



# **The Neurological Examination**

**Dr. Gary Mumaugh – Western Physical Assessment**

# Common or Concerning Symptoms



- Headache
- Dizziness
- Generalized, proximal or distal weakness
- Numbness
- Abnormal or loss of sensations
- Loss of consciousness, syncope or near-syncope
- Seizures
- Tremors or involuntary movements

# Health Promotion and Counseling



- Preventing stroke or TIA
- Reducing risk of peripheral neuropathy
- Detecting the “three D’s”
  - Delirium
  - Dementia
  - depression

# The Neurological Examination



## Six Parts of the Neurological Exam

- Mental Status
- Cranial Nerves
- Motor
- Coordination
- Sensory
- Gait

# Concept of a Screening Exam



- Screening each of the parts allows one to check on the entire neuroaxis (Cortex, Subcortical White Matter, Basal Ganglia/Thalamus, Brainstem, Cerebellum, Spinal Cord, Peripheral Nerves, NMJ, and Muscles)
- Expand evaluation of a given part to either
  - Answer questions generated from the History
  - Confirm or refute expected or unexpected findings on Exam

# Mental Status



- Level of Alertness
  - Subjective view of Examiner
  - Definition of Consciousness
  - Terminology for Depressed Level of Consciousness
  - Concept of Coma
  - Delerium
- Degree of Orientation
  - To what?
  - “A and O x 4”

# Mental Status



- Concentration
  - Serial 7's or 3's
  - “WORLD” backwards
  - Months of the Year Backwards
  - Try to quantify degree of impairment
  
- \* A and O and Concentration need to be intact for other aspects of the Mental Status Exam to have localizing value!

# Mental Status Memory



- Immediate Recall
  - A task of concentration
- Short-Term Memory
  - “3/3 objects after 5 minutes”
- Long-Term Memory
  - Last thing to go

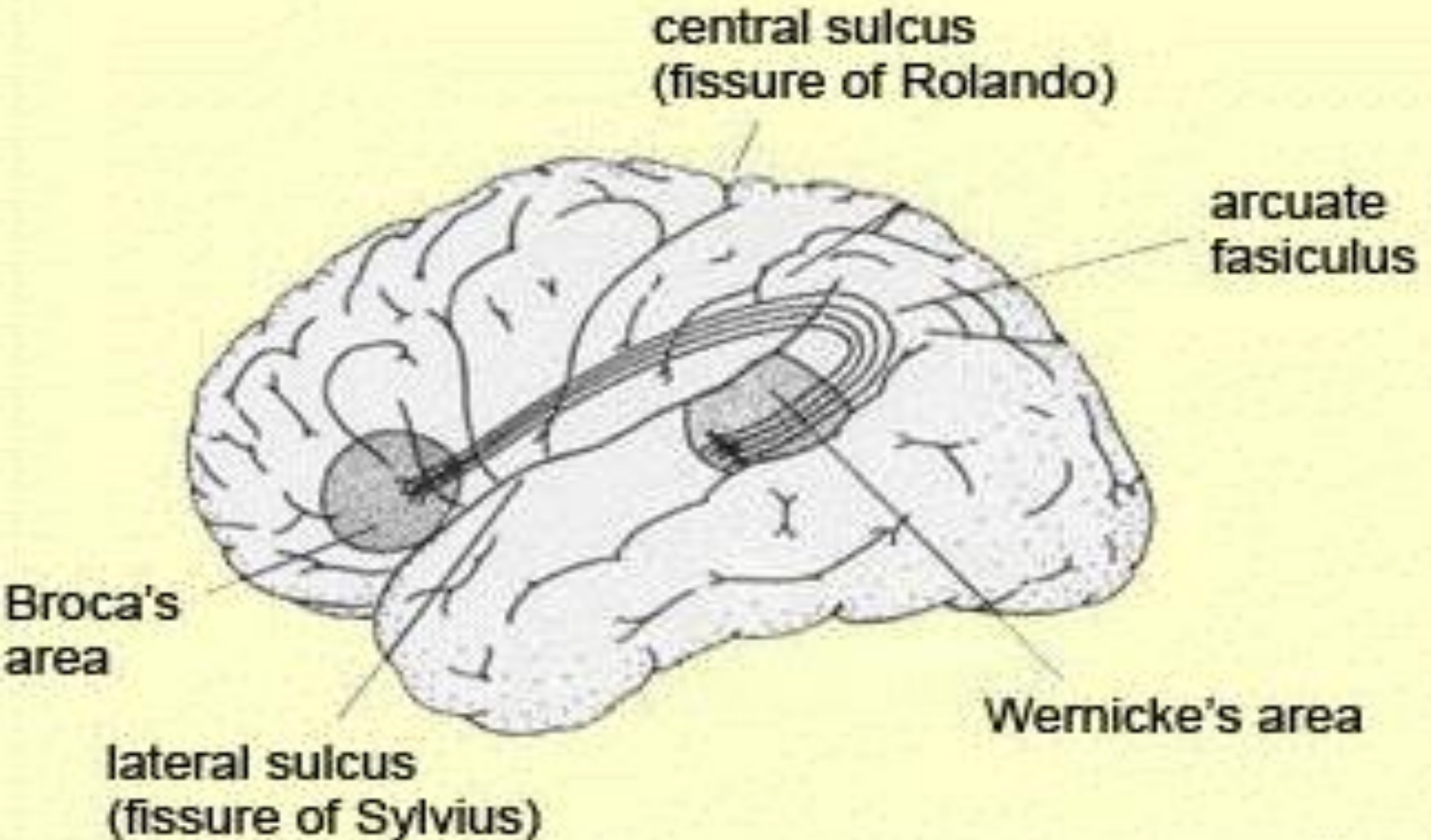


# Mental Status Language



- Aphasia vs. Dysarthria
- Receptive Language
  - Command Following
- Expressive Language
  - Fluency
  - Word Finding
- Repetition
  - Screens for Receptive, Expressive, and Conductive Aphasias

# Language

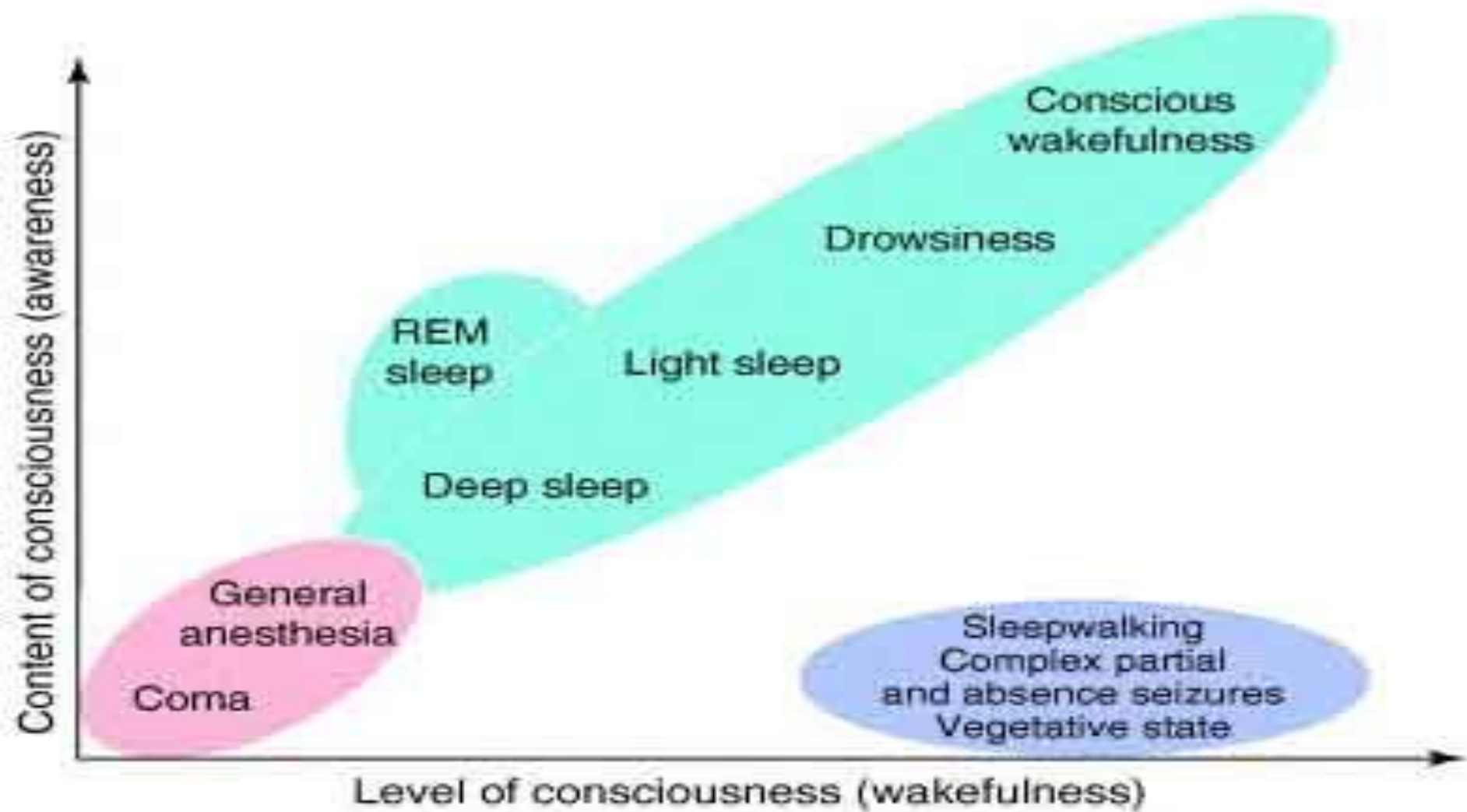


# What is Altered Mental Status?



- What are some symptoms that would make you think your patient has:
  - “Altered Mental Status”
    - Altered level of conscious
    - Disorientation
    - Inappropriate behavior
    - Altered cognition

# What is Level of Consciousness?



# What Is Altered LOC?

- Decreased wakefulness
- Unable to follow commands
- Decreased awareness
- Decreased responsiveness
- Unresponsive



# Altered Level of Consciousness versus Cognition?



- Alertness
- Wakefulness
- Awareness
- Responsive
- Sedation
- Coma
- Lethargic

- Orientation
- Confusion
- Concentration
- Comprehension
- Logic
- Able to follow instructions
- Memory –long and short term
- Appropriate behavior relative to the situation/environment
- Age specific
- Acute or chronic
- Continuum

# What is Altered Neurologic Status?



- Altered Level of Consciousness
- Altered Mental Status
- Abnormal cranial nerves
- Abnormal speech
- Abnormal motor function
- Abnormal sensory function
- Alteration in balance/gait

# What's Normal?

- Alert and oriented X 3 (Person, Place, Time/Date) consistent with developmental age
- Follows commands
- Responds to questions appropriately
- Speech Clear (?)

**My name  
is  
Barbara**



**But there's more to it....**



# Specialized Neuro Assessments



- AVPU (Alert, Verbal, Pain, Unresponsive)
- NIHSS (National Institute of Health Stroke Scale)
- Glasgow Coma Scale
- CAM – Confusion Assessment Method
- Cranial Nerve Assessment
- CMS –Circulation Movement Sensation
- Withdrawal Alcohol Screening (WAS)
- Mini mental health
- Electrolyte (Chvostec, Trousseau)
- Spinal

# What can cause alteration in mental status?



- Neurologic System vs. Other Systems
- Age Related
- Genetic/Hereditary
- Emotional/Psychiatric
- Acute vs. Chronic
- Sudden Onset vs. Slow Onset

# AEIOU TIPS

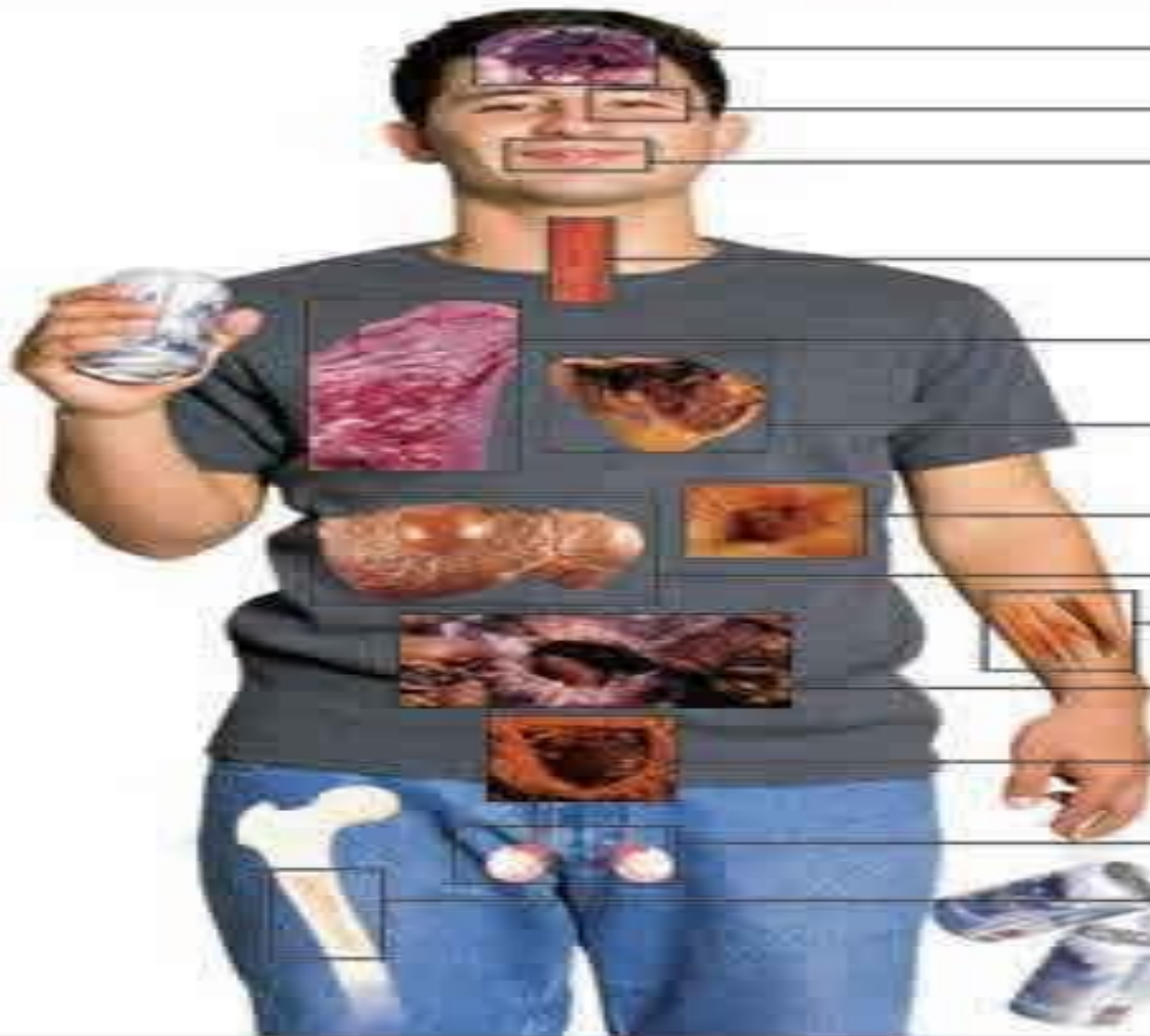


- A** Alcohol
- E** Electrolytes, Endocrine
- I** Insulin
- O** Oxygenation
- U** Uremia
- T** Trauma, Toxicity, Temperature
- I** Infection
- P** Psych, Pharmacy, Perfusion
- S** Space Occupying lesion, Stroke, Seizure

# A is for Alcohol



## ALCOHOL



### HARMFUL EFFECTS

**BRAIN DAMAGE  
ADDICTION &  
STROKE**

**BLURRED  
VISION**

**SLURRED  
SPEECH**

**BLEEDING  
THROAT**

**BREATHING  
MAY STOP**

**HEART DISEASE  
IRREGULAR  
HEART BEAT**

**STOMACH  
ULCERS**

**LIVER DISEASE  
LIVER FAILURE**

**MUSCLE  
WEAKNESS**

**INTESTINAL  
CANCER**

**INTESTINAL  
ULCERS**

**IMPOTENCE (MEN)  
& INFERTILITY  
(WOMEN)**

**OSTEOPOROSIS**

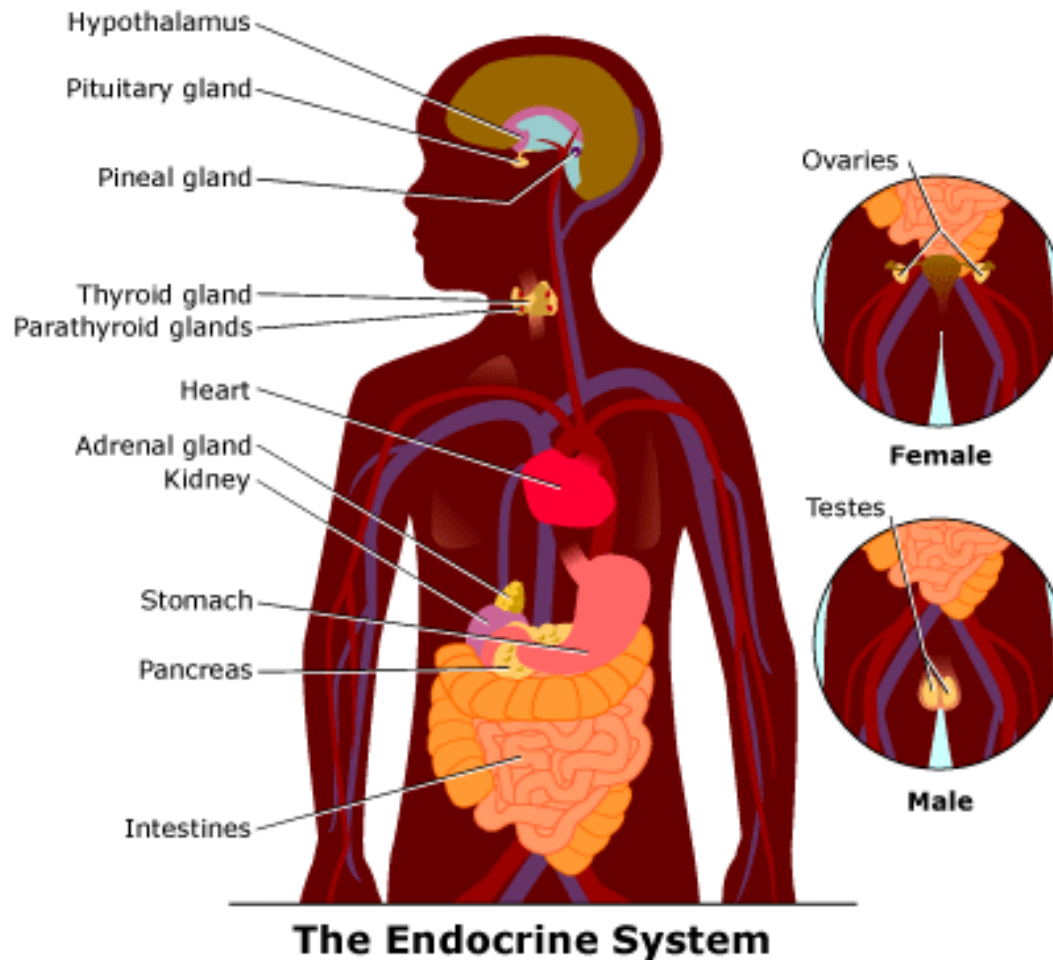


# E is for Electrolytes



Na <u>Sodium</u>	100%	Key regulator of water balance.
K <u>Potassium</u>	<10%	Associated with acid-base balance, promotes enzyme action for cellular metabolism.
Ca <u>Calcium</u>	100%	Integral role in clotting mechanism, and muscle physiology.
Mg <u>Magnesium</u>	<10%	Transmission and conduction of nerve impulses, responsible for transportation of Ca and K across cell walls via sodium-potassium pump.
HCO <sub>3</sub> <u>Bicarbonate</u>	100%	Carbonic acid/ Bicarbonate buffer systems.
SO <sub>4</sub> <u>Sulfate</u>	100%	Building block for sulfur amino acids
PO <sub>4</sub> <u>Phosphate</u>	100%	Phosphate buffer system.

# E is for Endocrine



# I is for Insulin

- Hypoglycemia
- Hyperglycemia
- DKA
- Hyper Osmolar (HHNK)
- Renal failure
- Chronic Changes to brain



# O is for Oxygenation

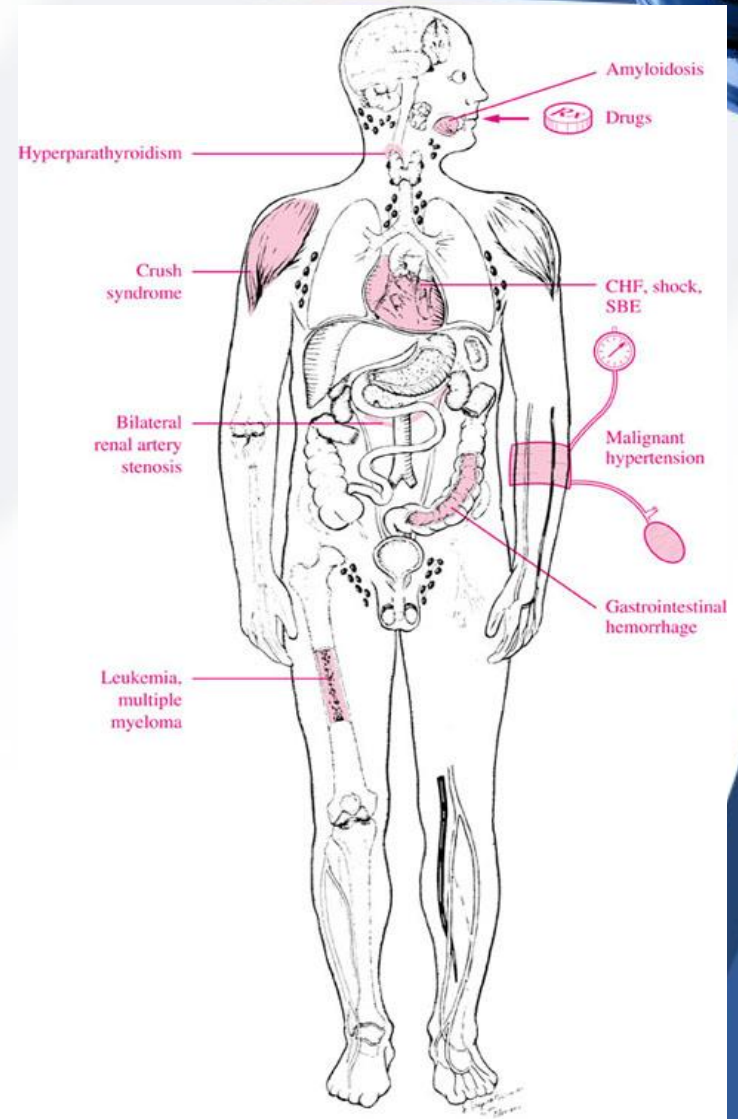
- Hypoxia
- Hyperventilation (Anxiety vs. Hypoxia)
- Respiratory Distress
  - Airway
  - Upper
  - Lower
  - Systemic



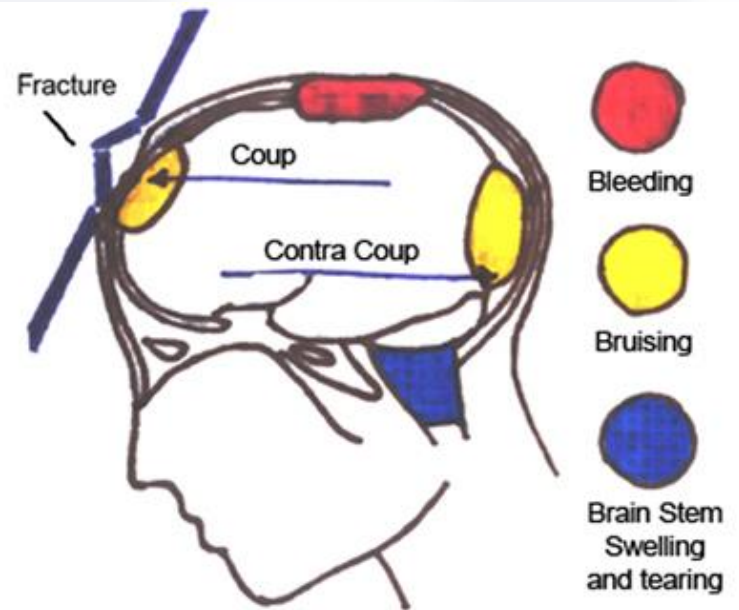


# U is for Uremia

- Kidney failure-toxins build up
- Encephalopathy
- Muscle weakness
- Mental status changes
- Seizures
- coma



# T is for Trauma



# T is for Toxicity (Poisoning)

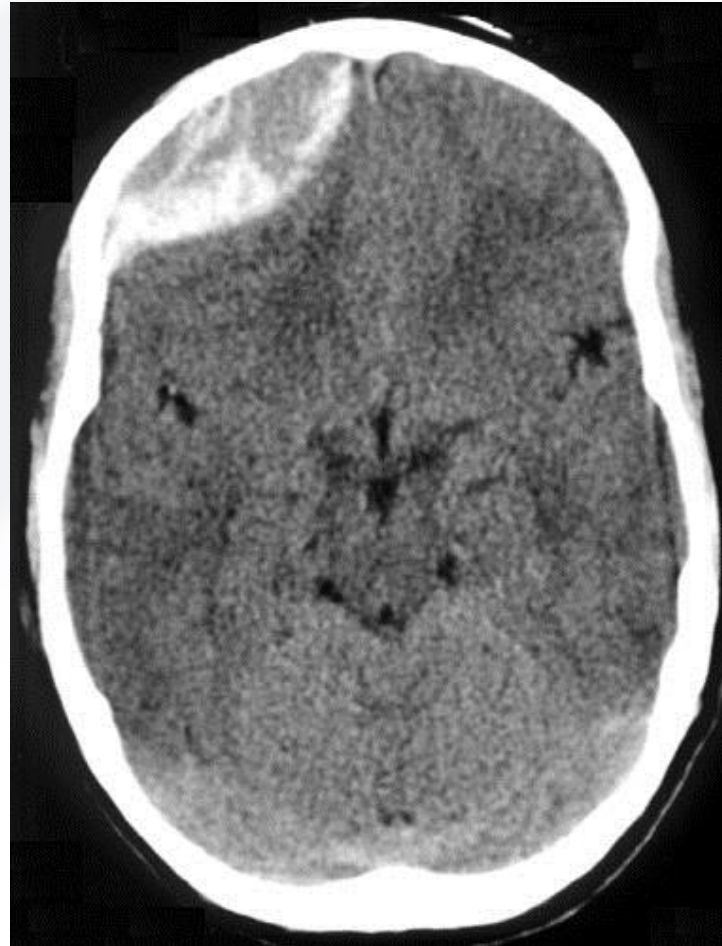


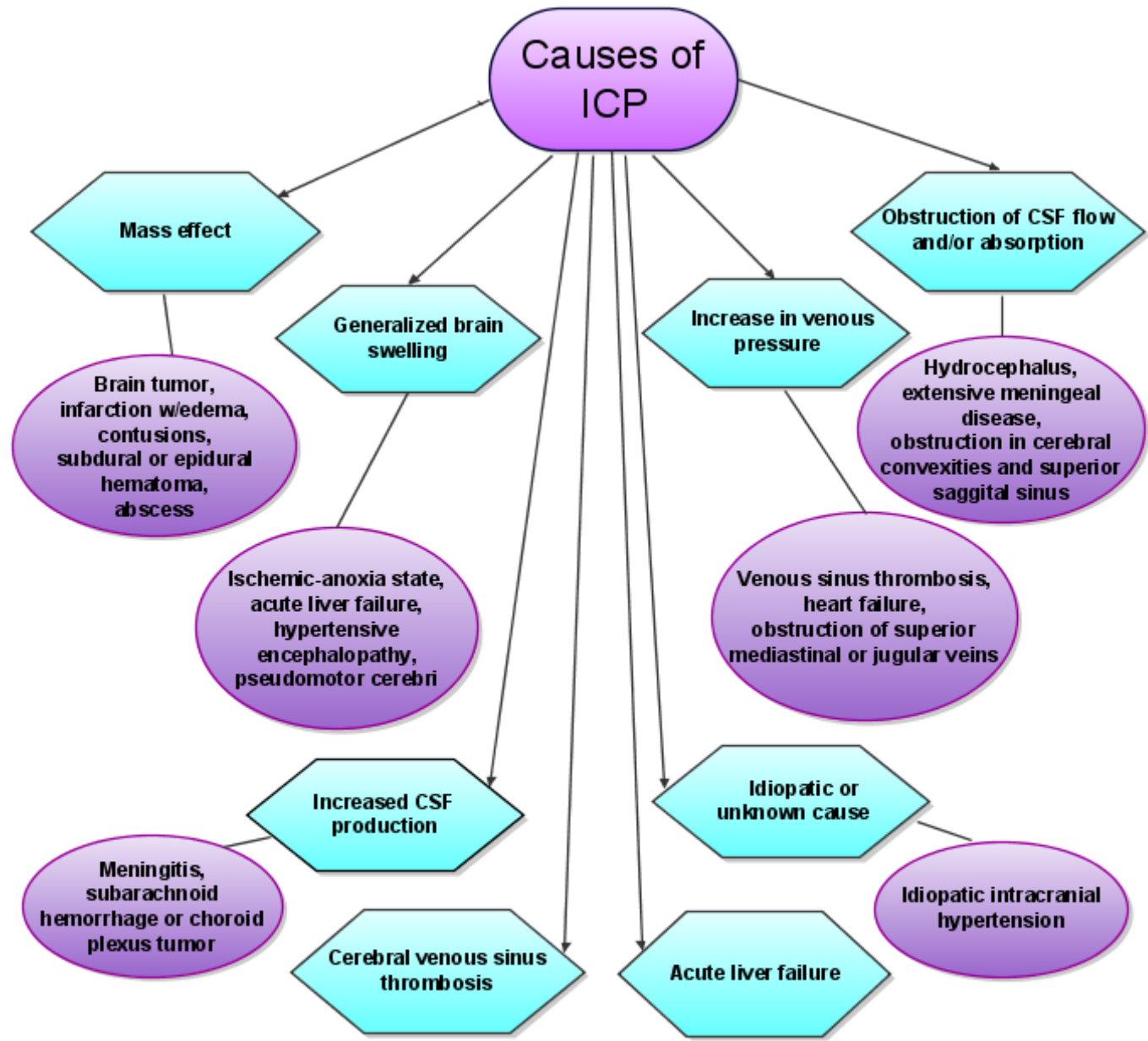
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# Intracranial Pressure

- Caused by
  - Tumor
  - Bleeding
  - Infection
  - Hydrocephalus
  - Swelling
  - Hyperosmolar
  - Seizures





# Causes of ICP

**Mass effect**

Brain tumor, infarction w/edema, contusions, subdural or epidural hematoma, abscess

**Generalized brain swelling**

Ischemic-anoxia state, acute liver failure, hypertensive encephalopathy, pseudomotor cerebri

**Increased CSF production**

Meningitis, subarachnoid hemorrhage or choroid plexus tumor

**Cerebral venous sinus thrombosis**

**Increase in venous pressure**

Venous sinus thrombosis, heart failure, obstruction of superior mediastinal or jugular veins

**Idiopathic or unknown cause**

Idiopathic intracranial hypertension

**Obstruction of CSF flow and/or absorption**

Hydrocephalus, extensive meningeal disease, obstruction in cerebral convexities and superior saggital sinus

**Acute liver failure**

# Temperature

- Fever
- Hyperthermia
- Hypothermia



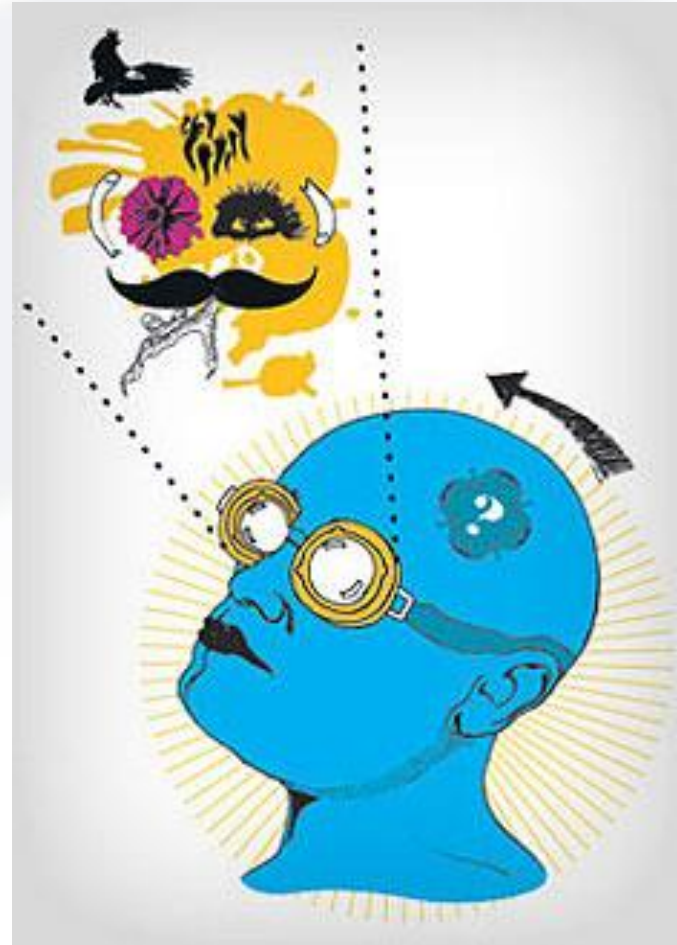
# I is for Infection

- Meningitis
- Encephalitis
- Brain Abscess



# P is for Psychiatric

- Acute psychosis
- Schizophrenia
- Bipolar
- Delirium
  - Hallucinations
  - Auditory
  - Delusional





# P is for Pharmaceuticals

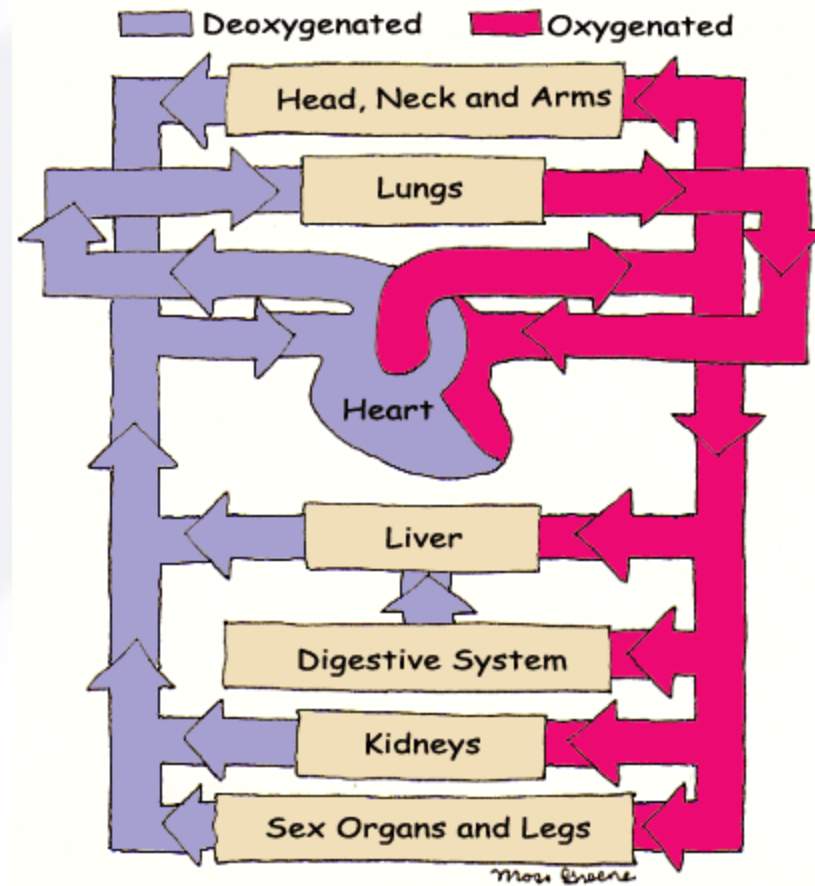


## Toxicity Focused Physical Exam Findings

Group	Vital Signs	Mental Status	Physical Exam
Stimulants	Hypertension, tachycardia, hyperthermia, tachypnea	Hyperalert, euphoria	Mydriasis, increased peristalsis, diaphoresis, tremor
Sedative-hypnotics	Hypotension, bradycardia, apnea	Stupor, coma, slurred speech	Decreased peristalsis, hyporeflexia
Sedative-hypnotic withdrawal	Hypertension, tachycardia, tachypnea, hyperthermia	Hyperalert, anxious	Mydriasis, increased peristalsis, diaphoresis, nausea, tremors, seizures
Opioids	Hypotension, bradycardia, apnea and shallow breathing, hypothermia	Stupor, lethargy, coma	Miosis, decreased peristalsis, hyporeflexia
Opioid withdrawal	Hypertension, tachycardia	Normal to agitated, but oriented	Mydriasis, increased peristalsis, diaphoresis, hyperactivity, nausea, vomiting, rhinorrhea, piloerection
Hallucinogenics	Hyperthermia, hypertension	Agitated but oriented, psychosis, panic	Mydriasis, synesthesias
Dissociative Agents	Hypertension, tachycardia, hyperthermia	Disorientation, lethargy, body image distortion, hallucinations, coma, depersonalization	Miosis, nystagmus, ataxia, vomiting

# P is for Perfusion

- Shock-state
- Hypovolemia
- Cardiogenic
- Distributive
  - Septis,
  - Neurogenic
  - Anaphylatic
- Obstructive



# S is for Space Occupying Lesion

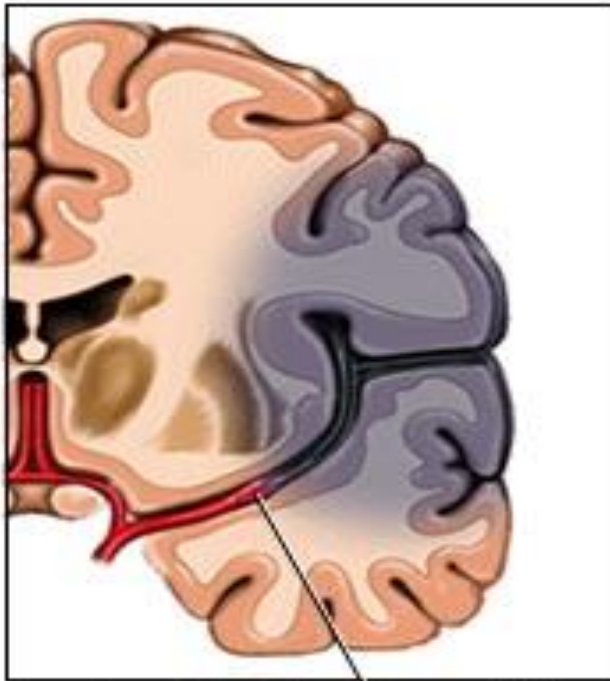


- Tumor
- Hemorrhagic
- Hydrocephalus
- Brain Swelling – brain injury

# S is for Stroke

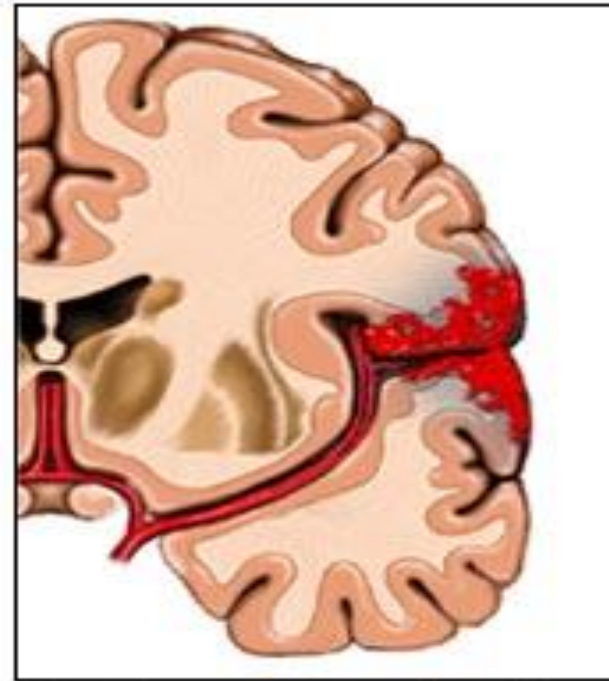


Ischemic stroke



A clot blocks blood flow to an area of the brain

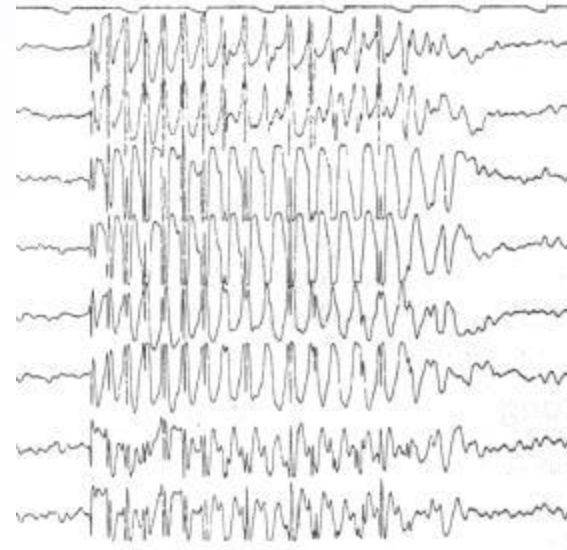
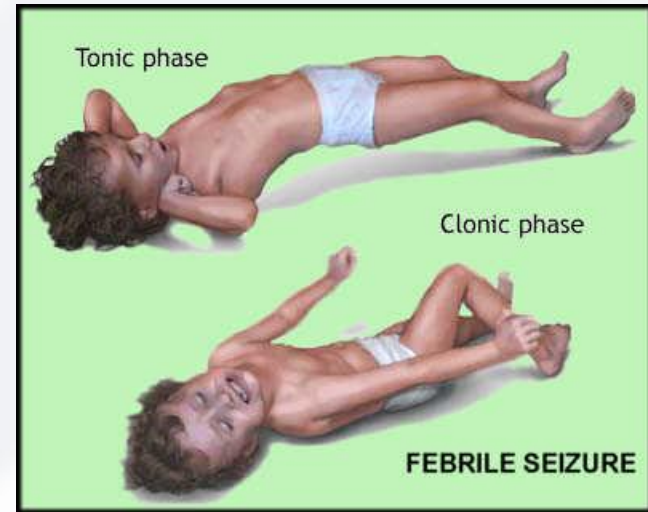
Hemorrhagic stroke



Bleeding occurs inside or around brain tissue

# S is for Seizures

- Generalized
- Tonic-Clonic
- Complex partial
- Absence
- Febrile

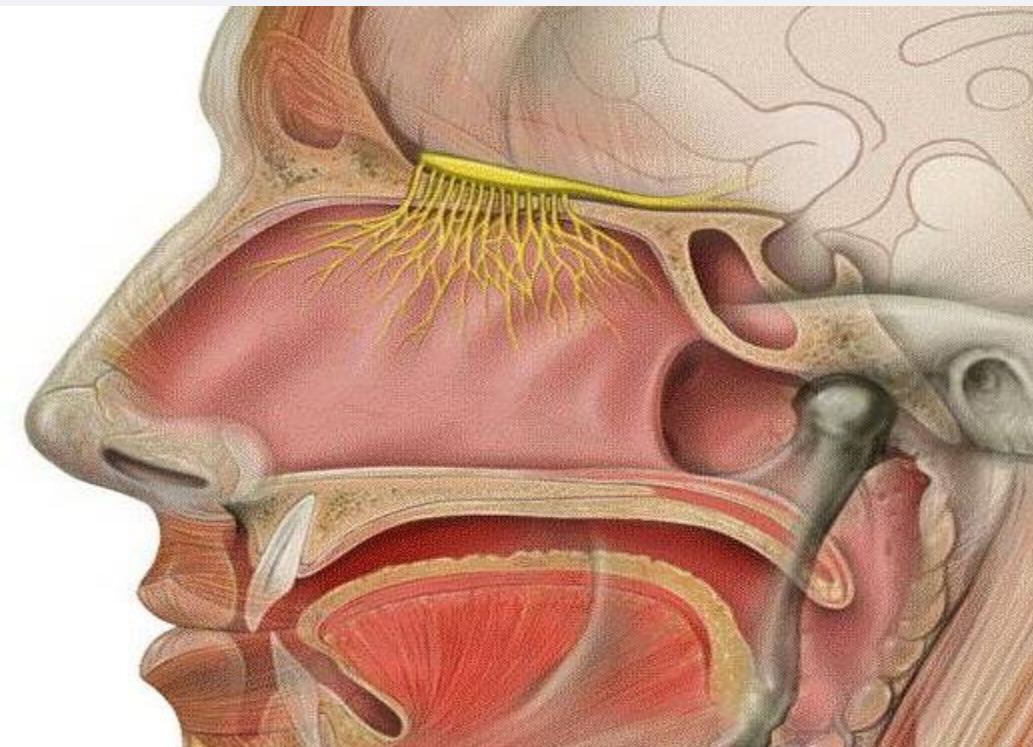


# The Neurological Examination

## Cranial Nerves



### Olfactory Nerve



# The Cranial Nerves

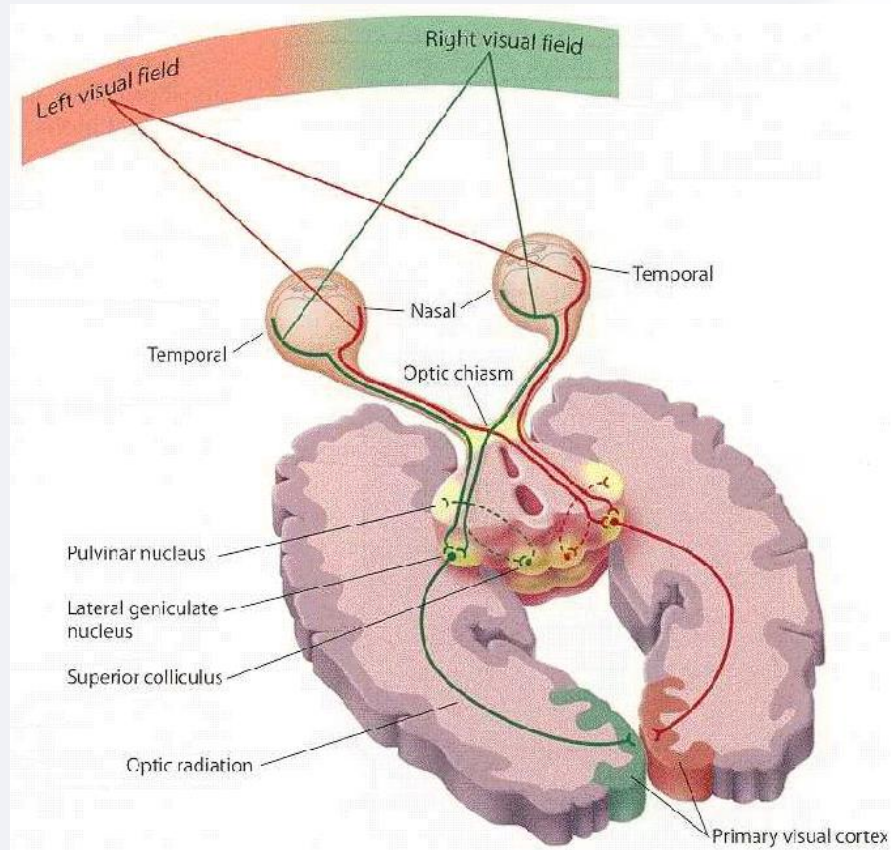


## Olfactory Nerve

- Distinguish Coffee from Cinnamon
- Smelling Salts irritate nasal mucosa and test V2 Trigeminal Sense
- Disorders of Smell result from closed head injuries

# Cranial Nerves

## Optic Nerve Cranial Nerve II





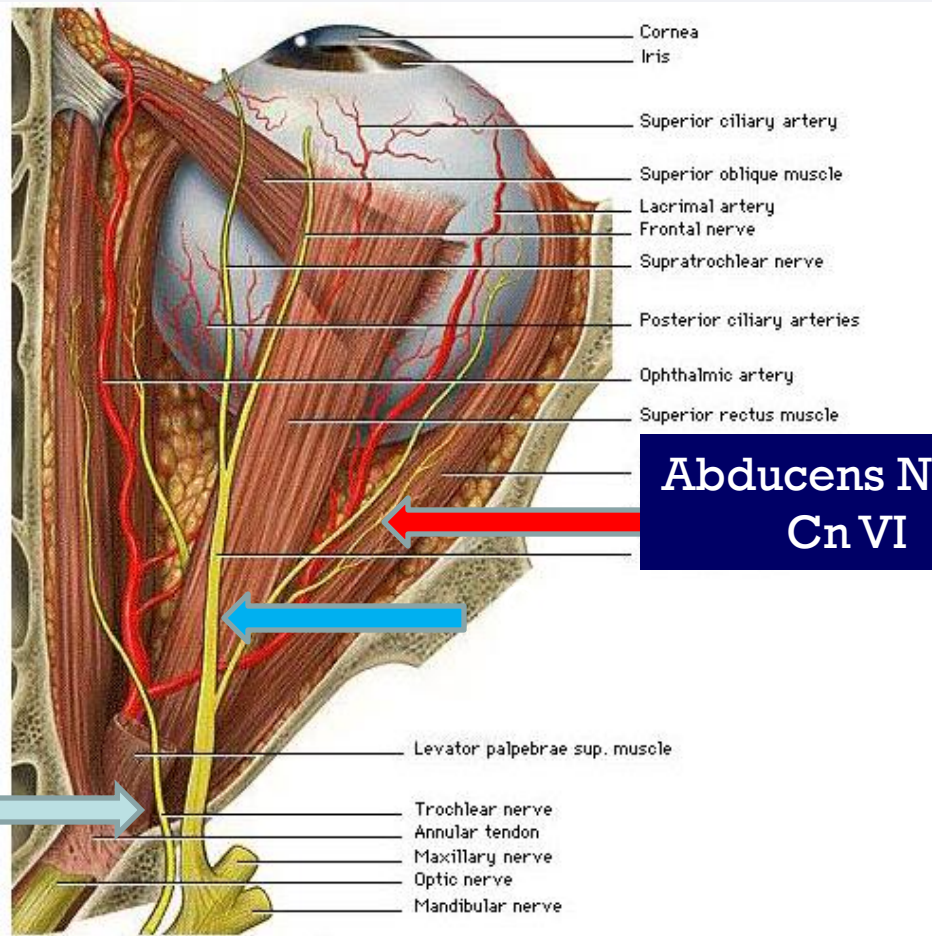
# Cranial Nerves



## Optic Nerve

- Visual Acuity
- Visual Fields
- Afferent input to Pupillary Light Reflex
  - APD
- Look at the Nerve (Fundoscopic Exam)

# Cranial Nerves



**Abducens Nerve  
Cn VI**

**Trochlear Nerve  
c.n. IV**

# Cranial Nerves

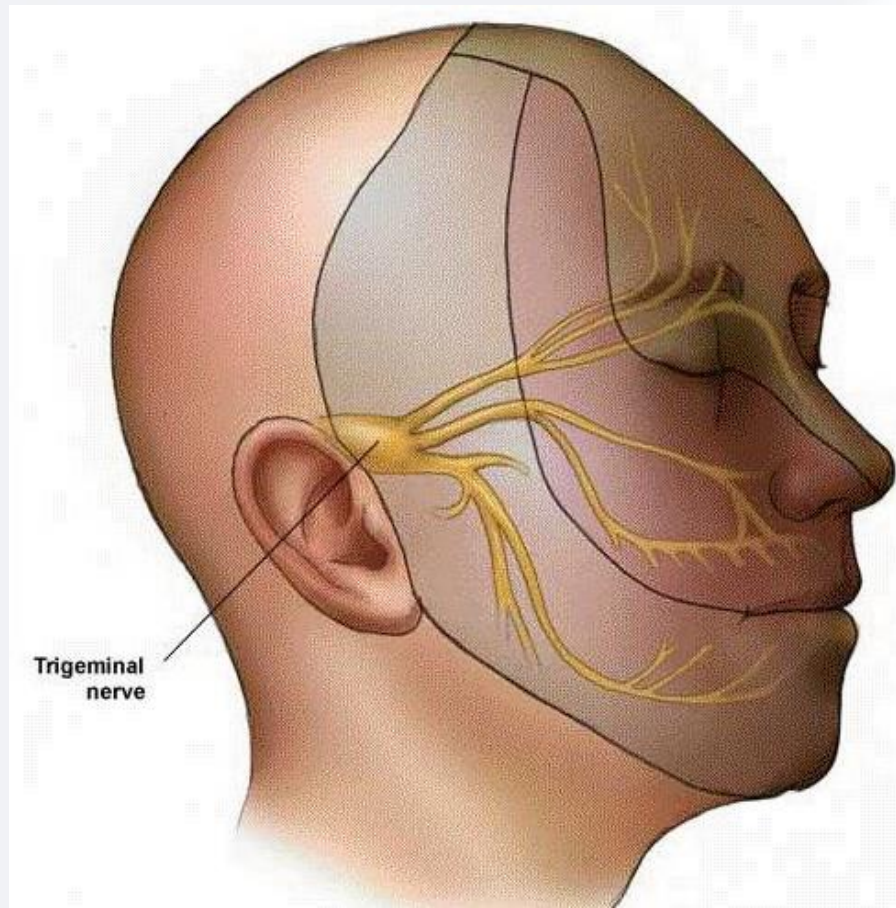
## Cranial Nerves III, IV, VI

- Extra-Ocular Muscles
- Efferent limb of pupillary light reflex (III)
- Ptosis
  - Oculomotor Nerve Palsy
  - Part of Horner's Syndrome
- Cardinal Directions of Gaze
- Efferent output for Oculocephalic Reflex
- Look for Nystagmus
  - “EOMI without nystagmus”



# Cranial Nerves

## Trigeminal Nerve C.N. V



# Cranial Nerves

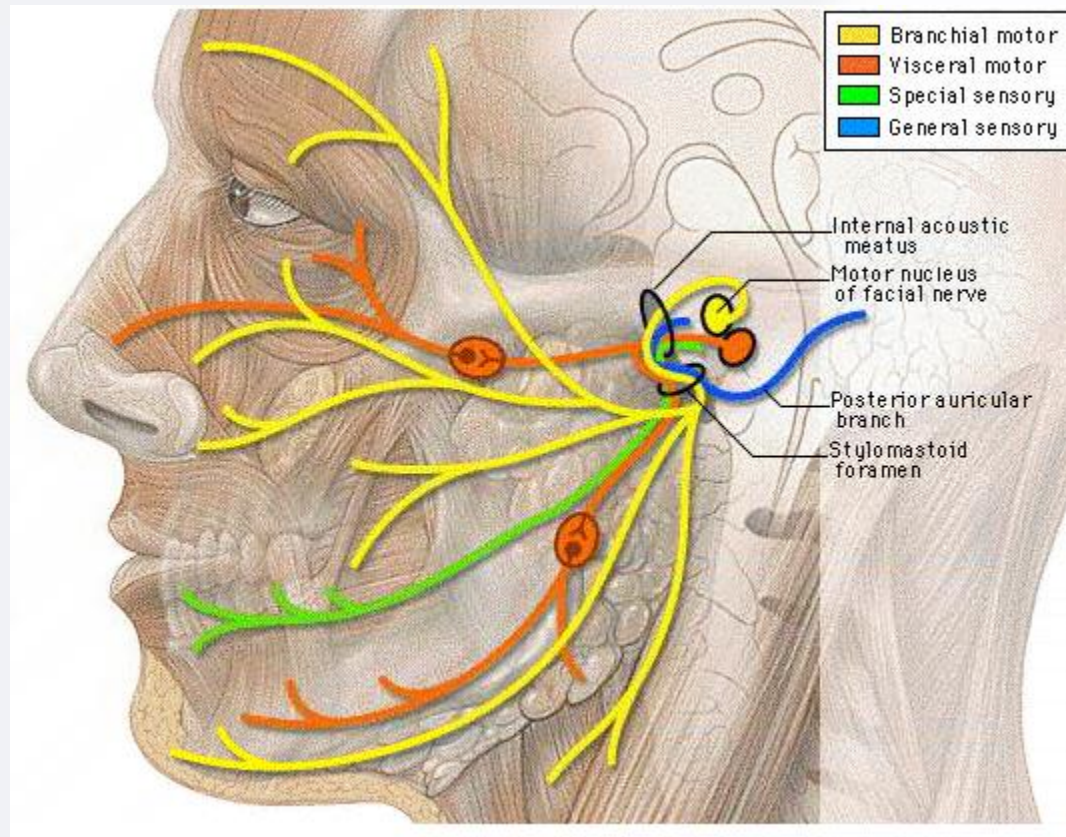


## Trigeminal Nerve

- Motor Component
- Ophthalmic (V1), Maxillary (V2), and Mandibular (V3) Distributions
- All modes of Primary Sensation Modalities can be tested
- Afferent input for the Corneal Blink Reflex  
“Facial sensation intact in all distributions”

# Cranial Nerves

## Facial Nerve C.N. VII



# Cranial Nerves

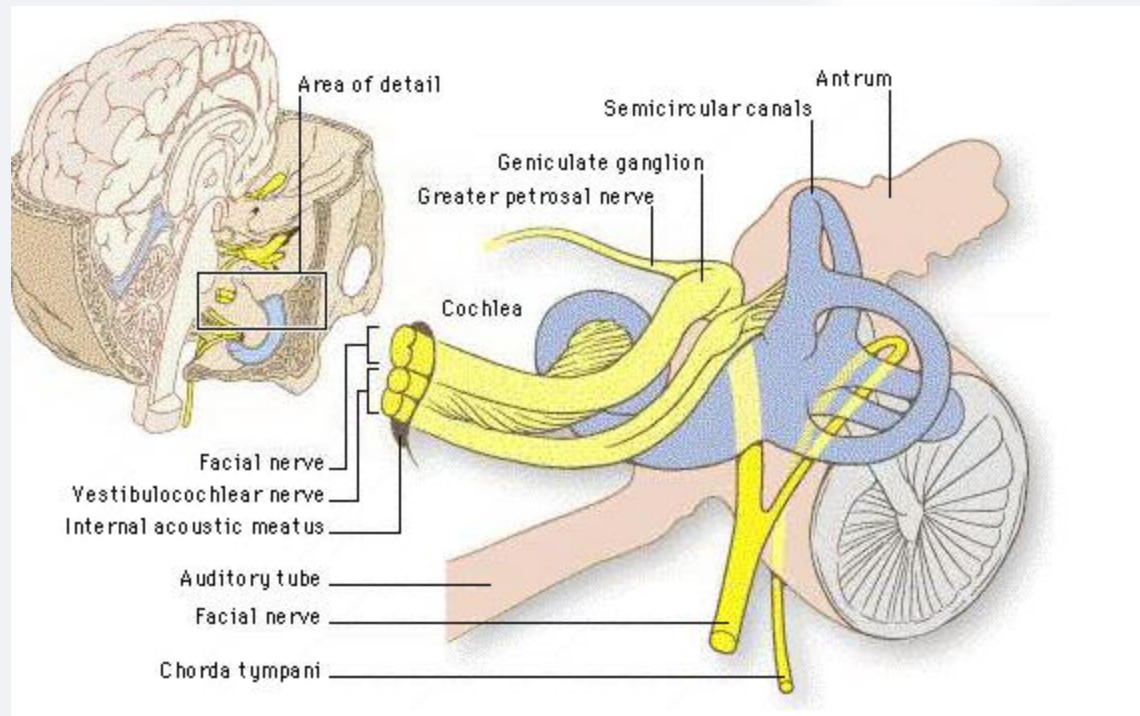


## Facial Nerve

- Motor innervation to facial muscles
  - UMN versus LMN Facial Weakness
  - Efferent output to Corneal Blink Reflex
  - Other Functions
    - Parasympathetic input to lacrimal, sublingual, and submandibular glands, taste to anterior 2/3 of tongue, general sensation to concha of earlobe and small part of scalp, motor input to stapedius muscle
- “Facial motor intact”

# Cranial Nerves

## Vestibulocochlear Nerve C.N. VIII





# Cranial Nerves



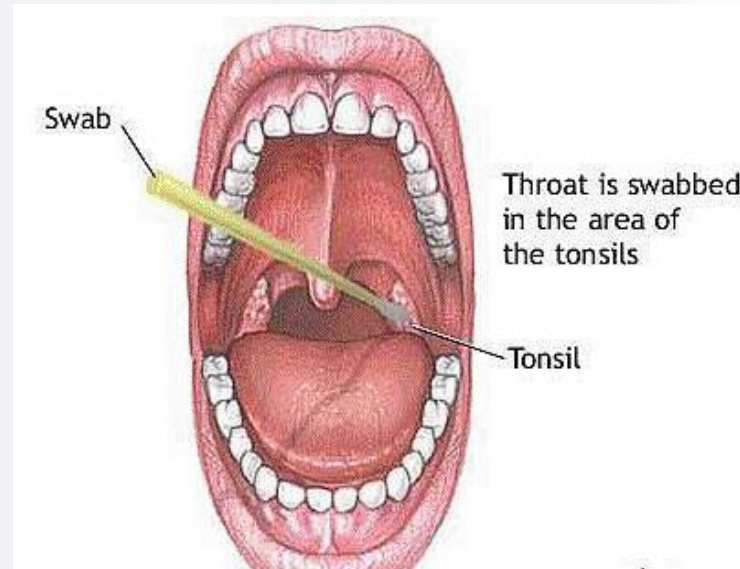
## Vestibulocochlear Nerve

- Hearing and Balance
  - Patients will complain of tinnitus, hearing loss, and/or vertigo
- Weber and Renee Test
  - Differentiates Conductive vs Sensorineural hearing loss
- Afferent input to the Oculocephalic Reflex
  - Doll's Eye Maneuver
  - Cold Calorics

# Cranial Nerves



## Glossopharyngeal and Vagus Nerves C.N. IX and X



# Cranial Nerves



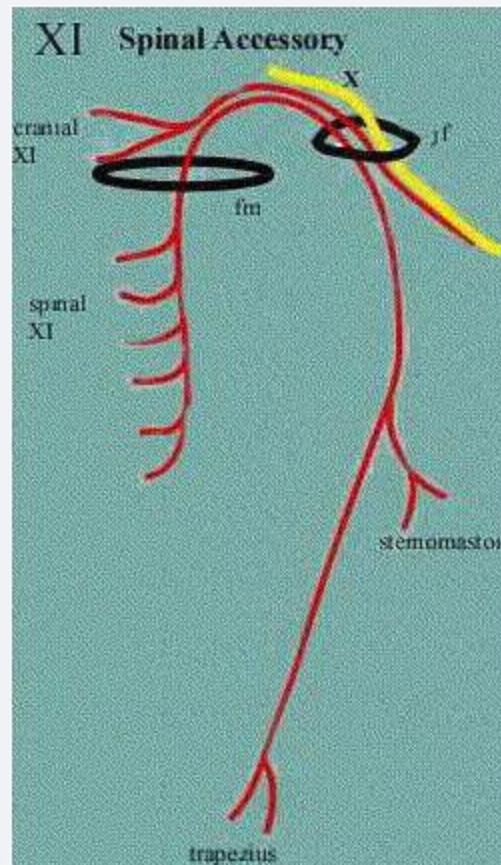
## Glossopharyngeal and Vagus Nerves

- Afferent (IX) and Efferent (X) components for the Gag Reflex
- Vagus Nerve also does all parasympathetics from the neck down until the mid-transverse colon

# Cranial Nerves

## Spinal Accessory Nerve C.N. XI

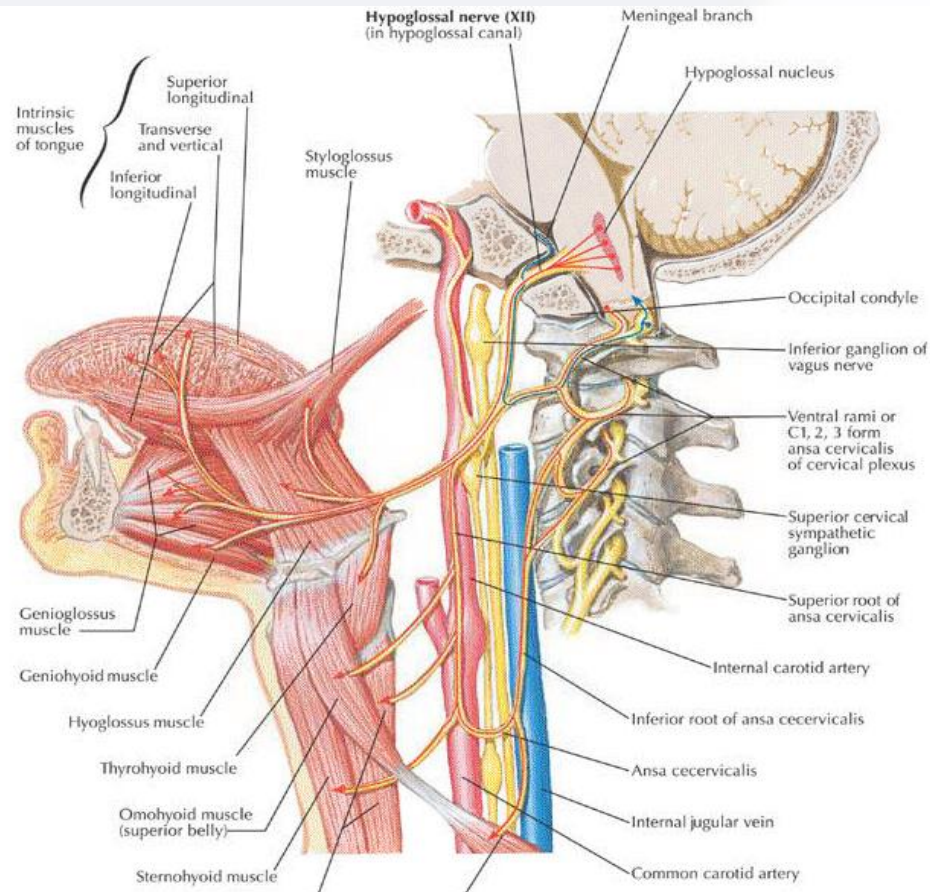
Sternocleido-  
Mastoid  
strength



Trapezius  
strength

# Cranial Nerves

## Hypoglossal Nerve C.N. XII



# Cranial Nerves



## Hypoglossal Nerve

- Protrudes the tongue to the opposite side
- Tongue in cheek (strength)
- Hemi-atrophy and fasciculations (LMN)

# The Motor Examination



- Strength
- Tone
- DTR's
- Plantar Responses
- Involuntary Movements

# Exam of the Motor System



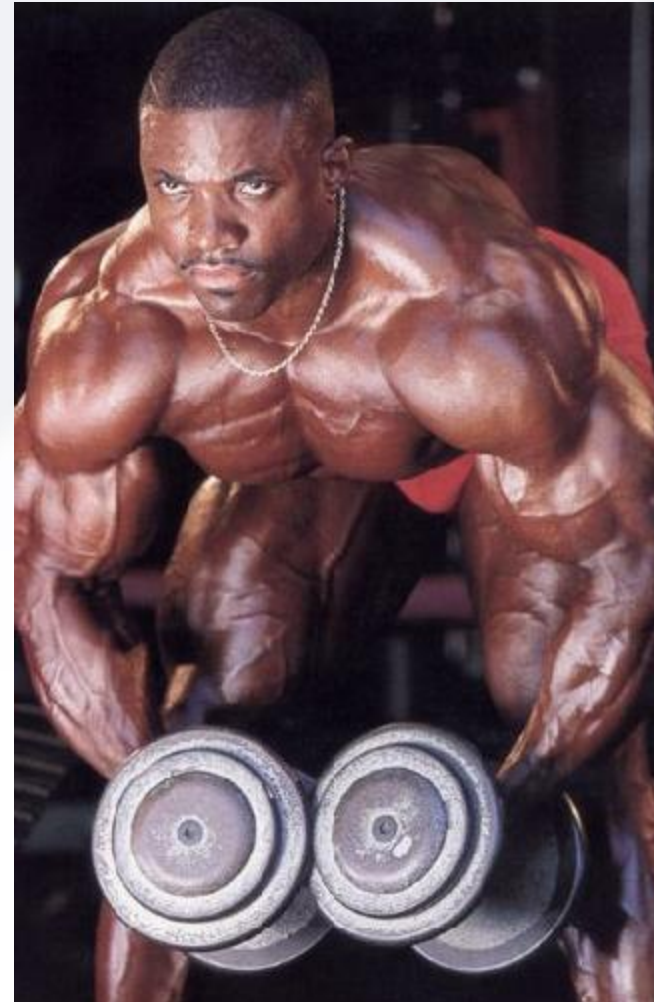
- Position, movement, muscle bulk and tone
  - Observe body position and involuntary movements such as tremors, tics, fasciculations
  - Inspect muscle bulk, note any atrophy
  - Assess muscle tone – flex and extend the arm and lower the leg for residual tension
  - Tics (sudden, rapid, non-rhythmic)



# The Motor Examination



Strength



# The Motor Examination



## Strength

### Medical Research Council Scale

- 5/5 = Full Strength
- 4/5 = Weakness with Resistance
- 3/5 = Can Overcome Gravity Only
- 2/5 = Can Move Limb without Gravity
- 1/5 = Can Activate Muscle without Moving Limb
- 0/5 = Cannot Activate Muscle

# The Motor Examination



## Weakness

- Describe the Distribution of Weakness
  - Upper Motor Neuron Pattern
  - Peripheral Neuropathy Pattern
  - Myopathic Pattern

# The Motor Examination



## Upper Motor Neuron

- Strength
  - Decreased
- Tone
  - increased spasticity
- DTR
  - increased or brisk
- Plantar reflexes
  - upgoing toes
- Atrophy/Fasiculations
  - None

## Lower Motor Neuron

- Strength
  - Decreased
- Tone
  - decreased hypotonia
- DTR
  - diminished or absent
- Plantar reflexes
  - downgoing toes
- Atrophy/Fasiculations
  - positive or negative

# Muscle Strength



- Test the following muscle groups and movements
  - Biceps and triceps – wrist flexion & extension
  - Handgrip, finger – abduction, adduction, thumb opposition
  - Trunk – flexion, extension, lateral bending
  - Thorax – expansion, diaphragmatic excursion during respiration
  - Hip – flexion, extension, abduction, adduction
  - Knee and ankle – flexion and extension

# The Motor Examination



## Tone

- Tone is the resistance appreciated when moving a limb passively
- “Normal Tone”
- Hypotonia
  - “Central Hypotonia”
  - “Peripheral Hypotonia”
- Increased Tone
  - Spasticity (Corticospinal Tract)
  - Rigidity (Basal Ganglia, Parkinson’s Disease)
  - Dystonia (Basal Ganglia)

# The Motor Examination



## DTR's

- 0/4 = Absent
- 1-2/4 = Normal Range
- 3/4 = Pathologically Brisk
- 4/4 = Clonus

# The Motor Examination



## Involuntary Movements

- Hyperkinetic Movements
  - Chorea
  - Athetosis
  - Tics
  - Myoclonus
- Bradykinetic Movements
  - Parkinsonism (Bradykinesia, Rigidity, Postural Instability, Resting Tremor)
  - Dystonia



# The Sensory Examination



## Primary Sensory Modalities

- Light Touch (Multiple Pathways)
- Pain/Temperature Sensation (Spinothalamic Tract)
- Vibration/Position Sensation (Posterior Columns)

## Cortical Sensory Modalities

- Stereognosis
- Graphesthesia
- Two-Point Discrimination
- Double Simultaneous Extinction

# The Sensory Examination



## Primary Sensory Modalities

- Reflect Input from sensory receptors, sensory nerves, spinal cord, brainstem, through to the level of the Thalamus.

## Cortical Sensory Modalities

- Reflect Processing by the Somatosensory Cortex (post-central gyrus)

# The Sensory Examination



## Pain and Temperature

- Small-unmyelinated fibers provide pain and temperature input which travels through the dorsal roots
- Second-order neurons cross midline at the anterior commissure and travel up the lateral spinothalamic tract

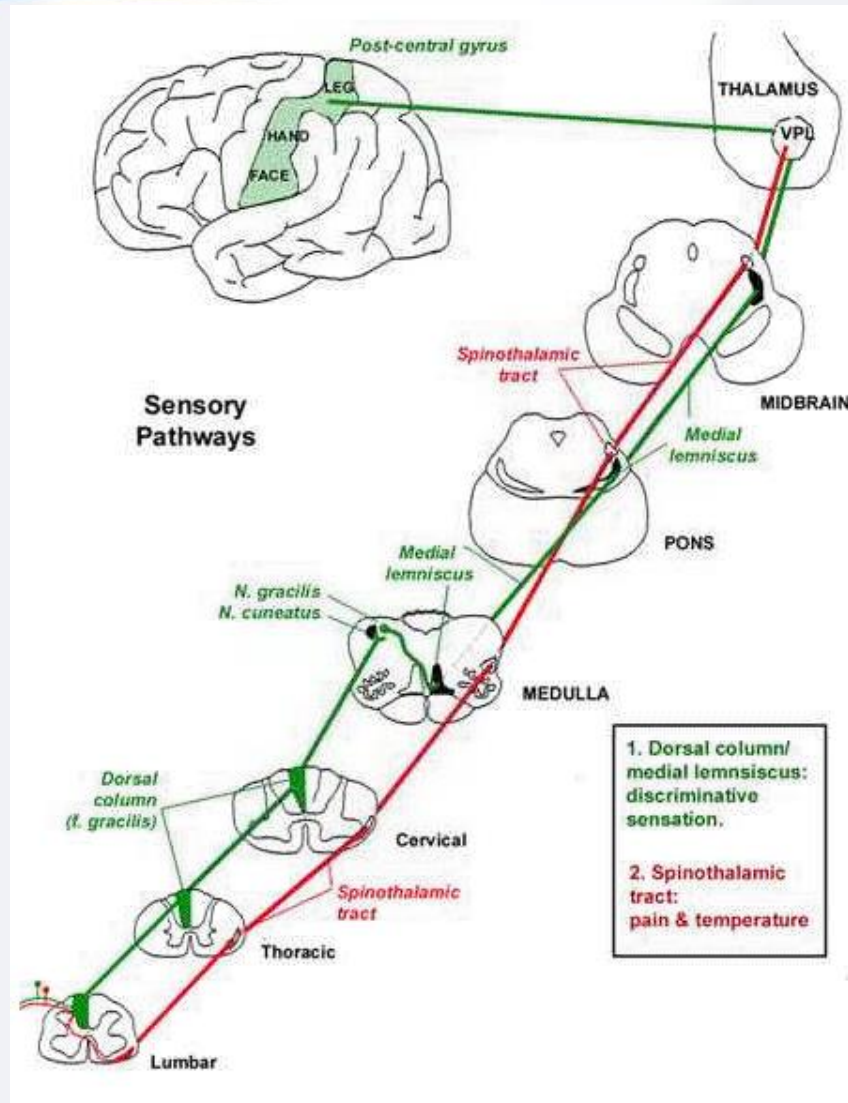
# The Sensory Examination



## Joint Position and Vibration

- Larger myelinated fibers bring sensory information concerning vibration and joint position
- Second-order neurons cross at the Thalamus

# The Sensory Examination



# The Sensory Examination



- Pain and Temperature
  - Pinprick (One pin per patient!)
  - Sensation of Cold
  - Look for Sensory Nerve or Dermatomal Distribution
- Vibration Sensation
  - C-128 Hz Tuning Fork (check great toe)
- Joint Position Sensation
  - Check great toe
  - Romberg Sign

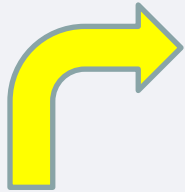
# The Sensory Examination



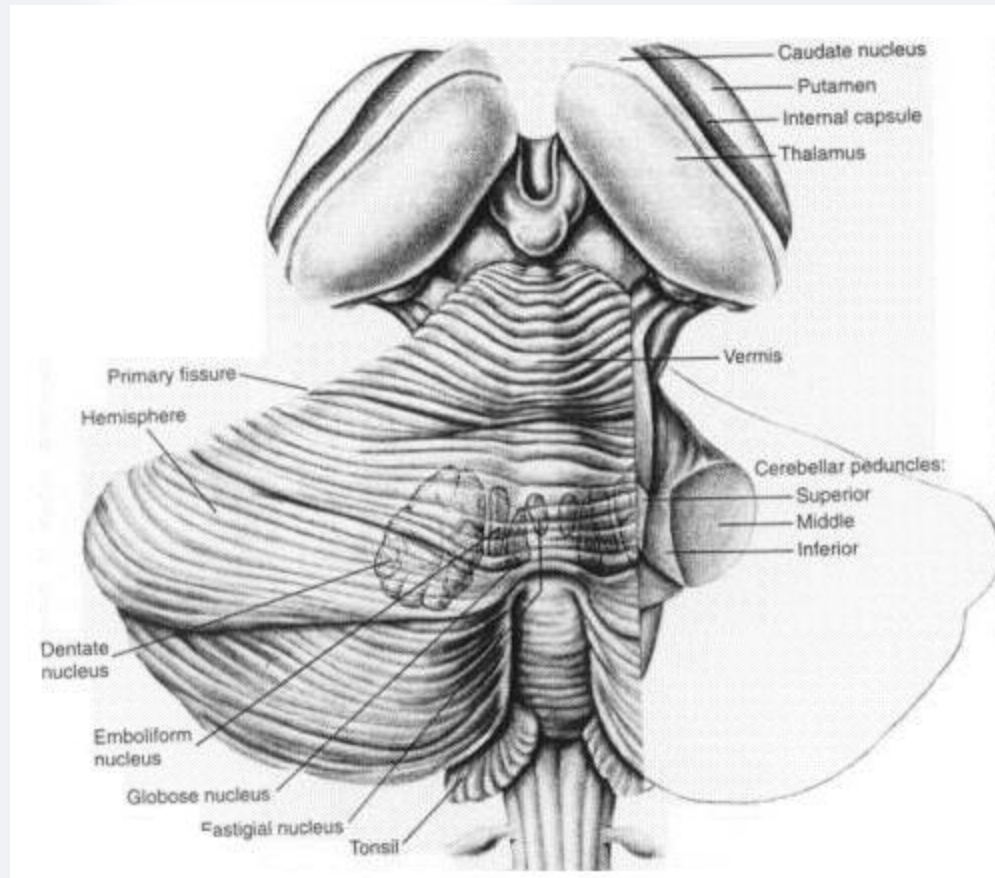
## Higher Cortical Sensory Function

- Graphesthesia
- Stereognosis
- Two-Point Discrimination
- Double Simultaneous Extinction
- Gerstmann's Syndrome (acalculia, right-left confusion, finger agnosia, agraphia)
  - Usually seen in Dominant Parietal Lobe lesions

# Coordination



Inputs



Outputs



## Cerebellum



# Coordination Examination



- Test coordination including
  - Rapid alternating movements
    - Repeating pronation supination palms
    - Tapping thumbs and fingers
    - Tapping ball of foot with fingers
  - Point-to-point movements
    - Touching face and nose
    - Moving heel down opposite leg



- Test coordination including
  - Gait – assess gait as patient
    - Walks across room
    - Walks heel-to-toe
    - Walks on toes and heels
    - Hops in place



- Test coordination including
  - Stance, namely
    - Rhomberg test
      - Patient stands with feet together and arms forward, eyes closed, for 30-60 seconds without support
      - Loss of balance with eyes closed is +
    - Pronator drift
      - Patient stands for 20-30 seconds with both arms forward, palms up, eyes closed, tap arms briskly downward
      - Pronation and downward drift is +

# Sensory Exam



- General Principles of Exam
  - Compare symmetric areas on both sides of the body
  - When testing pain, temperature, and touch, compare distal with proximal areas of extremities
  - Map out the boundaries of any area of sensory loss or hypersensitivity

# Sensory Exam



- Test pain using a disposable broken Q-tip or pin and discard after usage
  - Ask if the prick is sharp or dull or ask the patient to compare two sensations
- Test light touch using cotton wisp
- Test vibration with tuning fork
- Test proprioception – hold big toe by its sides between your thumb and index finger, pull it away from other toes, and move it up and down. Ask patient to identify the direction of movement.

# Sensory Exam



- Assess discriminating sensation to test the ability of the sensory cortex to analyze and interpret sensations
  - Stereogenesis – place a key or familiar object in patient's hand and ask patient to identify
  - Number identification (graphesthesia) – outline a large number in patient's palm and ask them to identify
  - Two-point discrimination – using two ends of an open paper clip, touch the finger pad in two places simultaneously and ask patient to identify 1 touch or 2



# Sensory Exam



- Assess discriminating sensation
  - Point location – lightly touch a point on the patient's skin and ask the patient to point to the spot
  - Extinction – touch and area on both sides of the body at the same time and ask if patient feels 1 spot or 2



# Deep Tendon Reflexes

- Select a properly weighted hammer
- Encourage the patient to relax, position the limbs properly and symmetrically
- Strike the tendon with a brisk direct movement using the minimum force needed to obtain a response
- Use reinforcement when needed
- Grade the response



# Reflex Grading



- + 4 Very brisk, hyperactive, with clonus (rhythmic oscillations between flexion and extension)
- + 3 Brisker than average; possibly, but not necessarily indicative of disease
- + 2 Average; normal
- + 1 Somewhat diminished; low normal
- 0 No response



# Deep Tendon Reflexes

Biceps



Triceps



Patellar



Patellar

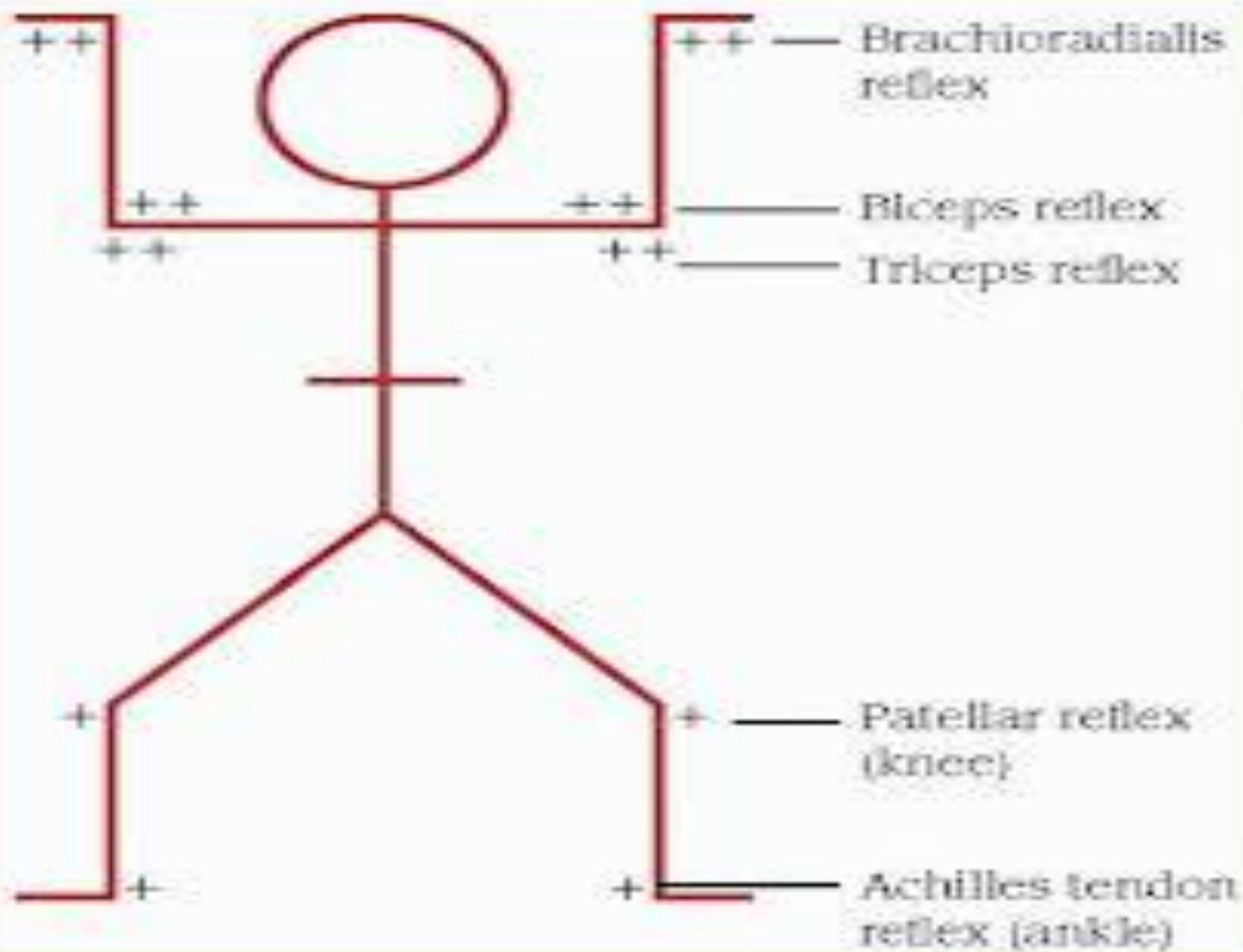


Achilles



Ankleclonus





# Deep Tendon Reflexes



- Biceps reflex C5-6
- Triceps reflex C6-7
- Brachioradialis or supinator C5-6
- Knee reflex L2-4
- Ankle reflex Mainly S1
- Clonus
  - A hyperactive response required for assigning a reflex grade of 4, usually elicited at the ankle

# Cutaneous Sensation Reflexes



- Abdominal reflex
  - Upper T8-10
  - Lower T10-12
- Plantar response – L5-S1
- Anal reflex – S2-4

# The Gait



- A normal Gait requires multiple levels of the neuroaxis to be intact
  - Vision
  - Strength
  - Balance/Coordination
  - Joint Position

# The Gait



## Observe Different Aspects of Gait

- Arm Swing
- Base of Gait
- Heel Strike
- Time Spent on Each Leg
- Posture of Trunk
- Toe Walking
- Heel Walking
- Tandem Walking



# The Gait



## Classical Patterns of Abnormal Gait

- Parkinsonism Gait
- Hemiparetic Gait
- Spastic Diplegia Gait
- Acute Ataxia Gait
- Chronic Ataxia Gait
- Waddling Gait (Hip Girdle Weakness)
- High Stepping Gait