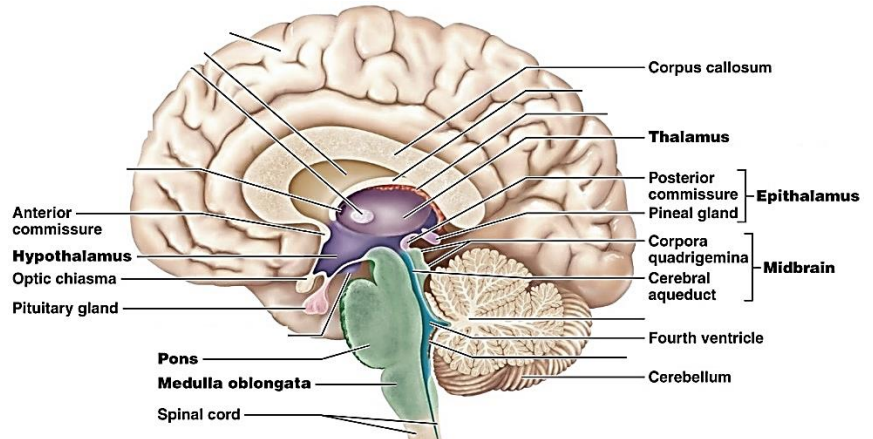
**+Roles:** autonomic reflex centre for homeostasis

-**Cardiovascular centre:** cardiac & vasomotor centres

-**Respiratory centres:** rate & depth of breathing

-**Other centres:** vomiting, hiccupping, swallowing coughing, sneezing

\*overlap with hypothalamus: hypothalamus controls most visceral functions by relaying instructions through medullary centres which carry them out



**The Cerebellum:** processes inputs from cerebral motor cortex, brainstem nuclei & sensory receptors -> timing & patterns of skeletal muscle contraction for smooth, daily movements

-connected by **vermis:** divides the 2 hemispheres, fine transverse fissures called **folia**

Each hemisphere divided into 3 lobes: anterior, posterior, flocculonodular

-anterior & posterior lobes have overlapping sensory & motor maps of body

**Medial:** trunk & girdle

**Intermediate:** distal limbs, skilled movements

**Lateral:** input from association areas of cortex (esp. planning movements)

**Flocculonodular lobes:** input from equilibrium sensors: balance, some eye movements

**Cerebellar Peduncles:** connects cerebellum to the brain stem

-almost all fibers entering & leaving cerebellum are **ipsilateral** (unlike cerebral cortex)

**Superior:** connect cerebellum & midbrain; fibers originate from neurons in deep cerebellar nuclei & project to cerebral motor cortex via thalamus

**Middle:** connect pons & cerebellum; one-way communication from pons to cerebellar neurons (informs cerebellum of voluntary motor activities initiated by motor cortex)

**Inferior:** connect cerebellum & medulla; afferent tracts - sensory info to cerebellum from muscle proprioceptors & vestibular nuclei of brain stem (equilibrium & balance)

**Cerebellar processing:**

**Cortex frontal motor association area** indicates intent to initiate action & sends collaterals to **cerebellum** to notify

-> **Cerebellum** also receives proprioceptive info & info from visual & equilibrium pathways

-> **Cerebellar cortex** receives this info & determines best way to coordinate force, direction extent of muscle contraction

-> by superior peduncles, **cerebellum** dispatches blueprint for coordination to **cortex**; output also to **brain stem nuclei** (eg: red nucleus) which project to **motor neurons** of spinal cord

**Functional Brain Systems:** for networks of neurons that work together but span large distances within brain

**Limbic (ring) system:** medial aspect of each cerebral hemisphere & diencephalon

Emotional-visceral brain – esp: **amygdala** (anger, fear, assess danger), **hippocampus** (emotions & memory), **anterior cingulate gyrus** (gestures, resolve conflicts when frustrated)

-link between odours, memories & emotions

-link for psychosomatic illnesses: stress & effects on bp, GI tract, heart

-links with cortex:(i) aware of emotions, (ii) react emotionally if consciously understand; also: emotions can override logic; reason can stop us from expressing emotions

## Nervous System Part2

**Spinal Cord:** divided into parts of vertebrae—Cervical, Thoracic, Lumbar, and Sacral spinal nerves

1<sup>st</sup>, 2<sup>nd</sup> lumbar vertebra for **Lumbar puncture:** taking cerebrospinal fluid

-Gives 2 way conduction system: major reflex center & initiates complex patterns of motor activity

-tracts include decussation, relay, somatotopy

Anchored in place by:

**Denticulate ligaments:** pia mater shelving

**Filium terminale:** pia mater-covered conus extension

Holds **31pairs spinal nerves**

**Cervical enlargements** - Responsible for supplying nerves to the upper limb

**Lumbar enlargements** - Responsible for supplying nerves to the lower limb

**Cauda Equina:** Lower lumbar & sacral nerves travel down vertebral canal & come out at different levels, nerves of spinal cord travel down to form this cluster of nerves (roots)

-Used to get CSF sample

-The collection of nerve roots at the inferior end of the vertebral canal

**Gray Matter & Spinal Roots:**

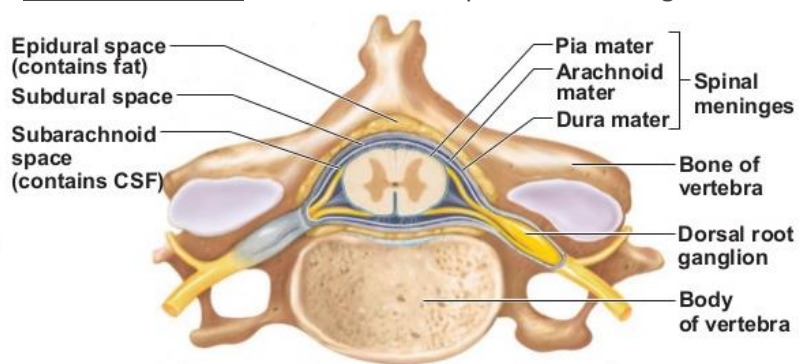
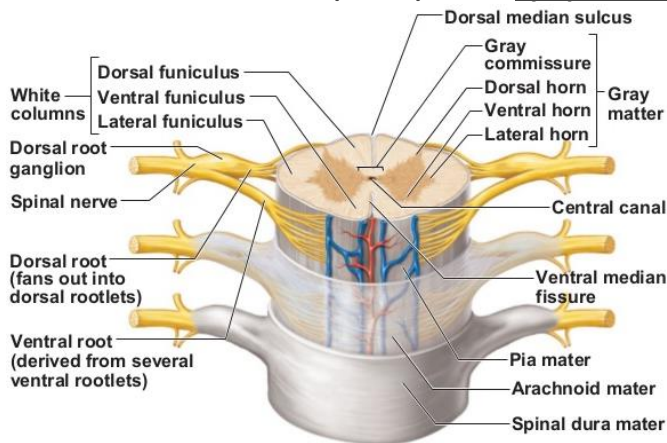
H-shaped Dark area - made up of cell bodies, dendrites, & unmyelinated axons

**Gray Matter Horns: Anterior(ventral) horns:** nerve cell body of somatic motor neurons —axons exit by ventral roots

-largest levels of cervical and lumbar enlargement since it carries the

**Lateral(dorsal) horns:** Sympathetic motor neurons to visceral organs —axons exit by ventral roots

Small lateral horns with thoracic & superior lumbar region



**Gray Commissure:** center of the gray matter -contains **central canal** which carries the **cerebrospinal fluid**

**Dorsal root:** posterior and sensory root part of the PNS

**Dorsal root ganglion:** **cell bodies of sensory** neurons whose axons conduct impulses inward from peripheral body parts

-Axons *enter* cord to - travel to higher cord/brain centres

- synapse with interneurons in posterior horns at level they enter

**Ventral root:** anterior and motor root part of the PNS -axons of motor neurons whose cell bodies are in the spinal cord

Spinal nerve = fused dorsal & ventral roots

-most pathways cross over from side of of CNS to other, all paired chain of mostly 2/3 neurons, consist somatotopy

**Poliomyelitis:** inflammation infectious viral disease that affects CNS and can cause temporary or permanent paralysis

**White Matter:** myelinated & unmyelinated fibers – talk between different **parts of cord** & between **cord & brain**

Ascending: to the higher centers(sensory)

Descending: brain or high part to the lower part of cord(motor)

Transverse: move side to side of the cord to other(commisural fibers)

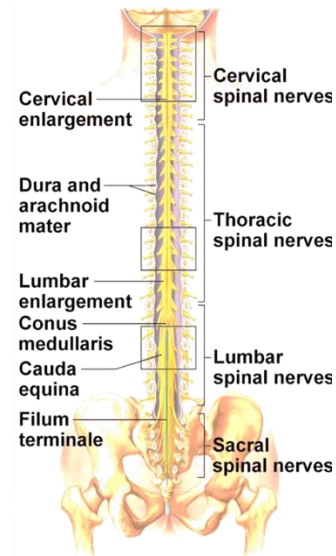
**Protection of the CNS:** 1. Bones 2. Meninges(meninx) 3. Cerebrospinal fluid 4. Blood-brain barrier

**Meninges(meninx)** -3 CT membranes: protect CNS, blood vessels/venous sinuses, contain cerebrospinal fluid, make partitions within skull

**Dura mater:** thick 2layers around brain —outer **periosteal** & inner **meningeal** layer

-**spinal cord** has ONLY meningeal layer -outermost layer of meninges brain/spine protection

**Dural septa:** divides the dura mater – **falx cerebri:** projects down into the longitudinal fissure to partition the two hemispheres **Falx cerebelli:** separates 2 lobes of the cerebellum **Tentorium cerebelli:** Supports the posterior part of the cerebrum and separates it from the cerebellum



**Arachnoid mater:** deeper layer of dura mater - release of cerebrospinal fluid into the dural sinuses

**Subarachnoid space:** between arachnoid mater & pia mater: have cerebrospinal fluid & largest blood vessels serving brain

**Arachnoid villi:** Extended up of the dura mater, Allows CSF to be absorbed into the venous blood of the sinus

**Pia mater:** made of delicate CT + tiny blood vessels - attached tightly to brain follows convolution

**Meningitis:** inflammation of the meninges - bacterial infection

**Encephalitis:** inflammation of the brain by infection/allergy

**Cerebrospinal Fluid:** 150 ml liquid for cushioning the CNS structures - 8h cycle - similar to plasma but less ptn, more vit C, Na+, Cl-, Mg2+ & H+, less Ca2+, K+

**Choroid plexuses:** part of CSF, a bunch of permeable capillaries under ependymal cells

**Hydrocephalus:** CSF accumulates in the brain mostly for infants, enlargement of head-cause brain damage

**Blood-Brain Barrier:** a filtering mechanism of the capillaries that carry blood to the brain and spinal cord tissue, blocking the passage of substances -glucose, essential amino acids, some electrolytes; also fats, fatty acids, oxygen, carbon dioxide, any other fat-soluble molecules

Composed of 3 layers:

- (i) Continuous epithelium of capillary wall (sealed by tight junctions)
- (ii) Thick basal lamina surrounding external face of capillary
- (iii) Fat, round feet of astrocytes

Not completely uniform - porous capillaries of choroid plexuses

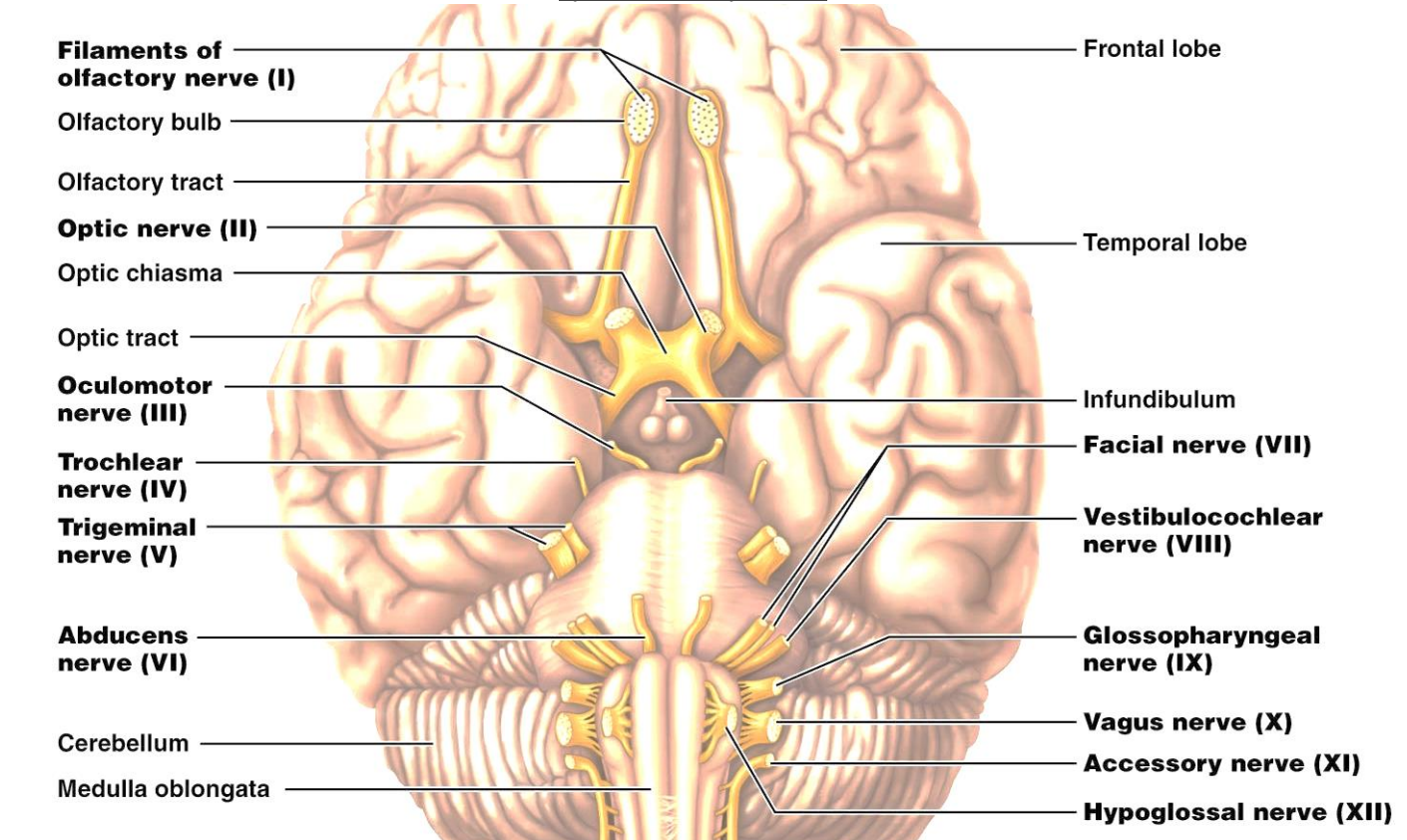
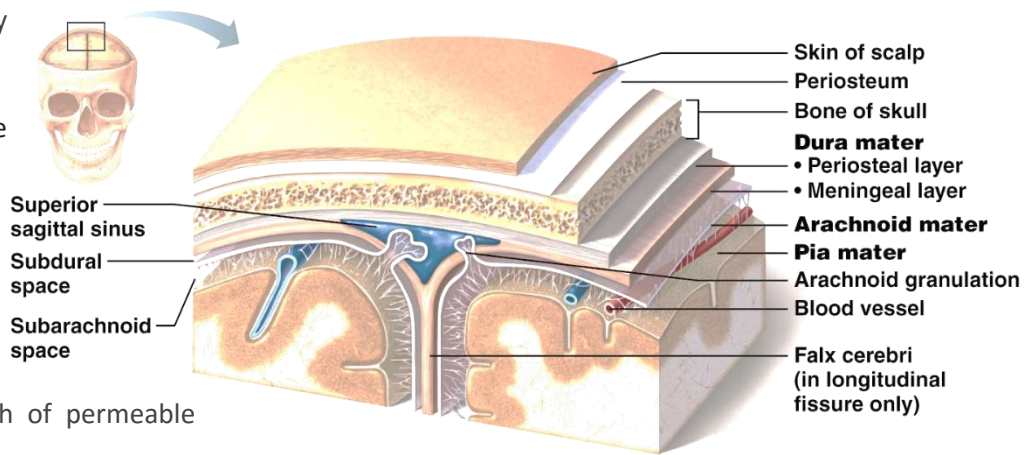
Very permeable near vomiting centre-toxicity of blood regulation, hypothalamus

**Peripheral NS-** 12 pairs **cranial nerves**

-All cranial nerves are for head & neck structures EXCEPT Vagus nerve

- First two pairs (Olfactory&Optic) attach to forebrain

-Most cranial nerves are mixed nerves EXCEPT Special sensory nerves



## 2 Sensory Nerves:

### 1. Olfactory Nerves: afferent sensory fibers for smell

-fibers from nasal mucosa to olfactory bulbs roots downward as olfactory tract to primary olfactory cortex

### 2. Optic Nerves: afferent sensory fibers for vision

-fibers from retina-passes through optic foramen of orbit

**Optic chiasma:** 2 optic nerves cross over each other allowing both eyes to be processed together

-then the optic nerves travel to optic tracts to thalamus, finally as optical radiation to occipital (visual) cortex

## 2 Motor Nerves:

### 1. Oculomotor Nerves: very precise eye mover(mixed motor nerves) that gives 4/6 extrinsic muscles of eyeball

-fibers from ventral midbrain through bony orbit to eye

-parasympathetic fibers to iris, lens, (sensory afferent from extrinsic eye muscles to midbrain)

### 2. Trochlear Nerves: support external eye muscle for orbit –rotation by using pulley mechanism

-motor fibers from dorsal midbrain to upper/lower **oblique eye muscle**-allows circular motion

## 1. Sensory/motor Nerves:

**Trigeminal Nerves:** largest cranial nerves-3 branches for sensory fibers to face & motor fibers for chewing

(S) **Ophthalmic division:** transport sensory impulses from anterior scalp, upper eyelid, nose, nasal cavity mucosa, cornea, lacrimal gland

(S) **Maxillary division:** transport sensory impulses from nasal cavity mucosa, palate, upper teeth, cheek skin upper lip, lower eyelid

(M) **Mandibular division:** transport sensory impulses from anterior tongue, lower teeth, chin skin, temporal region of scalp

\*Inferior alveolar nerve is useful for dentist, since it runs through all bottom teeth

## 1. Motor Nerve:

**Abducens Nerves:** controls extrinsic eye muscle for **abducting** eyeball – to lateral rectus muscle of eye

## 1. Sensory Nerves:

**Vestibulocochlear Nerves:** for hearing (cochlear) and balance (vestibular)-both fused together

## 1. Motor Nerve:

**Facial Nerves:** large nerve for facial expression –from pons to lateral face

Mixed nerve but mostly motor

-parasympathetic to lacrimal glands + sensory from anterior 2/3 of tongue

## 2. Sensory/motor Nerves

1. **Glossopharyngeal Nerves:** mixed nerves of medulla for tongue & pharynx

-gives swallowing/gag reflex + parasympathetic fibers to parotid glands

-4 main sensory from pharynx/under tongue

-chemoreceptor & BP sensory from carotid sinus

2. **Vagus Nerves:** mixed nerves of medulla for most of parasympathetic motor fiber to heart, lungs, upper digestive tract, and other organs of the chest -somatic to pharynx & larynx

Taste from proprioceptors in muscles of pharynx, larynx, sensory from carotid sinus

## 2. Motor Nerves:

**Accessory Nerves: Mostly Motor** accessory part of vagus nerve –made by junction of a cranial root with a spinal root

-mixed nerves but for head & neck movement –dual origin (brain & spinal cord)

**Hypoglossal Nerves: Mostly Motor** –tongue movement for mixing, swallowing and speech

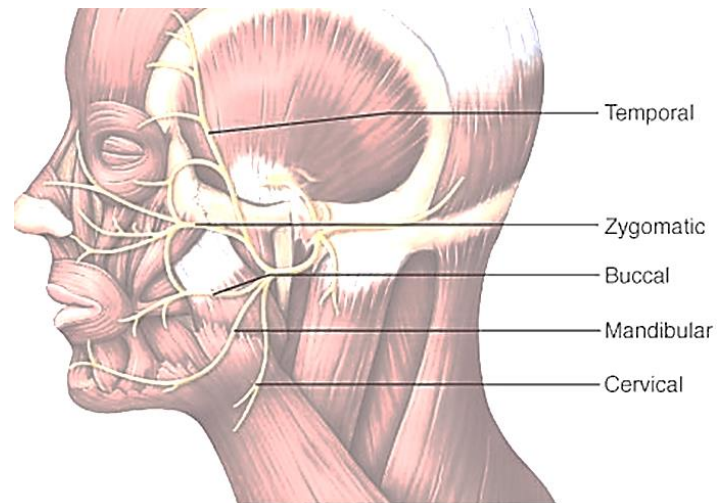
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**Spinal Nerves-** 31pairs of mixed nerves – C1-C0, T1-T12, L1-L5, S1-S5, C0

-exit from the foramen, each spinal nerve branches into a **dorsal ramus & ventral ramus**

**Root-only sensory**

vs

**Ramus-mixed both sensory & motor fibers** multi branches



**Nerve plexuses:** All **ventral ramus** multi branches & make lateral connections just outside spinal cord - except T2-T12  
 -contains fibers of several different spinal nerves, each ventral ramus travel to body periphery by several different routes

\*Damage to one spinal segment or root cannot completely paralyze any limb muscle –due to the multi joined nerves giving backup feedback for multiple nerves working instead of 1 muscle doing all.

**A. Cervical Plexus & the Neck: C<sub>1</sub>-C<sub>4</sub>**

- deep inside neck under sternocleidomastoid muscle
- mostly cutaneous nerve branches

**Phrenic nerve:** single important nerve –motor & sensory fibers to diaphragm

**B. Brachial Plexus & Upper Limb: C<sub>5</sub>-C<sub>8</sub> + T<sub>1</sub>**

- located partly neck, axilla-nerves supplying upper limb

**Axillary:** nerve to deltoid, teres muscles etc - to shoulder

**Musculocutaneous:** nerve to biceps brachii & brachialis - to flex arm

**Median:** nerve to flexor muscles in anterior forearm & into palm –form pronate forearm, wrist/fingers\ not thumbs

**Ulnar:** nerve running medial to elbow & follows ulna along medial forearm - wrist & finger flexion and adduction & abduction of medial fingers

**Radial:** **largest** nerve running to humerus & dorsal part of hand - elbow extension, supination of forearm, extension of wrist & fingers, abduction of thumb

**C. The Back: dorsal rami,** follows segmented plan

**D. Anterolateral Thorax: T<sub>1</sub>-T<sub>12</sub>;** simple & segmented for nerve supply of back

**Intercostal nerves:** to intercostal muscles –anterolateral thorax

**E. Lumbar Plexus: L<sub>1</sub>-L<sub>4</sub>;** branches to abdominal wall muscles + anterior & medial thigh

**Femoral nerve:** anterior thigh muscles -thigh flexors & knee extensors

**Obturator nerve:** medial thigh -adductor muscles

**F. Sacral Plexus: L<sub>4</sub>-S<sub>4</sub>;** caudal to lumbar plexus with fully packed branches to buttocks, lower limbs, pelvis

**Sciatic nerve:** back of thigh – then diverges into:

**Tibial nerve:** behind knee joint to posterior calf & sole of foot

**Common fibular nerve:** to knee joint, calf (anterolateral) & dorsal part of foot

**Superior & inferior gluteal nerves:** to buttocks

**Pudendal nerve:** muscles & skin of perineum (e.g. erection, voluntary urination)

-Thick/longest nerve in the body

**Dermatome:** area of skin nerve supply by cutaneous branches of a single spinal nerve

**Endoneurium:** loose CT that encloses nerve - fiber + associated myelin or neurilemmal sheath

**Perineurium:** coarser CT wrapping around a - group of fibers (fascicle)

**Epineurium:** tough fibrous sheath around all - the fascicles to make a nerve

