LP

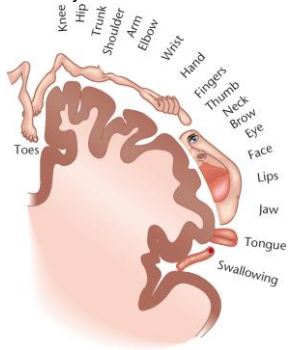
- Prior check coags, 2cc into each tube, angle 30 degrees to head targeting navel
- Layers: skin, subcutaneous tissue, supraspinous lig, interspinous lig, ligamentum flavum, epidural space (potential), dura mater, subdural space, arachnoid, subarachnoid space
- Check appearance and opening pressure
- Tube#1 Cell Count w/ Diff, Cytology, Protein, Glucose
- Tube#2 Gram Stain w/ Cx, Fungal Stain w/ Cx, AFB Stain w/ Cx
- Tube#3 Entero PCR, HSV PCR, VZV PCR, CMV PCR, EBV PCR, Arbovirus PCR, JC PCR, Crypto Ag, Histo Ag, VDRL, Fungal Immunofixation, etc
- Tube#4 Please Hold for further studies
- Order: remain recumbent for 4-6hrs
- Complications: HA, trauma to nerve roots, herniation, bleeding, meningitis

	Upper		Lower				
	Brain	Spinal	Root	Plexus	Nerve	NMJ	Muscle
Motor	Normal Mass Abnormal Movements (tremor, etc) Increased Tone Decreased Strength (regional)		Decreased Mass Abnormal Movements (fasciculations, etc) Decreased Tone Decreased Strength (segmental)				
Sensory	Variable		Variable			Normal	
Reflexes	Hyper (+Abnormal Reflexes)		Hypo			Normal	
Other		Bowel/Bladder/ Penile Problems	One -tome	Many -tomes		Fatigability	Proximal Symmetric

		Vessel	Structure/Function
Anterior Fossa (Carotid Circulation) (Pros-encephalon)	Cortex (Big Vessels) Thromboembolic Infacrts	ACA	Anterior Cerebral Artery Distribution (Tel-encephalon) • contralateral lower body sensory/motor deficits • Other: amnesia, abulia, urinary incontinence
		MCA	Middle Cerebral Artery Distribution (Tel-encephalon) • contralateral upper body / lower face sensory/motor deficits • L: aphasia + difficulty in reading/writing/calculating • R: anosognosia aka spatial neglect aka dysprosody (failure to be aware of objects, people, etc. (extrapersonal space) or take care of their own body (personal space) on the contralateral side of the lesion therefore usually left space, often have anosognosia (unaware that they have a problem), sometimes very obvious (pts don't look to the left side) or subtle (therefore require formal tests: (1) Object Copying Test (when you ask pt to copy and object pt only draws out the right side of the object), (2) Drawing a Clock Face Test (when you ash pt to draw a clock set to 9:45 pt squeezes all the numbers to the right side or has difficulty doing so), (3) Report Test (when you have pt call out 10 objects in room pt only locates objects in right part of room), (4) Personal Neglect Test (when you have pt comb hair, shave, or put on make-up pt only does so on the right side)) • Frontal: problems w/ executive fxn like complex cognition and problem solving (dorso lateral area), personality (medial lateral area), and comportment aka social behavior, insight/judgment, and impulse control (ventral lateral area) • Temporal: upper quadrant-anopsia • Parietal: lower quadrant-anopsia
		PCA	Posterior Cerebral Artery Distribution (Tel-encephalon) • Occipital: hemi-anopsia w/ macular sparing • Other: color anomia, visual agnosia, sometimes mild contralateral whole body sensory/motor deficits
	Subcortex (Small Vessel) Lacunar Infacrts	Lenticulo-Striates, et al	Internal Capsule (Di-encephalon) • contralateral entire body / lower face **motor** deficits
			Thalamus (Di-encephalon) integrates motor/sensory together • contralateral entire body / lower face **sensory** deficits • after recovery paradoxic pain "thalamic pain syndrome"
			Basal Ganglia (Di-encephalon) • contralateral difficulty starting **motor** actions

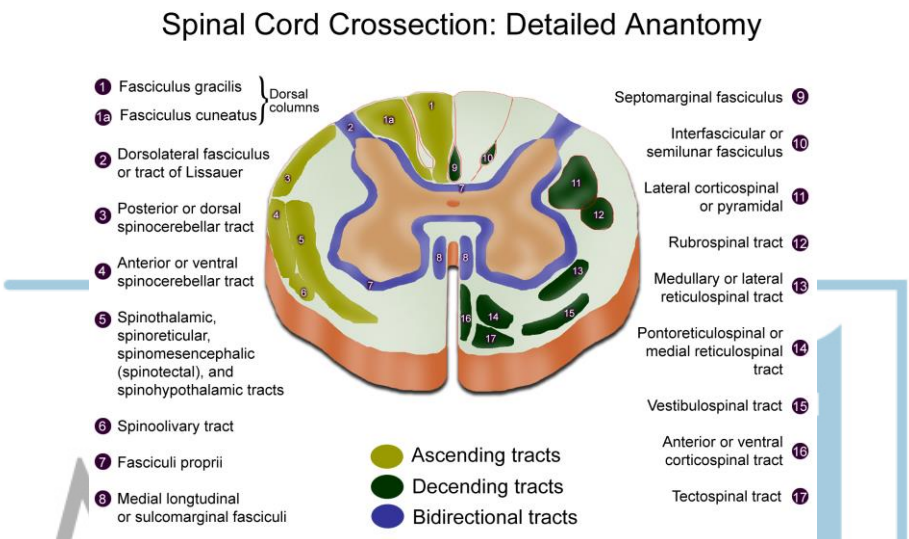
Posterior Fossa (Vertebral Circulation) (Rhomb-encephalon)	Cerebellum (Big Vessels) Thromboembolic Infacrts	PI/AICA (L) SCA (M)	Cerebellum (Met-encephalon) • clumsy hands • dysarthria, dysphagia • ataxia • dizziness, double vision, vertigo • nystagmus, disconjugate gaze
	Brainstem (Small Vessels) Lacunar Infacrts	PCA (L) Basilar (M)	Midbrain (Mes-encephalon) refer
		SCA (L) Basilar (M)	Pons (Met-encephalon) refer
		A/PICA (L) Ant Spinal (M) Vertebral (b/t)	Medulla (Myel-encephalon) refer

- CNS: Cortical Grey (cell bodies) → Cortical White b/c fatty myelin (axonal connecting fiber tract system)→ Subcortex Grey (Thalamus/Hypothalamus/Epithalamus aka Pineal Gland & Basal Ganglia) → Subcortex White (Internal Capsule) → Brainstem (Midbrain-Pons-Medulla) & Cerebellum → Spinal Cord
  - General
    - Telencephalon (Cerebrum, CN I), Diencephalon (Thalamus, Hypothalamus, CN II), Mesencephalon (Midbrain, CN III-IV), Metencephalon (Pons, Cerebellum, CN V-VII = "5,6,7,8 who do we appreciate the Pons, the Pons"), Myelencephalon (Medulla, CN VIII-XII)
    - NTs: + (Glutamate, Aspartate), - (GABA, Glycine), +/- (ACh, NE, Dopamine, Serotonin)
    - Neurons and Glia (astrocytes = maintain ionic/nutrient/NT environment, oligodendrocytes = maintain myelin, ependymal cells = line ventricles, choroid = make CSF)
  - **Cortex**
    - Frontal (human higher cognitive fxn) = weird syndromes
    - Temporal (limbic) = weird syndromes (collection of different structures forming the Papez Circuit that controls memory/behavior/emotion and includes frontal/temporal cortex, parts of thalamus, cingulated gyrus, hippocampus, amygdale, hypothalamus, etc)
    - Occipital (vision) = visual agnosia (visual perception is intact but there is no meaning to the pt like shapes or family member's face eg. Oliver Sack's *The Man Who Mistook his Wife for a Hat*)
    - Parietal (motor/sensory homunculus w/ auditory/speech) = below (NB motor is anterior and sensory is posterior)
      - L Hemisphere: speech is on dominant lobe which is opposite your dominant hand (95% of people are R hand dominant hence their dominant lobe is the L but even in the 5% of people who are L hand dominant their dominant lobe is still L!!!), aphasias (loss of language), distinguish from dysarthria, always check fluency (quality of words), repetition (repeat words), comprehension (understand command)
        - Aphasias: Broca's Area in Motor Cortex (Infarct = Expressive Aphasia = Can't Speak Fluently = Random Sounds) ← Arcuate Fasciculus (Infarct = Conduction Aphasia = Can't Repeat) ← Wernicke's Area in Sensory Cortex (Infarct = Receptive Aphasia = Can't Comprehend = Word Salad), NB there are rare combinations of different aphasias (eg. expressive + conductive)
      - R Hemisphere: spatial attention
        - Neglect: don't use/recognize L side of body, gaze preference to R side only, fail to draw symmetric objects like clocks



  - **Subcortex**
    - **Thalamus** (sensory/motor intermediate pathway to and from cortex)

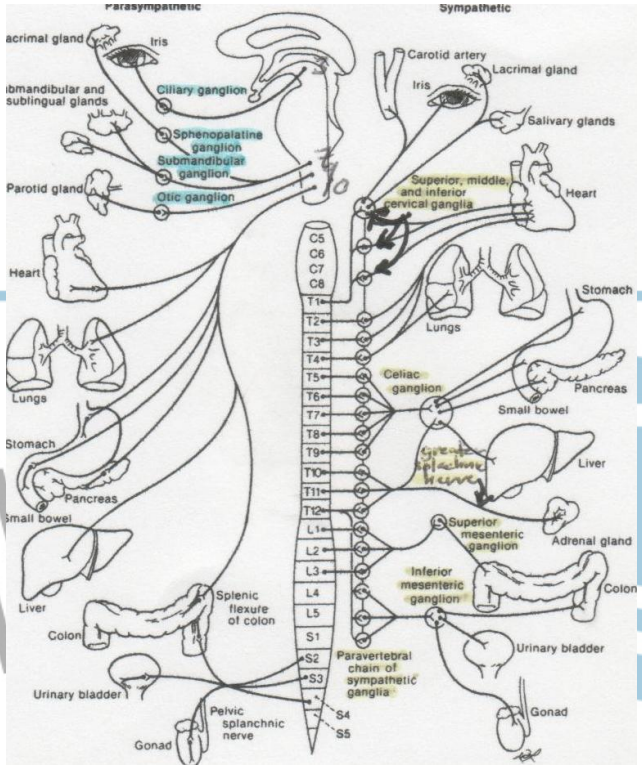
        - **Basal Ganglia** (motor intermediate pathway to and from cortex)
        - **Hypothalamus** (controls autonomic NS, temp/water/eating homeostasis, pituitary gland, circadian rhythm)
    - **Brainstem** (refer below)
    - **Cerebellum**: integrates sensory/motor input to control muscle tone + equilibrium + coordination
    - **Ventricles**: Lateral Ventricle → Foramen of Monro → 3rd Ventricle → Aqueduct of Sylvius → 4th Ventricle → Foramen of Luschka/Magendie → Subarachnoid Space →Arachnoid Villi → Sinuses → Veins (rate of 20cc/hr, 150cc total, obstructive/communicating/normal-pressure hydrocephalus, CSF made by choroid plexus cells that line all ventricles)
    - **Dura**: CNS → Pia (tightly attached to CNS space therefore no potential Subpia space) → Subarachnoid Space (CSF) → Arachnoid → Potential Subdural Space (traversed by bridging veins) → Dura → Potential Epidural Space (tranversed by meningeal arteries)
    - **Blood Supply**: Circle of Willis = Anterior ICA + Posterior VBA
    - **Spinal Cord**: core butterfly w/ ventral/dorsal horns grey matter surrounded by white matter, terminates @ L1-2



- PNS: Root → Plexus → Peripheral Nerve → NMJ → Muscle
    - General
        - Cells: Schwann Cells w/ Nodes of Ranvier (similar fxn to CNS Glial cells)
        - Motor/Efferent (Ventral Root from Anterior Grey Horn) & Sensory/Afferent (Dorsal Root Ganglion from Dorsal Root from Posterior Grey Horn) (similar to cortex)
    - **Motor**
        - Pre-Central Cortex → **Ventral/Lateral Corticospinal Tract** (pyramidal system vs extrapyramidal system where these fibers pass thru Basal Ganglia/Thalamus/Cerebellum) → Brainstem (90% of fibers decussate at medulla) → Spinal Cord (10% of fibers decussate at level of exit) → Muscle
    - **Sensory**
        - Post-Central Cortex ← **Dorsal Column Medial Lemniscus Tract** (thru Thalamus/Cerebellum) ← Brainstem (100% of fibers decussate at medulla) ← Spinal Cord ← Tactile/Vibration/Baroception/Proprioception (Pacini's, Meissner's, Spindle's, Golgi Tendon's)
        - Post-Central Cortex ← **Lateral Spinothalamic Tract** (thru Thalamus/Cerebellum) ← Brainstem ← Spinal Cord (100% of fibers decussate at 1-2 levels above entry) ← Nociception/Thermoception (free nerve endings)
    - **Autonomic**
        - Sympathetic Thoracolumbar: Motor (Short **ACh** Pre Nerves from Ventral Grey Horn pass thru Ventral Root and then innervate in Paravertebral Ganglia along spinal cord (to head/heart/lungs) OR pass thru and innervate in Prevertebral Celiac/Superior Mesenteric/Inferior Mesenteric Ganglia along aorta (to GI) with Long **NEpi** Post Nerves traveling w/ arteries) & Sensory (travel back the same way as motor but opposite direction) NB Adrenal is a modified Epi Post Nerve
            - $\alpha 1$: contract smooth muscle, mydriasis, stimulate secretions
            - $\beta 1$: ↑HR and ↑SV (determining systolic BP)
            - $\alpha 2$: feedback inhibition
            - $\beta 2$: relax smooth muscle, mobilize energy stores, renin, inhibit secretions
        - Parasympathetic Craniosacral: Motor (Long **ACh** Pre Nerves from Grey Matter of CNS and exit as CN3/7/9/10 (to Eye/Mouth/Mouth/Heart-Lungs-GI) or Grey Horn of S1/2/3/4 (to GI/GU) & Short **ACh** Post Nerves in target organ) & Sensory (travel back with CN9/10 & Splachnics) NB there are NO autonomic nerves coming from cervical section
            - CN III: iris (constriction) and ciliary muscle (bend lens)
            - CN VII: submandibular/sublingual glands (salivation)
            - CN IX: parotid glands (salivation)
            - CN X: thoracic/ab organs up to mid colon not including GU organs (refer below)

- S2-S4: distal colon (peristalsis)
- S2-S4: urinary bladder (contraction)
- S2-S4: genitals ("point")

- **Receptors**
  - **Somatic**
    - **End: Nicotinic**
  - **Autonomic**
    - **Ganglion: Nicotinic (ion channel)**
    - **End Sym: NE vs End Para Muscarinic (G protein)**
      - **M1,4,5 (CNS) vs 2 (heart) vs 3 (GI)**



1st Determine if pt is Alert & Aware

	Consciousness/Alertness (Test: GCS) Brainstem		
		Nl	Abnl (encephalopathy)
Cognition/ Awareness (Test: MMSE) Cerebrum	Nl	**Awake** **Locked In Syndrome** (pt is completely paralyzed aka all limbs and CNs but pt is perfectly alert and aware, NB sometimes pt can move one eye and blink, 2/2 infarct of bases of pons)	**Sleeping** **Lethargic** ↓ **Stuporous**
	Abnl	**Dementia** **Vegetative State** (this can move into (a) persistent if >1mo then to permanent if >3mo for non-trauma causes or >1yr for trauma causes or (b) minimally conscious then confused state then normal w/ or w/o persistent cognitive/motor deficits, pt is awake w/ sleep/wake cycles but not aware such that eyes/limbs move	**Confused** ↓ **Delirium** ↓ **Coma** (2/2 upper bihemispheric insult or lower reticulating activating system insult or metabolic insult affecting both, after this stage pts can (1) recover, (2) go into a vegetative state, or (3) develop brain dead, NB noxious stimuli cannot awake pt) NB to be called "coma" it must exist for >6/24/?hrs for structural problem/anoxia/trauma ↓ **Brain Death** (coma that has no brainstem reflexes, no reversible causes, and there

		but not purposefully aka tracking/withdrawal to pain)	is apnea, NB parts of the body can still be working like viscera aka heart/GI (not lung though) b/c they can work w/o neural input but the brain is dead, "body dead" is no heart beat but for legal purposes "legally dead" is equivalent to "brain dead") ↓ **Body Death** (entire body is not working)

- Brainstem Exam aka Consciousness/Alertness
  - **Ramsey Scale**
  - **Glasgow Coma Score aka GCS (MAX = 11 = E4V5M6, w/ coma and need for intubation if ≤8)**
    - Eye
      - no open = 1
      - open to pain = 2
      - open to voice = 3
      - open spontaneously = 4
    - Verbal
      - no sounds = 1
      - incomprehensible sounds = 2
      - inappropriate words = 3
      - appropriate but confused = 4
      - appropriate and aware = 5
    - Motor
      - no movement to nail bed pressure in all 4 extremities, sterna rub, supraorbital pressure, etc (lesion below pons) = 1
      - decerebrate posture aka extended U/LE (lesion below thalamus red nucleus but above pons) = 2
      - decorticate posture aka flexed UE and extended LE (lesion above thalamus red nucleus) = 3
      - withdraws to pain = 4
      - localizes to pain = 5
      - obeys commands = 6
      - NB observe for any spontaneous movements (purposeful vs non-purposeful)
  - **If low GCS then check Brainstem Reflexes, etc (1-4 midbrain, 5-8 pons, 9-12 medulla)**
    - Midbrain CN 1,2,3,4
      - Eye (fixed mid) (other causes: anoxia, hypothermia, drugs (Barbituates))
      - Reflexes: ?
      - Respiration: Cheyne-Stokes Breathing
      - Motor: Peduncles (contralateral entire body / contralateral entire face motor deficits)
    - Pons CN 5,6,7,8
      - Eye (fixed pinpoint) (other cause: drugs (Opiates, Sym-, ACh+))
      - Reflexes: Corneal Reflex (CN5/7) w/ cotton wisp drawn across cornea and if ipsi blinks then + direct response if both blink then + consensual response, Oculocephalic Test "Doll's Eyes" (CN6/8): briskly rotate head side-to-side, if nl brainstem the eyes will maintain a forward field of view and not move with the rotation, if abnl brainstem the eyes will move with the rotation, Oculovestibular Test aka "Calorics" (CN6/8): inject 120mL of ice cold saline over 2min into external auditory canal (clean of ear wax), normal pt's eyes will deviate toward tested ear otherwise abnormal, check other ear)
      - Respiration: Apneustic Breathing (inspiratory pausing)
      - Motor: ? (contra entire body / ipsi entire face motor deficits aka "crossed hemiplegia") therefore face crosses at pons proximal to body
      - Arousal
      - Autonomic
    - Medulla CN 9,10,11,12 "Lateral Medullary Syndrome" aka Wallenberg's Syndrome
      - Eye (fixed blown) (other causes: anoxia, hypothermia, drugs (ACh-, Sym+))
      - Reflexes: Gag Reflex (CN9/10) w/ Tongue Depressor to back of pharynx and Cough Reflex (CN9/10 aka Vagus) w/ ETT tube down trachea
      - Respiration: Ataxic Breathing (very irregular breathing)
      - Motor: Pyramids (ispilateral entire body)
      - Autonomic w/ Ipsilateral Horner's
      - Olives (?)
      - Nucleus Solitarious (CN 7,8,9,10,11) visceral sensory
      - Nucleus Ambiguus (CN 9,10) bulbar muscle
- Cerebrum Exam aka Cognition/Awareness
  - **CAM**
  - **Mini Mental Status Examination aka MMSE (MAX = 30)**
    - **Orientation**
      - Date (5)
      - Place (5)

        - Name (no #)
    - **Language**
        - Fluency: Observe Quality of Spontaneous Speech, Name Objects/Colors/People (2)
        - Repetition: “No Ifs, Ands, or Butts” (1)
        - Comprehension
            - Visual Comprehension of Written Command: “Close Your Eyes” (1)
            - Auditory Comprehension of Verbal Three Stage Command: “Take a piece a paper, fold it long ways and put it on the floor with your right hand” (3)
    - **Memory**
        - Immediate Memory which tests Registration: Recall 3 Objects Immediately After Given (3)
        - Recent Memory which tests Storage & Retrieval: Recall 3 Objects in 5 Minutes (3)
        - Remote Memory: Recall Past 5 Presidents, # of States in 1min w/ nl>20, # of Items in Grocery Store in 1min w/ nl>12, Significant personal/family history (no #)
    - **Attention**
        - Serial 7s, Make Change, Add 13+29, WORLD Backwards or in Alphabetical Order, 1A-2B-3C-…, Days in Week in Reverse (5)
    - **Integrative Function**
        - Integrating Motor & Sensory: Previously Learned Skilled Activity (Draw a Clock at 9:30, Copying a Square intersecting Pentagon or 3-D cube, Comb Hair, Dress, Walk, Graphesthesia where you Draw Number in Palm, Stereognosis where you Put object in palm) (2)
- **If low MMSE then check Cerebrum Reflexes** (there are none)

Differentiating Coma vs Brain Death

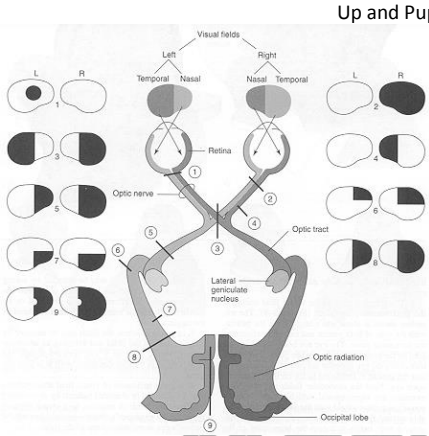
- **Step 1:** Reversible Metabolic Causes are Excluded w/ nl BP, nl Temp, Acid/Base balance, nl Glucose, nl Electrolyte, no Sedatives on Board, no illicit drugs, no Confounding Diseases eg GBS, cause of coma is known and sufficient to account for irreversibility
- **Step 2:** Negative Brainstem/Cerebrum Exam (above)
- **Step 3:** Loss of all Respiratory Drive w/ Apnea Test (an order set exists outlining what must be done before an apnea test and how to perform an apnea test)
    - Prerequisites Criteria
        - Inclusional: (1) suspected brain death is 2/2 to either: head trauma, CNS stroke, ABI, hepatic failure, hypoglycemia and (2) no brain stem reflexes and pt is comatose for >6hrs
        - Exclusional: (1) no severe electrolyte/pH/endocrine abnormalities, (2) no drug intoxication, (3) temp ≥32C/90F, (4) discontinuation of sedative/analgesics (>6hrs) and paralytics (>2/4 TOF)
    - Before you begin: temp≥36.5C/95F (b/c hypothermia slows metabolism and thus rise of CO2), SBP>90 w/ or w/o pressor support, check pre-ABG and PaCO2>40 and PaO2>90, place an art line
    - Perform Test: preoxygenate with 100% O2, adjust RR and TV to bring pCO2 to 40mmHg then separate pt from ventilator and deliver 100% O2 via canula into trachea to maintain oxygenation or use T-Bar, monitor BP/O2Sat/Respiratory Movements/Lethal Dysrhythmias, check ABG after at least 8min and reconnect the ventilator at prior settings
    - Negative Test (thus abort test b/f 8min): if Spontaneous Respiratory Movements, SBP<90, O2Sat<88%, or Lethal Dysrhythmias
    - Positive Test (if not aborted and the following…): pCO2 rises >20 or is >60, No Spontaneous Respiratory Movements, NB when pts are taken off ventilator and there is hypoxia they can have Lazarus’ Movements which are brief spontaneous movements 2/2 cervical spinal cord discharges in response to hypoxia
- **Step 4:** Confirmatory Test: loss of cerebral activity (EEG) and cerebral blood flow (transcranial doppler or technetium brain scan, NB cerebral angiography is the gold standard but never done b/c requires a transfer to radiology, etc) IN GENERAL DO NOT ORDER THESE TESTS JUST DO APNEA TEST B/C YOU CAN ACTUALLY HAVE FALSE NEGATIVES WITH THESE TESTS AS THESE TESTS DO NOT LOOK AT BRAINSTEM WELL

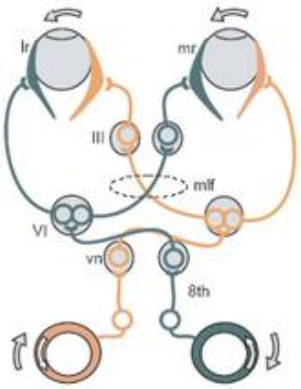
2nd If pt is Alert & Aware then move to neuro exam

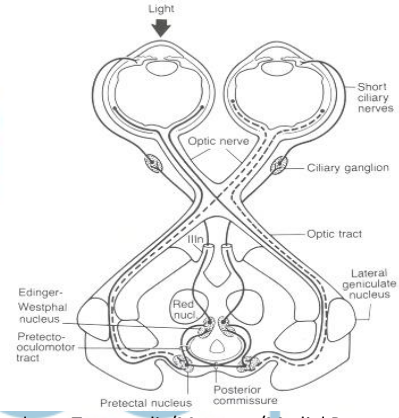
- Full Mental Status Examination aka Cerebrum Exam
    - Full Mental Status Eval = MMSE + General, Mood & Affect, Thinking Content & Process, Judgment & Insight
- Cranial Nerves aka Brainstem Exam
    - **CN1 (Olfactory):** check patency of each nostril and then with eyes closed and one nostril closed see if pt can recognize a familiar non-pungent odor (eg. cloves)
    - **CN2 (Optic):** OD/OS
        - Visual Acuity Test (20/20, Snellen Test at 20ft, if you can read a magazine at ~1ft distance then you have 20/20 b/c magazines are printed that way)
        - Fundoscopic Exam (fundus)
        - Color Testing (check accuracy and richness of color)
        - Visual Field Test (# of fingers holding up in all four quadrants and move them from periphery inward), (1) Left Central Scotoma, (2) Right Anopsia, (3) Bilateral Temporal Hemianopsia, (4) Right Nasal Hemianopsia, (5) Right Homonymous (nasal one side vs temporal other side) Hemianopsia, (6) Right Upper Quadrantic Anopsia (Left Temporal Lesion b/c affects inferior fibers), (7) Right Lower Quadrantic Anopsia (Left Parietal Lesion b/c affects

superior fibers), (8) Right Homonymous Hemianopsia, (9) Right Hemianopsia w/ Macular Sparing (sparing b/c macular fibers end at a watershed area b/c middle/posterior cerebral arteries and thus rarely infarcts)

- **CN3 (Oculomotor), CN4 (Trochlear), CN6 (Abducens) "STO-LAR"**
  - EOMI (conjugated vs stramisbus, w/o nystagmus)
    - 3rd Palsy (medial/superficial/inferior/inferior-oblique/levator/ parasympathetic) = ptosis/dilated+fixed/eyes down+out
    - 4th Palsy (superior-oblique) = eyes up+in (NB very vulnerable to trauma)
    - 6th Palsy (lateral) = eyes in
    - NB Deviation (eyes deviate towards cortical lesion and away from brainstem lesion)
    - NB Nystagmus: horizontal (peripheral dz) vs vertical (central dz or meds)
  - Conjugation: want to Look to the L → Stimulation of CN VI Nucleus → Contraction of L Lateral Rectus AND Stimulation of CN III Nucleus via MLF tract leading to Contraction of R Medial Rectus → L eye turns to the L AND R eye turns to the R
  - Pupillary Exam (shape, symmetric (vs anisocoria) size (nl 3-7mm) b/f and after light reaction (Direct and Consensual/Indirect) and near reaction (Accomodation))
    - Constriction: Light enters L eye → R Posterior Pretectal Nucleus → signal divides to R AND L Edinger-Westphal Nucleus → R AND L Ciliary Ganglion (Parasympathetic Nerves traveling w/ CN-3) → R AND L Pupils Constrict
    - Dilation: C9-T10 →Paravertebral Sympathetic Chain → Internal Carotid → Optic Nerve → Levator Up and Pupil Constrict







- **CN5 (Trigeminal):** sensation of face (V1, V2, V3) with pts eye's closed, palpate Temporalis/Masseter/Medial Pterygoid when biting down, corneal reflex (touch eye-lashes)
- **CN7 (Facial):** facial muscles (raise eyebrows, close eyes, smile, show teeth, frown, puff out cheeks), ant 2/3 taste, hyperacusis, "mi-mi-mi-mi" testing lips
- **CN8 (Vestibulocochlear):** Vestibular (dysequilibrium, vertigo, nystagmus) VS Cochlear (hearing loss, tinnitus, otoscopic exam then whisper a number b/t 1-100 in one ear soft enough that you can't even hear while rubbing fingers in the other ear, repeat on other ear)
  - Weber: Lateralizes to impaired ear if air conduction loss (b/c ambient noise is not there to wash out the sound of the tuning fork and thus the tuning fork is able to conduct thru bone without interference) vs Lateralizes to good ear if sensorineural loss (obviously) NB therefore if it lateralizes you don't know therefore you must always do Rhine Test
  - Rhine: BC≥AC (air conduction problem thus you can skip it by conducting through temporal bone) vs AC>BC (normal OR b/c normal air conduction is better than indirect temporal bone conduction if there was a sensorineural defect both would be diminished but air conduction would still be better than bone conduction)
- **CN9 (Glossopharyngeal):** post 1/3 taste, swallow, salivation, say "Ahh"
- **CN10 (Vagus):** mediates phonation/swallowing/elevates the palate/taste/viscera = gag reflex, post 1/3 taste, "kuh-kuh-kuh-kuh" testing palate, uvula deviates away from lesion, autonomic dysfxn
- **CN11 (Accessory):** have pt turn chin to shoulder then take 2 fingers and try to pull back against resistance and see how SCM/trapezius contracts (better than "No" "I Don't Know" against resistance) head turns toward lesion
- **CN12 (Hypoglossal):** protrude tongue and not any deviation (lesions result in deviation toward side of lesion aka "lick your wound") or atrophy, "la-la-la-la" testing tongue

- Motor
  - **Observation of Mass**: atrophy vs normal vs hypertrophy
  - **Inspections Movements**: involuntary/adventitious movements (refer)
  - **Tone**: check for resistance to passive movement by moving arms and legs in all directions while pt is relaxed (flexing and extending all three joints at once) flaccid/hypotonia (no resistance at all, seen in LMN dz) vs normal (slight resistance) vs spastic/hypertonic (high resistance, seen in UMN dz), also rigidity (unlike spasticity where the increased tone increases as you move the extremity in rigidity the increased tone is just constant, seen in BG lesions, cog-wheel = regular vs Gegenhalten = irregular)

- **Strength**: decreased strength is called *paresis* while complete absence of strength is called *plegia*, you can also check strength with drift (arms extended, hands up/supinated, eyes closed = no slow descent and no pronation) Pronator Drift: arms straight out, horizontal, with palms up, eyes closed and observe for (1) downward drift of arm and (2) pronation of forearm and if everything is alright tap arms briskly downward at forearm and see if arms return back to horizontal
    - 0/5 (no movement at all)
    - 1/5 (flicker of contractions)
    - 2/5 (movement perpendicular to gravity aka not against)
    - 3/5 (movement against gravity)
    - 4/5 (movement against gravity w/ minor resistance)
    - 5/5 (movement against gravity w/ major resistance)

- Reflexes (b/c a reflex involves a specific spinal segment an abnormal reflex can help locate a pathologic spinal cord lesion, Mechanism of Reflex Arc: Muscle Stretch → Ia Afferent Nerve → Spinal Cord → Stimulate Alpha Efferent Nerve → Muscle Contraction → Golgi Tendon Stretch → Ib Afferent Nerve → Spinal Cord → Inhibit Alpha Efferent Nerve = Everything in Balance (NB CNS via Gamma Efferent Nerves increases sensitivity of reflex arc)
    - **Normal Reflexes**
        - 0 /2 absent
        - 1/2 hypoactive (absent reflex improves distracting maneuvers like pulling hands apart for leg reflex or clinch teeth for arm reflexes)
        - 2/2 normal
        - 3/2 hyperactive
        - 4/2 clonus (continuous stretch produces continuous rhythmic contractions)
    - **Abnormal Reflexes** (upper motor neuron lesion, present normally as neonates but then are lost w/ pyramidal tract myelination, can be normal in the elderly)
        - Babinski Reflex: stroking lateral portion of sole from heel to base of 5th toe then across ball of foot to 1st toe elicits normally (aka Negative Babinski) flexion of 1st toe vs abnormally (aka Positive Babinski) extension of 1st toe and fanning of other toes
        - Wartenberg's Reflex: doctor uses his 2nd-4th fingers and pulls on the pt's 2nd – 4th fingers which elicits normally nothing vs abnormally adduction of thumb across palm
        - Hoffmann Reflex: flicking the middle finger elicits flexion and adduction of the thumb and flexion of the fingers (not a good reflex b/c not always pathologic)
        - Myerson Reflex: tell pt to keep eyes open while the examiner taps glabella, nl is brief blinking, abnl if persistent
        - Primitive Reflexes: Suck, Snout, Rooting, Grasp
- Sensation (for dermatomes picture a man with arms and legs split w/ up to down head (V1-3, C1-5), arms (C5-T1), torso (T1-T12, T4 = nipple, T10 = umbilicus), legs (L1-S2), groin (S2-S5), in general just touch pt w/ cold (spinothalamic) metal (spinocerebellar) stethoscope and ask if everything feels normal, once you check each sense you can then check secondary advanced coordinated sensation w/ two point discrimination, graphesthesia, etc)
    - **Spinothalamic**
        - Pain (cracked wood of Q-tip)
        - Temp (normal temp wooden tongue depressor vs cool temp metal tuning fork)
    - **Spinocerebellar**
        - Touch (Q-tip wisp)
        - Vibration (use 128Hz tuning fork, first do a fake test then actually hit it, start at distal joints if diminished proceed proximally until patient feels it)
        - Proprioception (move big toe and finger up and down and ask what pt feels when eyes closed)
- Cerebellar Exam (Ataxia = incoordination)
    - Romberg Test (arms down, stand feet together with eyes open for 20 sec and then eyes closed for 20 sec and observe for any swaying)
    - Dyssynergia (jerky vs smooth motor function)
    - Dysmetria (poor in judging distance as in finger to nose, heel to shin, etc)
    - Dysdiadochokinesia (poor rapid alternating movements as in patty cake, tapping finger, tapping foot against floor, tapping finger and thumb together, etc)
    - Poor Rebound (when the pt pulls against resistance and the resistance is suddenly released the pt is unable to stop output strength)
    - Intention Tremor
    - Dysarthria/Dysphagia
    - Nystagmus
    - Hypotonia
- Gait (incorporates every part of the exam above, observe for posture, balance, arm swing, leg movements, etc and pathology (broad based, shuffling, festinating, stooped posture, poor arm swing, etc) while walking naturally w/ head leading turns, heal to tow, on toes, on heels, on one leg)

	Dermatome	Myotome	Reflex
C1-4	Head	No True Motor Test	No True Reflex Text
C5	Shoulder	Shoulder Abduction	Bicep Reflex

C6	Thumb	Elbow Flexion	Brachioradialias Reflex
C7	Middle Finger	Elbow/Finger Extension	Tricep Reflex
C8	Pinky Finger	Finger Flexion	No True Reflex Text
T1-12	T4 = Nipple T10 = Umbilicus	No True Motor Test	No True Reflex Text
L1	Inguinal	Hip Flexion	Cremasteric Reflex (stroke skin of upper, inner aspect of thigh eliciting scrotum elevation)
L2	Lateral Thigh		
L3	Medial Thigh	Hip Adduction Knee Extension	Knee Reflex
L4	Medial Calf		
L5	Big Toe	Hip/Big Toe Extension	Plantar Reflex
S1/2	Small Toe	Knee Flexion	Ankle Reflex
S3/4/5	Genital/Anus	No True Motor Test	Anal Reflex (prick skin in perianal region resulting in contraction of external anal sphincter)